Markéta Dušková et al.

PLASTIC SURGERY

Textbook for Students of 3. FM CU

Univerzita Karlova v Praze,
3. Lékařská fakulta,
Klinika plastické chirurgie 3. LF a FNKV

2010

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Publisher: Univerzita Karlova v Praze, 3. lékařská fakulta, Klinika plastické chirurgie 3. LF a FNKV
Address 3. LF: Ruská 87, Praha 10, 100 00
1st edition, 2010
Print medium: CD
Price: not for sale

ISBN: 978-80-254-8781-5

Introduction

Markéta Dušková

Plastic surgery helps patients of all ages and types, improving the natural body or restoring a damaged or deformed body, whether for example it is a child with a birth defect, a young adult injured in an accident, or an older adult with a problem caused by different illnesses or even by aging.

Plastic Surgery in Ancient world and in Middle Ages

The Sushruta Samhita is a Sanskrit text on surgery, attributed to Sushruta, likely a physician of 6th century BCE in Varanasi, sometimes dubbed the "father of Surgery". Also the earliest known procedures of plastic surgery were described in this book, including a nose reconstruction, or rhinoplasty. The reason was high incidence of this problem, because amputation of nose was common practice in ancient India as a punishment. A method of rotated frontal flap and brilliance of approach was set on Sushruta's understanding of the function of skin blood supply (see fig. 1).

This approach was renewed and described in 1794 as the Indian Method (see fig. 2).

Fig. 1. Indian flap

A Greco-Roman tradition developed in the first century AD. Celsus described the advancement flap and a form of subcutaneous island flap in that time. In the Renaissance of the 15th century the Branca family in Sicily reapplied the Indian method to nasal reconstruction. They used the upper arm flap, a method later elaborated by Gasparo Tagliacozzi (1546-99) (see fig.3).

Fig. 2. Renewed Indian Method

Modern plastic surgery

The first half of the 19th century started the modern period of plastic surgery. Dieffenbach worked beyond the face on many reconstructive challenges. Von Langenbeck established new

principles of cleft lip and palate surgery. Dupuytren contributed by the pathology and correction of palmar fibromatosis and he made the classification of burns according to their skin depth. In 1804, Baronio published his experimental work on skin grafts in sheep. In 1817, Cooper performed the first successful human skin grafting. Further development of skin transplantation is mainly connected with names of Guyon, Warren, Reverdin, and Thiersch (1869).

Fig. 3 Upper arm flap

The two greatest advances in the history of surgery-anesthesia and asepsis-were brought further development during the 19th century.

Perhaps the most significant improvements in plastic surgical techniques however occurred in the 20. century. The World Wars had next important impact, connected with application of blood transfusion and antibiotics. So it was possible to operate even the condition, which had been not solved before.

In World War I, the maxillofacial wounds and the need of their repair reached unprecedented numbers. Morestin, Gillies, Kazanjan, Blair, Filatov, and Burian carried out the first distinguished steps in wound treatment and in reconstruction of these complex defects (see fig. 4-6).

Fig. 4a, 4b Patient of Harold Gillies with a facial defect

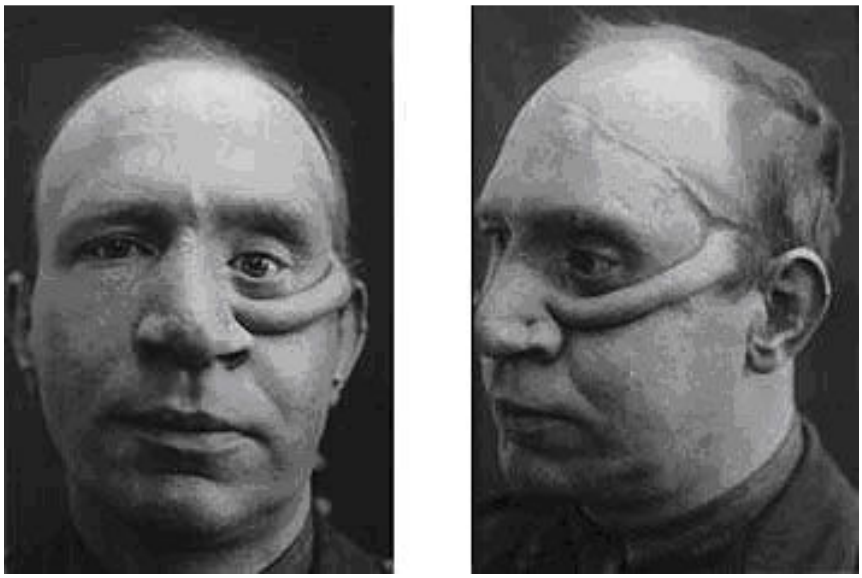


Fig. 5a, 5b Use of the tubed pedicled flap

Fig. 6a, 6b Post – operative result

(These figures become from the website where they are reproduced with permission from the Gillies Archive, Queen Mary's Hospital, Sidcup)

After World War I, the dispersion of plastic surgical knowledge had become notable for the shift of focus from post-traumatic deformities to more aesthetic concerns (Joseph, Aufricht), and further more for the beginning of postgraduate training in maxilofacial surgery (Gillies, Blair, Burian).

Technical innovations exploded current stage around 1970. They increased the capacity to correct major deformities. At first Tessier corrected severe craniofacial malformations. He introduced his concept of major one-stage movement of large blocks of the facial and cranial skeleton through wide exposure and extensive bone grafting with the idea to repair not only the function but also the appearance. Secondly Milton, Cherry, and others demonstrated that the arteries ascending from beneath the skin played the great role in flap survival. Thirdly

O'Brien and Buncke, developed the microsurgical technique to repair small vessels with diameter less than a millimeter. In 1962, Malt had reattached an amputated arm. In 1968 Komatsu and Tamai accomplished the first replantation of digit. Reconstruction of defect using the microsurgical transfer of tissue block came into the clinical application in 1972, connected with names Daniel, McClean and Buncke.
In the meantime, public demand was dramatically increasing for aesthetic surgery. The standard operations like rhytidoplasty, blepharoplasty, rhinoplasty, augmentation mammaplasty, and abdominoplasty underwent transformation and refinement. Beginning in the 1960s, bioinert silicones were adapted for several surgical applications (Cronin and Gerow). Later Illouz accomplished the aspiration of fat through hollow cannulas. In the 1990s, ultrasonic energy was incorporated into lipoplasty. Other technologies like endoscope and laser also came onto the stage improving the results, diminishing the risks, even shortening the recovery and costs.
The main aim of current plastic surgery is as ideal as possible function and shape. There fore the concern of contemporary clinical research is the tissue engineering, stem cells, fetal surgery, telemedicine, and robotics.

Concern of Plastic Surgery
The commonly used classification of plastic surgeries divides operations into the reconstructive ones and aesthetic procedures. However, the strict border does not exist. Both types have similar characteristics only each some is particularly more defined then the other.

A. Reconstructive surgery is performed on abnormal structures of the body, caused by birth defects, developmental abnormalities, injury, inflammation, degenerative processes, or tumors. Even the respective treatment of nosologic units mentioned above may be the motive. Generally, there is a disability function in the context of the external morphology disorder.
There fore the main aim is to improve function, but the surgeries may also be done to approximate a normal appearance.
There are two basic categories of patients: those who have congenital malformations, otherwise known as birth defects, and those with acquired deformities, as a result of accident or disease.

B. Esthetic surgery is performed to reshape normal but unwanted structures of the face or body to improve the patient's appearance, self-esteem, and quality of life. Thus it must respect the needs and aesthetic feeling of involved individual.

The surgical interventions of plastic surgery may be divided also by the different manner for example according the indication with regard to emergency and imperativeness of operation. We distinguish three main types: life-threatening problem, limb-threatening problem, and contour or functional disorders. However this classification is less frequent.

Generally, regardless of etiology, location, or type of the defect, its solution must be based on perfectly established diagnosis. Detailed analysis of the defect and the requirements for repair

or reconstruction must meet the specific needs of the individual patient. Therefore, frequently, the optimal treatment requires a multidisciplinary approach.

The issue of reconstructive cases is most frequently a defect of tissues and /or failure of function. Defect's size, severity and features including patient's condition and characteristics must be assessed carefully. Finally according to this evaluation one can choose suitable technique to restore particular defect.

1. Direct closure of the wound with the tissue advancement is suitable for minor lack of tissue. The advantage is the simplicity of the procedure and a low burden, a good functional and aesthetic effect; disadvantage is the certain limit of shift done by physical and biological characteristics of the defect surroundings.
2. If the defect bed is well nourished and capable to produce neocapillary network for graft supply, it is possible to use a tissue transplant. Healthy tissue (most common is skin graft) is harvested from one part of the body (this is called a donor site) and it is used as substitute in a defect where the similar tissue is badly damaged or completely missing (a recipient site). The advantage is the simplicity of the procedure and a low burden, acceptable functional and aesthetic effect; the disadvantage is dependence on neovascularisation and subsequent less resistence of reconstructed site to the stress.
3. The flaps bring larger volume of tissue and own vascularisation to the site of defect. This is the healthy tissue, which is transferred from one body part to another. Its own vascular, possible also nervous, supply is called the pedicle. It either remains connected with blood vessel in the place of harvest and flap is rotated into the site of application, or using special microsurgical technique the flap is transferred and the pedicle is connected to recipient blood vessels close to the defect. Flaps can restore form and function in a site, where is a lack of the skin, subcutaneous tissue, muscle and / or bone. The advantage is very functional and aesthetic effect, improvement of the vascularisation at the site of the original defect and the subsequent good resistance to stress; disadvantage is the higher demand of the surgical procedure and higher burden for the patient.

The unwanted shape or contour is the most frequent issue of aesthetic operations. Its solution consists mostly in the translocation, reposition, remodeling, and redistribution of own tissues. It is also possible to remove excess skin, muscle and fat (such as the correction of aging face), to tighten lax muscles and fascia (eg abdominoplasty), or to change completely the shape and size of certain parts of the body (i.e. rhinoplasty, mammaplasty).

Risks and complications in plastic surgery

It is necessary to point out; there exist a lot of mythic too positive ideas about the easy post-op course and no complications in plastic surgery. But as other surgeries the procedures of plastic surgery present certain risks. They may appear local complications like extensive bleeding, long lasting seroma, the wound infection, tissue necrosis, and nerve damage with numbness or hyperestesia, which may fade after time but which may also be permanent. Also general complications like tromboembolism, allergy, unwanted reaction to the anesthesia or treatment like brain damage, strokes or paralysis, and even death may happen.

During postoperative course the natural sequels like edema and bruises are common. The scars will bleach in time, but they cannot disappear completely and exist forever. Plastic surgery is connected with adjusting the skin and tissues in various manners. Resulting marks can be in appearance of body surface like dimples, irregularities, puckers and asymmetry.
Also cosmetic operations are connected with some pain and other sequels like described above.
At last but not least there is certain special issue of plastic surgery. Psychological aspect plays an important role. Plastic surgeons changing the body image must deal with the psychological needs and responses of their patients on a daily basis. It is necessary to point out the existence of the pathological mental condition, which is the body dysmorphic disorder (BDD) (also Dysmorphophobia or Dysmorphic syndrome). It is a disease in which the affected person is excessively concerned and preoccupied by a perceived visible defect in his or her physical features. Due to this problem he or she repeatedly haunts the doctors, mainly plastic surgeons, also dermatologists and dentists, to erase these imaginary faults without any importance or nonexistent for anyone else to notice, but she or he imagines the flaw to be so significant that it must be fixed. However despite repeated operations the patient is never satisfied with the outcome. Body dysmorphic disorder is a failure of self-esteem of own body, which is persisting after any improvement. This may be up to such intensity, where it meets the criteria for other disease - disorder with delusions. Typical is controlling, masking, make-up, avoiding contact with people, etc. This mental condition, when untreated, can intensify and lead to serious health problems, depression and suicide. In treatment the administration of selective serotonin reuptake inhibitors (SSRIs) and cognitive behavioural therapy (CBT) are effective.
The plastic operations always demand a close cooperation between a surgeon and a patient. Doctor must have a deep empathy to the patient. He should be a good surgeon and also a good psychologist at the same time. The patient must have the realistic expectations and compliance. Just so the outcomes of surgery can be satisfactory for both sides - patient and surgeon.
Demands of modern society to the appearance of person are high. Good elimination of visible disorder can improve an appearance and self-esteem of affected individual The more perfect the result of treatment, the better the prerequisite of patient´ s fulfillment in society and high quality of her or his life.

Wound healing and treatment

Eva Dřevínková, Michal Haas

Wound healing is a broad and complex process.The repair cascade consists of 3 phases- inflammatory, proliferative, and remodeling phase. These overlapping phases act in highly coordinated relationships.

- **Inflammatory phase**

Inflammation is a first stage of wound healing and includes haemostasis and inflammatory infiltrate.
Collagen exposed during wound formation activates the clotting cascade (both the intrinsic and extrinsic pathways), initiating the inflammatory phase. The cell membranes damaged from the wound formation, release thromboxane A2 and prostaglandin 2-alpha, potent vasoconstrictors. This response helps to limit haemorrhage. After a short period, capillary vasodilatation occurs secondary to local histamine release, and the cells of inflammation are able to migrate to the wound bed. The timeline for cell migration in a normal wound healing process is predictable.
Platelets, the first response cell, release multiple chemokines, including epidermal growth factor (EGF), fibronectin, fibrinogen, histamine, platelet-derived growth factor (PDGF), serotonin, and von Willebrand factor. These factors and mediators help stabilize the wound through clot formation, act to control bleeding, and limit the extent of injury. Platelet degranulation also activates the complement cascade, specifically C5a, which is a potent chemoattractant for neutrophils.
The inflammatory phase continues, and more immune response cells migrate to the wound. The second response cell to migrate to the wound, the neutrophil, is responsible for debris scavenging, complement-mediated opsonisation of bacteria, and bacteria destruction via oxidative burst mechanisms (i.e. superoxide and hydrogen peroxide formation).
The next cells present in the wound are the leukocytes and the macrophages (monocytes). The macrophages are essential for wound healing, as they secrete numerous enzymes and cytokines. These include collagenases, which debride the wound; interleukins and tumour necrosis factor (TNF), which stimulate fibroblasts to produce collagen and promote angiogenesis; and transforming growth factor (TGF), which stimulates keratinocytes. This step marks the transition into the process of tissue reconstruction, i.e. the proliferative phase.

- **Proliferative phase**

Proliferative phase is characterized by fibroplasia, granulation, contraction, and epithelisation**,** which are anabolic part of wound healing.
Epithelialisation occurs early. If the basement membrane remains intact, the epithelial cells migrate upwards in the normal pattern. This is equivalent to a first-degree skin burn. The epithelial progenitor cells remain intact below the wound, and the normal layers of epidermis

are restored in 2-3 days. If the basement membrane has been destroyed, similar to a second- or third-degree burn, then the wound is reepithelialised from the normal cells in the periphery and from the skin appendages, if intact (i.e. hair follicles, sweat glands).
Angiogenesis, stimulated by TNF-alpha, is marked by endothelial cell migration and capillary formation. The new capillaries deliver nutrients to the wound and help maintain the granulation tissue bed. The migration of capillaries into the wound bed is critical for proper wound healing. The granulation phase and tissue deposition require nutrients supplied by the capillaries, and failure for this to occur results in a chronically unhealed wound. Mechanisms for modifying angiogenesis are under study and have significant potential to improve the healing process.
The final part of the proliferative phase is granulation tissue formation. Fibroblasts differentiate and produce ground substance and then collagen. The ground substance is deposited into the wound bed; collagen is then deposited. Many different cytokines including PDGF, insulin like growth factor (IGF), and EGF are involved in the proliferative phase of wound repair. The steps and the exact mechanism of control have not been elucidated.

- **Remodeling phase**

The final phase of wound healing is the remodeling phase, also called the maturational phase. The wound undergoes contraction due to the collagen maturation, ultimately resulting in a smaller amount of apparent scar tissue. The entire process is a dynamic continuum with an overlap of each phase and continued remodeling. Collagen deposition continues for a prolonged period, but the net increase in collagen deposition plateaus after 21 days. The scar reaches maximal strength at one year, with a tensile strength that is aproximetely 30% of normal skin.

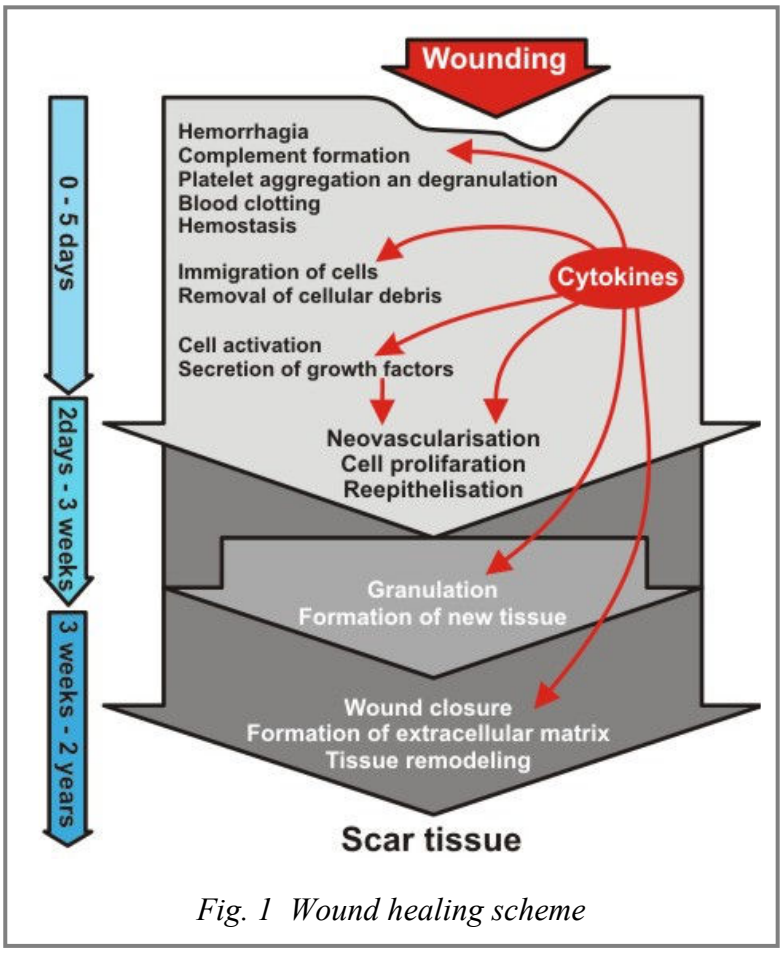


Fig. 1 Wound healing scheme

Summary of wound healing (see fig. 1):

1. *Inflammatory phase* - haemostasis and inflammatory infiltrate
2. *Proliferative phase* – fibroplasia, granulation, contraction, epithelisation
3. *Remodeling phase*- scar maturation

Proper wound healing involves a complex interaction of cells and cytokines. In recent years, more chemical mediators integral to this process have been identified. The sequential steps and specific processes have not been fully differentiated.
For more details about wound healing process including healing perprimam intentionem and per secundam intentionem see the chapter Wound healing in textbook of Physiology, Pathological Physiology, and Basics in Surgery.

Wounds
Wound classification and their characteriscs are included in the textbook Basics in Surgery.
Most wounds will heal with minimal intervention in a healthy individual. Conversely, the incidence of non-healing wounds is higher in patients with systemic diseases.

Non-healing wounds are open wounds that fail to epithelialize and close in a reasonable amount of time, usually defined as 30 days. These wounds typically are clinically stagnant and unable to form normal granulation tissue. Many factors contribute to inhibit healing in these patients, but no unifying theory can explain the etiopathogenesis of each individual.

The list of systemic and local factors which can interfere with healing are described below:

Systemic **–** age, alcohol, smoking, parallel chronic diseases: metabolic disorders for example diabetes mellitus, diseases of cardiovascular system for example arteriosclerosis, ICD, diseases of respiratory system, anaemia, leucopoenia, hypoproteinaemia, insufficiency of vitamin C, malnutrition, immunosupression, chemotherapy, steroids, exhausting processes and fatal health condition for example generalization of malign tumours, sepsis, etc.

Local **–** haematoma, ischaemia, necrosis, foreign body, wound infection, acutely or chronically affected tissue (dilacerations, contusion, changes after radiation, scars after previous operation, paralysis), decreased perfusion from high or long lasting external pressure, chemical irritation, unsuitable treatment including traumatizing operating technique**.**

Treatment and wound care
Management is based mainly on the wound characteristics. All wounds, whether acute or chronic, should be evaluated initially by surgeon to determine the mechanism and to outline an approach to treatment.

The basic steps of care:
1. Optimization of systemic parameters - It is necessary to compensate the parallel diseases, to control the inner environment and to compensate the blood loss.
2. Optimization of local condition

All uncomplicated wounds may be closed as soon as possible -primary wound closure. Secondary or delayed suture is performed after a certain period; primarily it is necessary to stop major bleeding, to remove impurities and evidently avital tissue only. The reason can be

serious overall state or unsuitable local conditions such as uncertain vitality of tissues, infection and so on.

Closed wounds require less care than open wounds. Closed wounds should be kept sterile for 24 to 48 hours until epithelialization is complete. At this point, water barrier function has been restored and shower or bath is highly recommended. Water makes light massage and removes unwanted contamination. It reduces infection risk. The bath has also the calming effect, providing a positive psychological benefit, which improves recovery.
At 3 weeks collagen cross-linking is becoming significant. In that time the tensile strength of a closed incisional wound is only 20% comparing with normal skin. At 6 weeks, wounds are at 70% of the tensile strength of normal skin, which is nearly the maximal strength achieved by scar. Therefore, if absorbable suture is used to close deep structures that are under significant tension, such as abdominal fascia, the suture should retain significant tensile strength for at least 6 weeks. In addition, heavy activity should be limited for a minimum of 6 weeks in these cases.
The timing of removal of stitches depends on site of wound, strength and thickness of skin at this place, size of the wound, healing quality, patient gender, age, general condition, etc. But generally on head and neck we remove them on day 4-8 after operation, body and limbs on day 8-14.

Open wounds heal with the same basic processes of inflammation, proliferation, and remodeling as do closed wounds. The major difference is that each sequence is much longer, especially the proliferative phase. This type of healing process is referred to as secondary intention. The scar has less tensile strength and is more susceptible to trauma than normal skin is. Thus, these scars more easily break down from local trauma such as pressure.
Healing with the epithelisation from edges can happen in wound till 2 cm of diameter. Larger area has the tendency to state transition into chronic wound.

Chronic wounds - because the etiopathogenesis of chronic wounds is multifactorial, coordinated care by multiple specialists is required for optimal results. That is why specialised teams approach the treatment of chronic wounds. Members include a plastic surgeon, vascular surgeon, orthopaedic surgeon, internist, endocrinologist, hyperbarist, and infectious disease specialist. Prosthetics and physical therapists also belong to the team.
Treatment begins with debridement of necrotic tissue, which removes a potential source of bacterial infection and converts the chronic wound to an acute wound. Active medical comorbidities are aggressively treated.

Difficult types of wounds:

- Infected wounds – treatment includes the mechanic cleaning, debridement of necrotic tissue, excision of edges, drainage, antibiotics according to the sensitivity, possible delayed primary closure or local wound care, bite wounds – treatment includes mechanic cleaning, debridement, primary closure, drainage is mostly helpful, antibiotics, tetanus vaccination, antidote if available. An examination of animal by

veterinarian with regard to lyssa is obligatory in the CR. If for some reason it is not possible, then the infectious disease specialist decides further care.

- Decollement (=avulsion of tissue block) – the best treatment is the replantation if it is possible, otherwise skin transplantation or flap can be used
- Problem wounds - pressure sores, lower extremities wound with vascular diseases like crural ulcers or diabetic foot, radiation defects, malign tumours, chronic infection like osteomyelitis, malnutrition, chemotherapy etc.
- Pressure ulcers – defects, that are associated with a skin and tissue damage due to insufficient blood supply (pressure, often in combination with reduced mobility or paralysis, friction, moisture). There are 4 types:

Grade I	pressure ulcer without skin defect
Grade II	pressure ulcer with particular skin defect
Grade III	pressure ulcer with destruction of all layers of tissue compressed between the bone and plate
Grade IV	pressure ulcers complicated with purulent inflammation of bone and inflammation of the adjacent joints

Another classification is NPUAP classification (National Pressure Ulcer Advisory Panel 1989) and Darrel Shea classification, which are substantially similar:

Grade I	erythema and induration without damaging the skin
Grade II	damage of the part of skin thickness
Grade III	pressure ulcers with the destruction of all layers of the skin, but without penetration of fascia
Grade IV	affection of the entire thickness of the skin but also of muscle, bone, tendon or joint capsule

The location may be predisposing the sacral region, heels, the area above the great trochanter and the tuber ischiadicum, ankles, shoulder blades, ears (95% lower body, pelvis 65%). Therapy follows three fundamental principles: pressure elimination, local wound therapy (removal of necrosis and selection of appropriate materials for wet wound healing together with promotion of granulation and epithelisation) and therapeutic improvement of the overall condition (pain relief, improvement of nutrition, improving the overall state of mobilization).

1. Leg ulcers – most often arise on the basis of chronic venous insufficiency (about 85%) – ulcus cruris venosum, on the basis of inadequate arterial supply (about 10%) – ulcus cruris arteriosum and from other reasons (vasculitis, lymphoedema) or mix of previous mentioned reasons. The treatment is to remove the cause (*venosum* – compressive therapy, exercise, overall therapy; *arteriosum* - angioplasty, by-pass, fibrinolysis, in exercise, overall therapy). Local therapy is focused at cleaning up the base, keeping moist environment, using a shower to defect, massages, using of ointments to defect surroundings, bandages, elastic bandages to treat or stockings to reduce swelling.
2. Diabetic leg syndrome – is defined as ulcer of destruction of tissue of foot in diabetic patiens connected with neuropathy and different grade of ischemia and also very often

connected with infection. Treatment is complex and it is neccessary to educate patient to ensure patient's compliance. Compensation of diabetes is fundamental. Next step is foot relief (using special shoes), improving blood flow to affected vessels (surgical vasodilatation), treatment of local infection and the ulcer treatment (regular cleaning of wounds, soft cover, which facilitates the cleaning of wounds and promote granulation formation).

3. Postradiation injury – it is one of the most complicated chronic wound and the treatment is also very complicated. Excision is often needed throughout the defect and is followed by a large plastic surgery. Chronic skin damage caused by ionizing radiation is manifested as chronic radiodermatitis. This may result in the formation postradiation ulcer, which may even turn into malignant squamous cell carcinoma in the so-called Marjolin's ulcer. Local treatment again consists of cleaning the wound, in a wet coverage and promoting granulation.
4. Tumors – cause of chronic non-healing wounds may be also exulcerated tumors. If there is no wound improve after correct treatment of chronic wounds, it should be thought of as a possible neoplasia. For diagnosis a tissue sample for histological examination could be heplful. The condition of successful healing is therapy of the basic disease.

Reconstructive surgical option for the most problematic defects is the rotation or free transfer musculo-cutaneus flap, which brings into the defect enough tissue and a good vascularisation.

Basic steps of wound care in difficult wounds:

1. Debridement
2. Suppression of infection and support of the granulation growth
3. Reconstruction (see chapter Soft tissue defects coverage)

1. Debridement

Debridement removes unwanted material fron the wound. Mostly there are the foreign bodies, dead tissue, eschars, crusts, occasionally hypertrophic granulation and/or epithelium of poor quality around margins. Without an adequate debridement, a wound is persistently exposed to cytotoxic stressors and infection.

Debridement is typically considered to be *surgical*, but it may also be mechanical, enzymatic, chemical or autolytic (occurring through the action of leucocytes).

The example of a *mechanical* debrider is the pressurized water jet (VersaJet, Smith&Nephew), a Waterpic or even a low-tech device as a handheld shower spray. Both remove released avital particles together with gentle massage. *Enzymatic* and chemical are delived mostly as specialities (Iruxol®) or they are prepared magistraliter (10-20% salicylic acid in ointment base).

2. Suppression of infection and support of the granulation growth

Dressing

Its primary task is to protect the wound from external environment, especially against dessication and infection, to treat unwanted processes in the wound, in particular the secretion and proliferation of infections.

The types of dressing can be broadly divided into films, composites, hydrogels, hydrocolloids, alginates, foam, and other absorptive dressings. The goal in clean wounds that are to be closed primarily or are granulating well is to provide a moist healing environment to facilitate cell migration and prevent desiccation of the wound. Consequently, films can be used for incisions, and hydrogels or hydrocolloids can be used for open wounds. The amount and type of exudate that is present in the wound will direct the dressing used in wounds that have some degree of bacterial colonization. In general, hydrogels, films, and composite dressings are best for wounds with light amount of exudates; hydrocolloids are used for wounds with moderate quantities; and alginates and foams are useful for wounds with heavier volume of exudate.

Gauze was in the past the first choice for the generic care of wounds. The disadvantage of this type of dressing is traumatic and proinflammatory effect, they are often more painful and it needs to be changed more often when compared with modern dressings. However, the material expense of these dressings is really low.

Gauzes are excellent as surgical bandages and can be used in small, non-complicated wounds or as secondary dressing. They are also available impregnated with petrolatum, iodinated compounds, or other materials useful for keeping the wound bed moist.

Semiocclusive dressings are sheets that are impermeable to fluids but permit the passage of small gas molecules. They are commonly used to cover and protect freshly closed incisions and skin graft donor sites, and likely enhance epithelisation.

Hydrogel dressings are great for maintaining a moist wound bed and rehydrating wounds to facilitate healing as well as autolytic debridement. They are usually composed of complex polysaccharides (e.g. starch). As mentioned earlier, they are good for use in wounds with a light amount of exudate. They can be also used in infected wounds. They are non-adhesive, and therefore cause minimal pain with dressing changes, but they usually require a secondary dressing.

Hydrocolloids are represented by pastes, powder, or sheets, usually should be covered with a dressing. Hydrocolloids consist of gel-forming agent (typically gelatine, carboxymethylcellulose, or pectin) that are impermeable to gases and liquids. They may be left on the wound for 3 to 5 days. They provide a moist environment that promotes cell migration and wound debridement autolysis. They should not be used on heavily colonized and highly exudative wounds.

Foam dressings are made of non-adhering polyurethane, which is hydrophobic, and an occlusive cover. The polyurethane is highly absorptive and acts as a wick for wound fluids, making foam dressings useful in highly exudative wounds.

Alginates (derived from brown seaweed) are great in wounds with a significant amount of exudate. They should not be used in non-exudative wounds because they can dry out the wound bed. They come in several forms, including a rope/ribbon form that is useful for packing wounds with deep pockets. These dressings can absorb approximately 20 times their dry weight in fluid. They should be usually covered with a semiocclusive dressing. The manufactural alginate dressing is also available with silver.

Antimicrobials are a generic term for a dressing that contains an antimicrobial agent. Especially beneficial is silver, which is active against a broad range of microorganisms in addition to bacteria, and also maintains activity against vancomycin-resistant Enterococcus (VRE) and methicillin-resistant Staphylococcus aureus (MRSA). Other antimicrobials include cadexomer iodine, silver sulfadiazine, mupirocin, and topical antibiotics, including neomycin, gentamicin, metronidazole and bacitracin ointments and creams.

Growth factors - currently, cytokines have a limited role in clinical practice. The first growth factor approved for clinical use is platelet-derived growth factor (PDGF), marketed under the name becaplermin (Regranex). It is approved for treatment of diabetic foot ulcers. It has been widely used „off-label“ for the treatment of variety of other wound types, such as irradiated wounds and in aged patients. Other growth factors, including vascular endothelial growth factor (VEGF), are currently in clinical trials.

Enzymes debriding agents act selectively by digestion of necrotic, devitalized tissue and prevent slough and eschar from accumulating. These agents include such products as pappain with urea, and are general proteases. Their use is sometimes associated with pain, which may limit their use. Another enzyme used is collagenase, which is less traumatic to healthy tissue than surgical debridement if properly used.

Skin substitutes and human tissue equivalents:

- Regular: only prevent excessive drying out of the wound and reduce the penetration of external infection, the simplest example is gauzes impregnated with petrolatum, another special product is COM ®.
- Last generation: They are the first tissue-engineered products applied to clinical use. They provide wound coverage and some of these products contain living cells that produce a broad spectrum of growth factors and other bioactive molecules that assist in healing. They need to be carefully used only on clean wounds with adequate vascularity and site needs to be immobilized to prevent shearing and graft loss. The indications for use depend specifically on patient and should be used in specific centres. As well as the materials (for example Integra, Biobrane) are very demanding with regard to technique and to expences.

Negative-pressure wound therapy (NPWT) supports the formation of granulation tissue. It consists of a porous sponge set into the wound, a vacuum pump, and a transparent film (see fig. 2, 3). It can be used in both inpatient and outpatient settings. Device is useful for

decreasing the size of large wounds on the extremities and trunk in preparation for reconstruction. The clinical situations include lymphatic leaks, venous stasis ulcers, diabetic wounds, and wounds with fistulae. It also assists in managing sternal wounds, orthopaedic wounds, and abdominal wounds.
However, there are several contraindications including the presence of a malignancy, use on wounds characterized by ischaemia, and inadequately debrided or badly infected wounds

Fig. 2 NPWT device

Fig. 3 Applied NPWT on foot in patient with pressure sore

Hyperbaric oxygen

The use of hyperbaric oxygen (100% O2 saturation at 2 to 3 ATA) raises the dissolved oxygen saturation in plasma from 0.3% to nearly 7%. Occasionally, hyperbaric oxygen may be used as a means of limb salvage in a patient with an ischaemic wound who is not a candidate for a surgical or endovascular procedure. But more recently, there has been some interest in regional oxygen therapy to the wound itself. Next details are available in the texbook Basics in Surgery.

Treatment of scars

Pressure massage is the basic step of treatment, which can achieve certain improvements in appearance and function. This massage is done mostly manually. The principle is the elimination of swelling and limitation of congestion from scars. It reduces unwanted amount of collagen and improves its quality. Expended force corresponds to a force, which invokes the bleeching of clamped finger. The massage is made subsequently along the whole scar. At every site a force should be applied about 30 seconds. It is possible to move the scar together with force. This movement can release the fixation of scar to the deeper tissues. But finger must not slide on the surface, because it would wipe down the epithelium and irritate the scar. Connective tissue could respond with excessive growth, epithelium with epidermolysis. The silicone plates for minor scars or pressure garments and compression dressings for large areas can be set after massage. Another possibility is the application of steroids to scar tissue (Diprofos ®), or use of various supporting technologies (biolamps, soft laser, etc.)

Excessive scars

Normal wounds have "stop" signals that halt the repair process when the dermal defect is closed and epithelisation is complete. When these signals are absent or ineffective, the repair process may continue unabated and cause excessive scar.

Under certain circumstances, this trend is higher. The most common cause is irritation in the wound (the blood disorder of wound margines, lack of contact of edges, contusion and bruises of tissue, infection), then tension of the scars towards to skin fissionability, hormonal effects (adolescence and growth hormone), stress, and certain location (the frontal area of the neck and upper part of frontal chest, sites of joints). Hypertrophic scars and keloids are unique to humans and do not occur in animals for unknown reasons. Both can be described as fibroproliferative disorders of wound repair with excess healing.

Hypertrophic scars

Hypertrophic scars are defined, as scars that have not overgrown the original wound boundaries but are instead rise. They usually form secondary to excessive tensile forces across the wound. They are most common in wounds across joint surfaces on the extremities but also commonly occur on the sternum and neck. Hypertrophic scar is a self-limited type of overhealing that can regress with time. These scars generally fade as well as flatten to the surrounding skin levels (see fig. 4).

Fig. 4 Hyperthrophic scar

Keloids

Keloids are scars that overgrow the original wound edges. True keloid scar is not common and occurs mainly in darkly pigmented individuals with an incidence of 6% to 16% in African populations (see fig. 5). It has a genetic predisposition with autosomal dominant features. The keloid scar continues to enlarge past the original wound boundaries and behaves alike a benign skin tumour with continued slow growth. However, complete excision with primary closure of the defect results in recurrence in the majority of cases. Hyperpigmentation and hypopigmentation of scar increase its contrast with the surrounding skin, making the scar more visible. Sun protection of all wounds and unmatured scars is recommended to prevent these colour changes.

Fig. 5 Keloid scar.

Oedema care

The swelling is an important factor that may contribute to failure of healing or even be a cause of it. The reason of tissue swelling can be a chronic inflammatory reaction, venous insufficiency, lymfoedema or cardiovascular disease, a mechanical block based on scarring of drainage vessels. Treatment consists of massage, lymphatic drainage and application of compression bandage (eg compression stockings or sleeve, pressure garnments). Is it possible

to administer even the systemic antioedematous pharmaceuticals (e.g. Wobenzym ®, Reparil ®, etc.)

Future treatment

It may be possible in the future to augment healing mainly in problematic cases (wounds with chronic infection, paralysis, diabetic, or irradiated patients, elderly patients) with the use of autologous stem cells.

The directed and precisely manipulated growth of appendages such as hair follicles, and the precise modulation of melanocytes, could potentially result in imperceptible scars.

Soft tissue defects coverage

(Advancement, skin grafts, skin flaps, muscle and musculocutaneous flaps, free flaps)

Miroslav Tvrdek

Advancement

When the lack of tissue in wound is small, a defect can be closed by mobilizing of its margins and advancement towards each other. Condition of uncomplicated healing is the possibility of such a release to obtain enough tissue for direct suture without tension and blood supply disorder. Other important factors are location of the defect, the characteristics of the surrounding tissue, age, gender and overall condition of the patient.

Skin grafts

Skin grafts are appropriate to address the shallow planar defects.

The take of a skin graft depends on adequate vascularisation of the recipient bed. It gives the nutrition to the graft by perfusion during first 24-48 hours. Then it produces the buds of primitive vessels which ingrowth into the graft. Later the vessel net is developed here. It is responsible for the graft healing and permanent supply. There fore the good contact between the graft and the bed is necessary. Insufficient contact may be caused by the collection of wound secretion (blood, serum, pus) between graft and wound bed or by movement of the graft on the bed.

Areas with poor vascularisation are bad recipient areas for skin grafts. Accordingly the chronic ulcers with increased fibrosis, areas of radiation damage, exposed bones or cartilage without periosteum or perichondrium, tendon and nerves without a paratenon or perineurium layer are unsuitable indication. Coverage of these areas requires the use of skin flaps or muscle flaps that bring not only the tissue but also additional vascularisation.

The appropriate donor site choice is important. Ideally, identical skin with regard to colour, texture, thickness and hair-bearing qualities should be used.

The best possible colour match and texture is obtained when the donor area is located close to the recipient area.

A skin graft or also skin transplant as a term is used consists of epidermis and dermis. Graft is completely separated from native blood supply and transferred to a distant site.

Skin grafts are classified by thickness to split-thickness (thin, intermediate, thick), which content of certain part of the skin, and full- thickness grafts.

Classification of skin grafts is also possible according to their source of origin, respectively to the relationship of the harvest site to the site of application:

Autologous graft – transplanted from one region to another of the same individual

Allogenous graft – transplanted from a different individual to the site of afflicted one, both of the same species

Xenogenous graft – transplanted from a different individual to the site of afflicted one, each of the different species

The split-thickness skin graft contains a variable amount of dermis. The donor site still contains epidermal cells in deep layer of dermis and/or in skin appendages that allow healing of harvest site by spontaneous epitelialization. The thinner grafts have the advantage of easier and faster healing and less donor morbidity. The thicker grafts have more normal skin appearance and sensation, and greater resistance to subsequent trauma. They also follow less the contraction of connective tissue in the wound bed. The place of harvest is mostly the front and outer surfaces of thighs, upper part of buttocks, outer side of arm, and back.
After placing the graft into the wound the stitches fix it to the edge of the defect. In places that are easy to immobilize, fixation of transplant is possible by dressing only. Graft is fully healed after 10-14 days.

Full-thickness grafts include complete skin, e.g. epidermis and all the dermis. This graft behaves very much like normal skin but survive transplantation least well than split-skin grafts. Donor site is limited and incurred wound must be closed surgically. Usually they are locations where it is possible to utilize natural skin fold and surroundings are ductile. Frequently they are groins, the back of the auricle, preauricular area, wrist, cubital fossa, supraclavicular fossa, and upper lid. The graft must be fixed into the defect by stitches usually knotted over the bolus. Transplant is fully healed within 10-21 days.

Harvesting of skin grafts
The donor site is also called secondary defect. Various instruments are used for harvest of split skin grafts, starting with special knives (Watson, Humby) to dermatomes (electrodermatom, airdermatom). Secondary defect is healed by spontaneous epithelisation from deeper layer of dermis and from skin appendages within 14-21 days according to the thickness of tissue removed. The full thickness skin transplants are harvested by regular scalpel. A secondary defect is closed by advancement and direct suture in absolute majority of cases. Resulting in linear scar the wound is healed within 10-14 days.
The review of advantages and disadvantages of various types of skin grafts is in the following table:

Type of graft	Advantages	Disadvantages	Application
Thin split thickness	Survive transplantation most easily and donor site heal most rapidly	Fewest qualities of normal skin, maximum contraction least resistance to trauma, sensation poor, aesthetically poor	Contaminated wounds, burn surfaces, poorly vascularised surfaces
Thick split thickness	Less contraction. More qualities of normal skin. More resistant to trauma. Aesthetically more acceptable	Survive transplantation less well. Donor site heals slowly.	Better vascularised, not too extensive defects

Type of graft	Advantages	Disadvantages	Application
Full thickness	Nearly all qualities of normal skin. Minimal contraction, Very resistant to trauma. Sensation good. Aesthetically good	Survive transplantation least well. Donor site must be closed surgically. Donor sites are limited.	Well vascularised surfaces, usually face

Meshed grafts are usually intermediate or thick split-thickness grafts that have been rolled under a special cutting machine to create mesh pattern from the original plate. Grafts thanks to these perforations can be expanded. Widening in ratio 1:1.5 to the unmeshed size is the most useful. Secretion drainage of the wound bed is equally important purpose of opening creation. The foramina heal by epithelisation from their margins within several weeks.

Cultured epithelial grafts – epithelial cells can be cultured in vitro and made to coalesce into sheets. This cultured skin graft can be used to cover full-thickness wounds. This technique is used in selected patients with extensive burns where donor sites are very limited. The main disadvantage of cultured grafts is their fragility, uncertainty of graft take and high tendency to contract. This technique is presently being used together with application artificial dermis made out of a collagen matrix.

Flaps

Flaps are segments of tissue, usually composited, that retain their native blood supply (rotation flaps), or the vasculature may be reatached at the recipient level by microvascular technique (free flap).

Their classifications are variable according different aspects. The most important ones are according to:

- Relationship to the defekt localisation: local flaps and distanc flaps
- Blood supply: random flaps and axial flaps
- Composition: skin flaps, fasciocutaneous flaps, myo or myocutaneous flaps, osseous, osseocutaneous or osseomyocutaneous flaps
- Timing of the flap application into the defect
- Function of the flap

Classification according to the relation of the localization defect

According relation to the location of the defect we divide local and distant flaps. Among the local flaps there are flaps risen from the immediate or near of the defect. Distant flaps include free flaps, which are transferred to the site of the defect from distant parts of the body on vascular or blood vessel and nerve pedicle. This pedicle is connected through microanastomosis to the recipient vessels in the vicinity of the defect. Both types of flaps may be composed of different tissues.

Classification according blood supply is basic one.

Skin flaps can be divided into random or axial pattern according to the distribution of the blood supply. The random pattern flaps derive their blood supply from the dermal-subdermal plexus, which in turn is fed by deeper perforating musculocutaneous vessels. The random flap has an uncertain blood distribution and can be used safely only when the length-to-width ratio does not exceed 1.5 to 1. The only exception is the facial area.

The axial pattern flaps derive their blood supply from a defined cutaneous artery and vein. These flaps are more reliable and maintain a greater length-to-width ratio.

Random skin flaps

Among the most common random pattern flaps is the Z-plasty. This is an extremely useful technique to lenghten a linear scar or a contracture or to change the orientation of a scar so that it will lie within the lines of minimal tension. Essentially, two triangular random skin flaps are interchanged one for the other. The limbs of the Z should equal the lenght of the central member. The angels used may vary from 30 to 90 degrees, but the classic, most popular Z-plasty uses 60-degree angels.

Other random pattern flaps include V-Y advancement flap, the transposition flap, the rotation flap, door flap, the Limberg flap, and others.

Axial skin flaps

Axial flaps, with their well-defined circulation, are more reliable and versatile than random flaps. As the vascular anatomy of the skin and underlying tissues has become more clearly defined, more and better axial flaps have continued to be proposed. Some flaps have been used for sometime without full knowledge of the axial circulation. To this group belong the median forehead flap (indian flap) for nose reconstruction, based on the supratrochlear vessels, and the deltopectoral flap, based on the upper perforating branches of the internal mammary artery and used for head and neck reconstruction. The groinflap based on the superficial circumflex iliac artery has been used for hand and forearm reconstructions.

Muscle and musculocutaneous flaps

Muscle and musculocutaneous flaps are special types of axial patern flaps.

Muscles are available in the most body regions. Each muscle has potential as a muscle flap. Musculocutaneous flaps include muscle together with the overlying subcutaneous tissue and skin. Musculocutaneous perforators nourish that skin. The vascular pedicles enter the muscle between its origin and insertion. When more than one pedicle enters the muscle, the larger or dominant pedicle generally enters the proximal muscle in the extremity or near the midline of the trunk. Aproximately 40 muscles and more than 20 musculocutaneous flaps have been described for clinical application. Nahai and Mathes have classified muscle tissue with respect to its type of vascular supply into five categories. The extent of elevation of muscle from its normal anatomic position without devascularization and its subsequent ability to reach adjacent defect determine the arc of rotation. The point of rotation is determined by the site of entrance of the dominant or major vascular pedicle into the muscle. Only the muscle distal the point of rotation is actually used as a transposition flap.

With this knowledge an entire muscle or segment can be transferred to cover poorly vascularized and even contaminated wounds. The excellent blood supply of the muscle provides necessary nutrients and cellular and humoral elements to effective combat infection and promote healing. This is why muscle containing flaps are the best choice for coverage of wounds caused by radiation or osteomyelitis.
The most commonly used muscles and musculocutaneous flaps are the latissimus dorsi, pectoralis major, tensor faciae latae, rectus abdominis, rectus femoris, trapezius, temporalis, serratus anterior, gluteus maximus, gracilis and gastrocnemius muscles.

Free flaps
Free flaps are also axial flaps. Their free transfer involves tissue transplantation from the distant part of the body. We use microvascular technique for this purpose.
All tissues with axial pattern circulation theoretically are free flap candidates. In clinical practice, the following requirements must be satisfied: the vessels nourishing the tissue must consist of one artery and one or two veins with diameter large enough for microvascular anastomoses, these vessels must have a wide vascular network sufficient to nourish the entire flap, the anatomical variation in the location of these vessels must be minimal.
The vessels nourishing the flap are isolated, detached and than reatached to suitable distant recipient vessels by means of microvascular technique.
The obvious use of the microvascular free flap is in areas where no local or regional flaps are available.
Free flaps may be classified according to tissues contained in the flap as follows:
1. Free skin flaps and perforator flaps
2. Free muscle and musculocutaneous flaps
3. Free vascularized bone grafts, free osteocutaneous flaps and osteomyocutaneous flaps
4. Free tissue transfer from the abdominal cavity : omental flaps and intestinal flaps
5. Free toe transfer

Large skin and subcutaneous tissue defects, which require repair with distant flaps usually, indicate the necessity for free flap transfer. Trauma, cancer ablation, radiation necrosis and so forth may cause extensive tissue loss that results in the exposure of deep vital structures and require prompt coverage. Compound defects involving skin, muscle and/or bone also indicate free musculocutaneous or free osteocutaneous flaps, which can repair complicated defects in one operation.

Classification according to the timing of flap application lobe into the defect
Classification is different for defect arising from accidents and defects caused by radical tumor removal.

The classification of flaps for posttraumatic defects:
- In primary care within 24 hours (emergency flap)
- Acute (1 to 7 days after injury)
- Delay (after 7 days)
- Secondary (at any time when the flap replaces yet healed soft tissue)

Early flap coverage of the defect, which includes the first two kinds of flaps, it is necessary in cases where critical structures are exposed such as vascular and nerve trunks, bone without periosteum, tendons without paratenonia. Delayed lobe is used mostly for injuries which had been primarily treated in traumatology where no possibility to cover the flap was earlier. Furthermore, in cases where a necrotisation of tissue continues and flap is used only after full completion of necretomies. Secondary flaps are used to replace unstable scars, to reshape deformities, as well as the treatment of osteomyelitis and functional disability.
The flaps used for defects resulting from removal of the tumor lobes are divided into primary, when the reconstruction is performed immediately and the secondary, where the reconstruction is made later.

Classification by function of the flap
The most commonly used flaps are local skin flaps, which are used for closure of defects, the Z-sculptures to correct contracting scars.

Muscle and myocutaneous flaps, as well vascularised tissue, improve blood supply in areas in which they are transferred (osteomyelitis, pressure sores, radionecrosis). Muscle transposition or free muscle transfer as motor units are used to replace the functions of different types of paresis (paresis n. facialis, substitution of the m. biceps brachii).

Free transmission of fingers from the leg replaces a traumatic loss of thumb and also multiple losses of three-phalangeal fingers and restores the functional ability of the hand. This method of reconstruction can be used even in some birth defects of the hands.

Due to their own vascular supply vascularised bone grafts have the greater capacity for healing than conventional bone grafts (fibula - the reconstruction of long bones and mandible, iliac crest bone - mandible, smaller defects of long bones). Free transfer of vascularised jejunal segment is used to replace the cervical esophagus.

Figure annex:

Fig. 1-5 Coverage of the defect by meshed skin graft

Fig. 6-7 Closure of the defect by local rotation flap

Fig. 8-10 Closure of the defect by axial fasciocutaneous flap

Fig. 11-13 Multiple Z-plasty of scar at buttocks

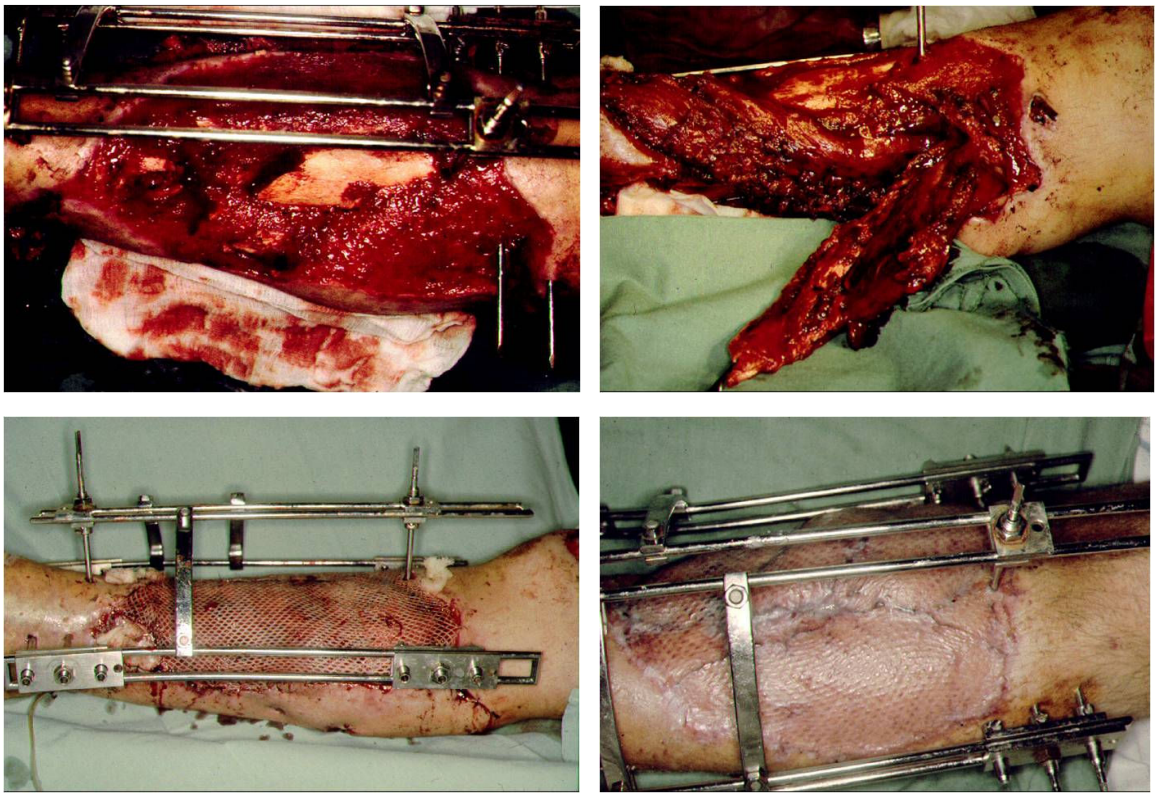


Fig. 14-17 Transposition of gastrocnemius medialis muscle and soleus muscle for closure of tibia defect,muscle was covered by the meshed skin graft.

Fig. 18-20 Closure of the defect of left foot by free transfer of latissimus dorsi muscle and meshed skin graft.

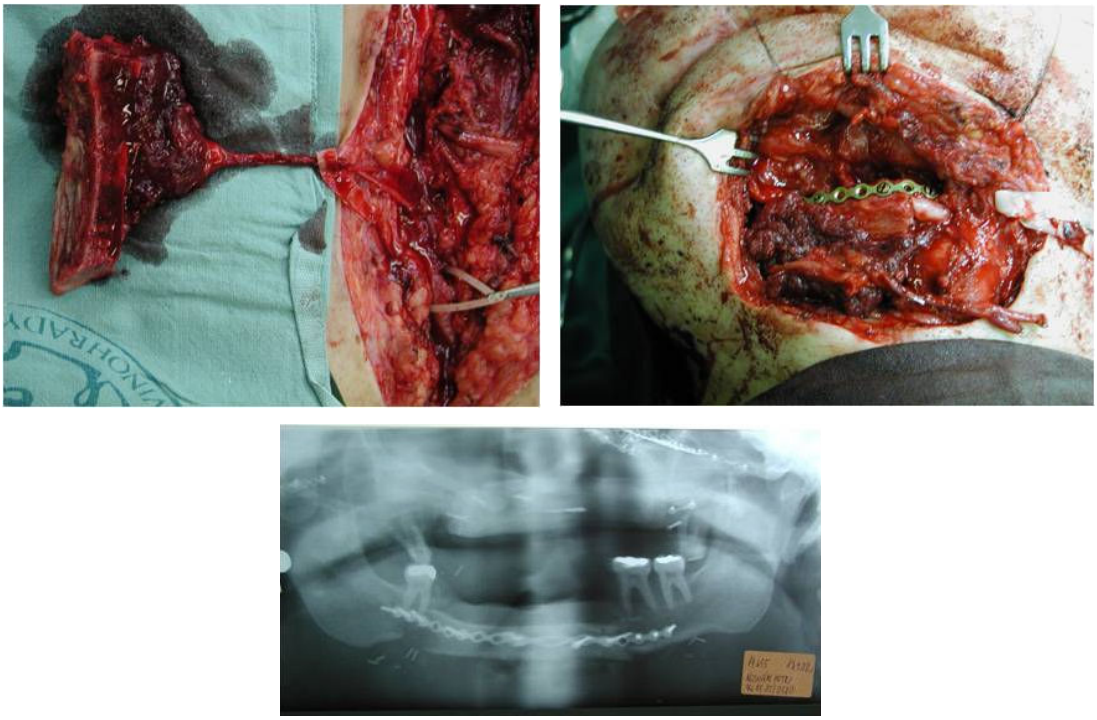


Fig. 21-23 Reconstruction of mandibular defect by osseomyocutaneous free flap from iliac crest bone.

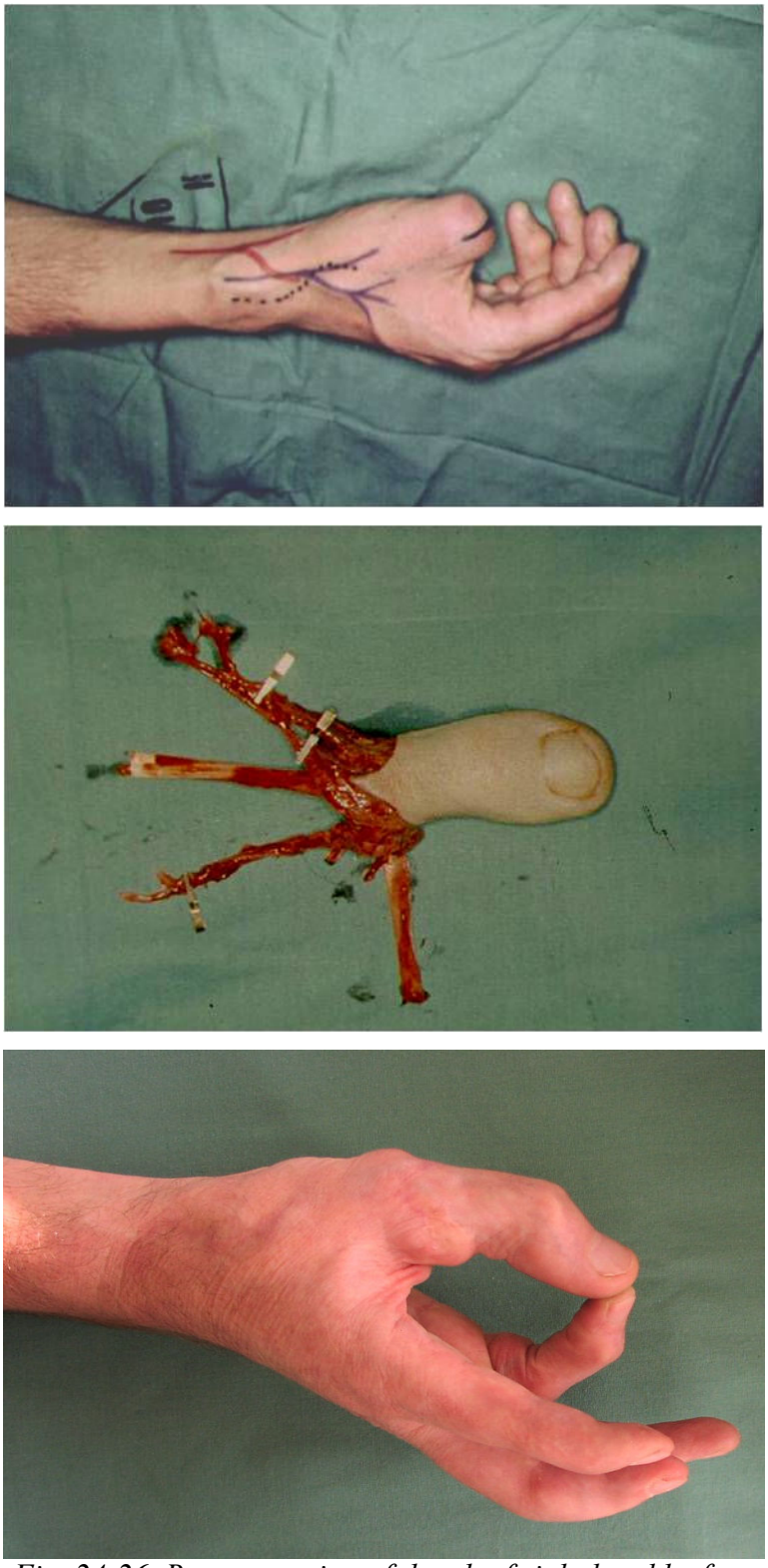


Fig. 24-26 Reconstruction of thumb of right hand by free transfer of thumb of the foot.

Facial injuries

Jiří Bayer

The face presents a dominant unit of human appearance. It has a fundamental importance for communication and formation of social relations. Major disability of facial area often results in severe psychological trauma and in extreme cases into the social death. Together with other, sometimes even more important, factor, which is the functional disability, this issue constitutes a separate branch, which often requires an interdisciplinary cooperation.
A common trend of rising accident rate is reflected also in facial injuries. This is due to an increasing traffic, due to the increasing number of physical assault and popularity of adrenaline sports. 80% of affected are men and mostly in the age group 21-30 years.
Soft tissue injuries are commonly encountered in the care of these patients. Many of these injuries are simple superficial lacerations that require nothing more than a straightforward closure. Other seemingly uncomplicated wounds harbor injuries to the facial skeleton, teeth, motor and sensory nerves, parotid duct, eyes, or brain. The types of soft tissue injuries encountered include abrasions, tattoos, simple or "clean" lacerations, complex or contusion - type lacerations, bites, avulsions, and burns. Recognition of the full nature of the injury and a logical treatment plan determine whether there will be future aesthetic or functional deformities. All wounds will benefit from cleaning, irrigation, conservative débridement, and minimal tension closure. Some wounds will benefit from local or regional flaps for closure; a few wounds will need tissue expansion or free tissue transfer for complete restoration of function and appearance.

Symptoms, clinical examination and imaging methods

Clinical picture - pain, facial deformation (soft tissue injury, blood outflow, edema, subcutaneous emphysema, deformation of skeletal shape), occlusion disorders, disorders of function (chewing, swallowing, breathing, vision, speech, smell), patologic mobility or crepitation of fragments, etc.)

History - directly from the injured or accompanying persons, look for diseases that may be in connection with an injury (epilepsy, DM, neurological disorders, etc.), previous injuries or operations in the area of head and neck. The most important data include the mechanism of the injury, the time and place. It is necessary to search for the signs of unconsciousness, presence of nausea or vomiting, in order to exclude possible injury of CNS.

Aspection – look for any facial asymmetry, disorder of appearance and shape (S-shaped deformation of the nose or saddle-back shape in nasal bones fracture, flattening of cheek area, etc.), the presence of lacerations, tissue loss, bleeding, hematoma, swelling or foreign bodies. Our attention should not miss any liquid leaking (likvorea, blood) from the wound and/or body openings or eye bulb dislocation.

Palpation - detection of palpable sensitivity and pain, pathological mobility of the skeleton and crepitation of fragments, subcutaneous emphysema, the presence of free foreign bodies in oral cavity or the stability of teeth. Symptoms, however, are relatively soon obscured by growing swelling and haematomas.

Malfunction - asphyxia (tongue latch, lower jaw fracture, larynx entrance obturation, tongue edema, or hematoma, etc.), chewing and swallowing disorders, nasal congestion, visual impairment, neurological deficit, etc.

Imaging methods - basic imaging examination remains simple x ray of facial skeleton in two orthogonal projections (backfront and lateral). Semiaxial projection (Waters) is used to capture the upper and middle facial etage. Screening for petris bone by Stenverse is appropriate to assess the pyramid, including the tip and the internal auditory duct. The area of mandibular angle and body shows oblique projection by Eisler. Among the most widely used belongs the targeted projection for nasal ossicles. Computed tomography (CT) has substantially higher investigative value. It provides better information on the status of facial soft tissues, the presence of foreign bodies (even the translucent ones), injuries of brain or orbit (including its contents). Due to improving availability of this method is CT becoming No. 1 in craniofacial trauma examination.

Principles of first aid

- *Life-saving actions*: release and preservation of airway patency, control bleeding, antishock measures, transport in a stable position to specialised center
- *After management of the life-threatening conditions*: fixation of fractures, basic treatment of wounds, etc.
- *Definitive surgical treatment*: in the interval of several days to weeks after the injury, facial soft tissues suture may delay up to 48 hours, reposition and definitive fracture fixation after stabilization of the overall situation (possible even after 3-4 weeks).

Facial soft tissue injury

The injuries of this area, even heavily contaminated wounds, usually heal very well due to a rich blood supply of face soft tissue. Forehead is most commonly affected; next parts are eyebrows, cheek and chin. The basis of treatment is the perfect wound toilet, often using a brush, sand paper, scalpel or scissors. Consistent removal of impurities disposes of infection sources and prevents formation of a traumatic tattoo. Next step is a wound revision, where we find out the depth and extent of the wound, the presence of foreign bodies and hidden bleeding. Bruised and necrotic wound edges are to be excided. The approach however is very conservative, because due to the above-mentioned blood supply the revitalisation is possible. With the exception of wounds extremely bruised and contaminated we generally preffer primary wound closure. Perfect adaptation is an essential condition of the face suture. We start with the basic stitches set to the borders of aesthetic subunits. With advantage we mark the borders before the infiltration of local anesthetics. In large poorly arranged wounds we adapt at first those parts, which correct site is unambiguous. We get a better picture of the condition and possible loss of tissues. We close the wounds in layers, trying to avoid the formation of dead space. Suture must not be under tension, otherwise failure of blood supply can occur with easier development of infection even followed by hypertropic scarring. For skin we use monofilamental or polyfilamental stitches 5/0 or 6/0 (Prolene, Ethilon, Monocryl, Mersilk) as an intradermal continuous stitch or single adapt stitches. In clean simple wounds even resorbable braided fiber (Vicryl 4/0 or 5/0) can be used for mucous membrane and muscles. In contaminated wounds or in wounds with unclear vitality of margins we use

monofilamentous stitches as monolayer set as deep as possible in „8“ manner. Adapted stitches should be removed on the 5^{th} - 6^{th} day, the key stitches 7^{th} - 10^{th} day, nonresorbable running ones on 8^{th} - 10^{th} day. The wounds should be drained by fine capillary drains, wounds with larger extension even by suction drainage however the external compression of tissue (elastic bandage or garment) is necessary. In principle we control the vaccination against tetanus. In primarily infected wound, especially after bitten, always give systemic antibiotics.
Patient is placed in half-sitting position. Injured region is chilled over a bandage or antioedematic treatment is applied. Dressing is changed once a day, in contaminated or potentially infected wounds several times a day. A sterile, moisted gauze is attached on affected place. Gauze is moistened with non-irritating solution, typically 3% pine water or herbal water or tea. Wound toilette is performed at each dressing change using saline solution. Wound and its surroundings is greased with indiferrent ointments or antibiotic ointment if needed. Shower is applied as soon as possible.

Injuries of the splanchnocranium

Luxation of temporomandibular joint:

Strained joint ligaments and reflectoric spasm of masticatory muscles restrain the return of the joint head back to the articular fossa. In addition to severe pain patient displays an open mouth, advanced lower jaw and front teeth don´t occlude (open traumatic bite). There is palpable empty articular fossa there. Hippocratic maneuver is used for reposition. Thumbs of both hands lean on the patient´s bottom molars, the other fingers clasp the lower jaw from the bottom. By the pressure of thumbs we press down the mandible to get the articular head lower than the joint prominence. We lift the chin part and try to plug heads into the holes. After reposition it is appropriate to immobilize the lower jaw, at least for 24 hours.

Fractures of the mandibule:

- *Fractures of the alveolar prominence* - often associated with dental root fractures, oral dislocation of affected area is apparent by aspection, also a traumatic step may be present. Therapy: manual reposition, fixation using Sauer splint for 4-5 weeks.
- *Fractures of the middle part* - without major dislocation, isolated movement of each half, extended gap between the incisors
- *Fractures of the joint prominence* – one of the most frequent, mostly broken indirectly by the bending of jaw (strike on the contralateral angle or fall on the chin with open mouth), the symptoms are swelling and palpable pain, difficult if not impossible opening the mouth, therapy of nondislocated fractures is conservative.
- *Fractures of the toothed part* - mostly in the area of canines (long root), traumatic step and deformation of dental arch, especially the double fractures are dangerous - the risk of click language. Therapy: Reposition and fixation by bone stitch or miniplate.
- *Fractures behind the dental line* - very common, the trabecular bone in the angle is the sparsest. They appear mostly by the striking fist, often with contralateral fracture of the jaw neck (indirectly by bending load of the bone). Therapy: reposition and solid fixation.

- *Fractures of the muscle prominence* – isolated is rare, pain at the site upon m. temporalis, Therapy: conservative.

Fractures of the central facial etage:

Border of the area is cranialy by the horizontal line through the nose root and caudaly by the occlusion plane of the upper jaw teeth .

Classification of fractures:

1) Fracture of the central part
   A. the bottom layer (suborbital)
      - fr. of alveolar prominence of maxila
      - Le Fort I fr.(lower subzygomatic)
      - fr. of sagittal maxilla and palatinal bones
   B. the upper layer (subbazal)
      - nasal bones fr., nasomaxillar complex
      - Le Fort II fr. (upper subzygomatic, pyramid)
2) Fractre of the lateral part
      - fr. of the zygomatic arch
      - fr. of the zygomaticomaxillar complex
      - hydraulic fracture of the orbit (blow out)
3) Combined fractures (central and lateral part)
      - Le Fort III fr. (suprazygomatic)
      - combined Le Fort II and zygomaticomaxillar complex

Classification of fractures of the middle facial etage is not simple due to the complexity of anatomical structures. With regard to the changing mechanisms of injury (traffic accidents) classical classification according to Le Fort is no longer fully up to date. Comminutive fractures involve larger extension; there is a shattering of fragments and their dislocation. For didactic reasons, however, the traditional classification of Le Fort is still used.

Therapy:

1. *Fracture of alveolar prominence and lower layer of maxillar fractures* – reposition by pressure of fingers (rarely surgical) in local anesthesia, fixation (jaw intraoral splint) for 5 weeks, intermaxillary fixation.
2. *Le Fort I-III fractures* - reposition - easy in fresh fr., but often postponed because of the overall complications, after 2-3 days are adhesions already fixed - need to be surgically released and fixed by a titanium splints type mini-plate and micro-plate.
3. *Fracture of cheekbones and zygomatic arch* - transcutaneous reposition by a bone hook in general anesthesia, there is no need to fix. Older fractures require surgical reposition and fixation by micro-plate splints.
4. *Nasal bones fracture and nasal septum involvement (luxation, fractur*e) - digital reposition by elevatorium or surgical, nasal tamponade fixation (10-14 days, exchange after 6-7 days) and plaster splint.

Teeth injury

The most commonly affected are the front teeth of upper jaw. Injury can involve just tooth or periodontal ligaments.

- *Tooth contusion* - the mildest affection of periodontal tissues, characterized by sensitivity of the tooth to tapping and feeling of exserted tooth. Usually a period of 14 days of rest and soft diet is sufficient.
- *Tooth subluxation* – more severe disability of periodontium associated with a change in the position of the tooth, looseness, pain on percussion and bite. In lighter cases, sufficient therapy is slop diet and routine control of tooth vitality. In more severe cases reposition and fixation of the tooth is necessary.
- *Tooth intrusion* - a special kind of tooth subluxation, when the tooth is inserted into it´s bed. This condition is often associated with comminutive root or dental bed fracture. The diagnosis by X-ray examination is necessary. The adjustment is usually spontaneous.
- *Tooth extrusion* - is the opposite of intrusion, treatment is similar.
- *Tooth luxation* - is a situation in which the tooth gets out of it´s bed in alveolus. Periodontal ligaments together with the nerve-vascular bundles are completely interrupted. Dislocated tooth could be under favorable conditions replanted. That should be done within 90 minutes. Until the replantation the tooth should be kept in humid environment to prevent drying of the root.
- *Tooth fracture* - is divided into extra- and intraalveolar. The future of the tooth depends on the line of fracture. Fractures could be transverse, oblique, longitudinal or comminutive. If the fracture line passes through the center of root or the fracture is longitudinal, it is usually necessary to extract the tooth. In other cases, we try to preserve any of the usable tooth parts in dental prosthetics. In the case of total loss of the tooth a dental implant may be an option.

Missile wounds

Due to the intensive traumatic strength these injuries are often associated with considerable tissue damage, often also with their significant loss. Missile injuries are divided into full penetration, inshot and tangential wounds. In the full penetration smaller entry wound is typically found which is gradually expanding into projectile channel and finishing with a large exit wound, where the bullet left the body. The lumen of the projectile channel is filled by roughly crushed tissue. Channel contains blood clots, often foreign bodies, and always bacterial contamination. Neighborhood of the projectile channel is affected by bruising from secondary projectiles such as bone fragments, teeth, dental fillings, and dental prostheses. There is an area of so-called molecular concussion of tissues with disturbed cell viability more around this zone. Important, especially from the forensic point of view, is the distance factor of the missile injury. When the nozzle of gunpoint touches to skin, an extensive destruction of tissues caused by intrusion of combustible gases into the subcutaneous tissue is present. In this area we find a large number of gunpowder particles and contusion of skin corresponding to the circular shape of gunpoint. Burns of the skin and inshot particles of gunpowder can be found even if shot was from a distance of 10 - 15 cm.

Burn face
see the Burns.

Complications of facial injuries

1. Early complications:
    a) ***Bleeding***

It is among the most common complications. It usually does not cause life-threatening circulatory decompensation; however, it brings a high risk of aspiration and subsequent respiratory insufficiency. Capillary bleeding from superficial abrasions under physiological coagulation parameters stops spontaneously in a few minutes. Otherwise, we attach compression. Venous bleeding often occurs after the strike to the nose. For hemostasis we use greasy gauze tamponade. Major venous bleeding is often necessary to stop by ligature, stitch or electrocoagulation of vessel. The arterial bleeding is the most serious one. In the first aid we stop bleeding by compression with bandage or fingers in the so-called pressure points. We compress a. facialis against the body of the lower jaw in front of m. masseter and a. temporalis superficialis in front of tragus against mandibule head or temporal bone. Using the pressure of the index finger and middle finger against the transversal prominence of the sixth cervical vertebra (vertebral tuberculum) we stop the bleeding from the a. carotis externa. In the oral cavity the bleeding of inferior alveolar artery may appear in a connection with fracture of the lower jaw. Careful reposition of fracture is usually sufficient for hemostasis. In tongue injury bleeding of a. lingualis shall be mannaged by stitch or ligature of vessel. In the case of failure it is possible to ligate the artery in the trigonum Pirogowi or anulus Beclardi after preparation of the vessel in the submandibular area. In practice, however, is usually preferred much faster and easier ligature of a. carotis externa in the trigonum caroticum.

    b) ***Asphyxia and aspiration***

The causes of suffocation in the face injuries may be a lot: double dislocated lower jaw fracture, swelling of the tongue root, sagging soft palate, foreign body, laryngospasm from blood aspiration, etc. In these cases the most important step to save life of affected person is to release and maintain clear airways. Fundamental is the mouth inspection, possible removal of clot or foreign bodies, fixation of the language and control of bleeding. Patency of the airways is provided by endotracheal intubation, coniopunction or tracheostomy.

    c) ***Injury to CNS and PNS***

Brain concussion frequently associates the facial injuries. It is typical by a short-term unconsciousness (seconds, minutes), retrograde amnesia, headache, dizziness, nausea or vomiting. More severe infliction is a cerebral contusion, in which mainly prolonged unconsciousness dominates at various levels (somnolence, sopor, coma). Unconsciousness can be also caused by bleeding into the brain tissue. Computed tomography (CT) and magnetic resonance (MRI) examination are used to establish the diagnosis. Warning symptom of skull base injury is the likvorea or leakage of cerebrospinal fluid from nose or external auditory duct. Biochemical analysis is used for its verification. Likvorea usually stops after reposition of middle facial etage fractures; otherwise a participation of the neurosurgeon is

necessary.He will make a plasty of dura mater in 2-3 weeks. Attempt to stop likvorea by performing a nasal tamponade is a gross error, which ultimately can lead to ascendent infection of intracranial space.
A common injury accompanying head and face traumas is breakage of the seventh head nerve - nervus facialis. Nerve may be injured in its extra- or intracranial course, often in a connection with fractures of the pyramid. It is necessary to relieve and, where appropriate, to reconstruct as soon as possible. Reconstruction of the nerve could be *early* (0-3 weeks, primary suture), *deferred* (3 weeks-2 years, nerve grafts, cross-operations) or *late* (2 years and more, local muscle transfers, microvascular transfers).

d) ***Traumatic shock***

It occurs in isolated facial injuries rarely. It is always necessary to search for other hidden injuries (chest, abdomen, limbs). It is necessary to prevent the development of shock by early control of bleeding, ensuring the rest, relieving pain and preventing of getting cold through. A propriate intake of fluids is very important, in difficult cases through intravenous way even through the central application for example v. subclavia.

2. Late complications:

a) ***Infection***

Inflammatory complications are not too common in the facial soft tissue injuries due to the rich blood supply of this region. In contrast, the fractures of facial bones are often open, because of frequent communication of the bone fissure with external environment through the broken skin or mucous membrane. Then the connection with oral cavity or paranasal sinuses leads to bacterial contamination of wounds and risk of subsequent development of traumatic osteomyelitis. The inflammatory complications may be also caused by unrecognized foreign bodies. The basic prevention of infectious complications is a thorough surgical revision of the wound, meeting of all principles of asepsis and antisepsis, meticulous haemostasis, suture of soft tissue without tension, fixation of fractures and prophylactic administration of broad spectrum antibiotics.

b) Pulmonary complications

Inflammation, abscess or gangrene develops mostly 4th-7th day after the injury, mostly as a result of aspiration. For prevention the broad spectrum antibiotics may be administered. The nursing aid should include the regular positioning, breathing exercises and good nutrition, including hydration.

Consequences of facial injuries

Injuries of face often do not remain without consequences, whether temporary or permanent. Among the most negatively perceived are visible scars of the face. Second in frequency are neurological sequelae, including postcommotion and postcontusion syndrome or paresis of n. facialis. Other consequences include posttraumatic facial deformities, arising from badly treated fractures, e.g. so called dish face, resulting from the lack of treatment of fractures of the middle facial etage type Le Fort I-III. A frequent complication of fractures of the lower jaw is occlusion disorder and cross-bite. The occlusion problems could also be caused by the

loss or development of the lower jaw pseudoartrosis. Mandibular joint may be affected by traumatic ankylosis. Other complications may be posttraumatic stenosis of lacrimal duct, mucocele, salivary fistulas, chronic sinusitis, diplopia or eye bulb movement disorders, etc.

For details see chapter Facial reconstruction and/or the textbook of Stomatology, Ophtalmology, Otorhinolaryngology, and Traumatology.

Hand injuries, diagnostics, treatment, physiotherapy

Andrej Sukop, Eva Dřevínková

Hand is one of the absolutely perfect instruments which allow us not only a grip but also the connection with the surrounding world. Hand mediates information by its sensors for temperature, cold, pain, deep sensation and also gives a large scale of possibilities for non-verbal communication. The lower function, alteration of morphology or loss of part or even the whole hand cause severe worsening of a quality of life. Therefore it is necessary to be aware of any hand injury and to rule out the ommision or insuficient treatment which can have serious consequences in the future. Majority of hand injuries does not lead to life threatening situations. There is always enough time to make a careful preoperative assessment and than an operation. But the time plays the main role in amputation injuries when the replantation is indicated (see Chapter about amputations).
Hand injury can affect all anatomical structures i.e. skin, tendons, muscles, nerves, bones, vessels. Injuries can be simple or combined (involving more anatomical structures). Minor injuries are usually treated in traumatology departments. They are easily accessible in the place of injury in the whole Czech Republic. Difficult, combined, devastating, eventually amputation injuries suitable for replantation should be treated in special hand surgery departments. Historically and nowadays this treatment is the role of plastic surgery.
The complex injuries often require multidisciplinary team. Hand injury is not treated only by plastic surgeon, but more doctors with different specialities can be involved - surgeon, orthopaedic surgeon, neurosurgeon, physiotherapy doctor.

Examination of the patient with hand injury
Examination of the patient with hand injury is the same as any kind of patient‘s examination. We should take a medical history and perform physical examination of the patient with the consideration to the speciality of hand injury.

Medical history
Firstly we start with asking about presenting complaint. We let the patient to tell us by himself/herself how the injury happened. During the conversation with the patient we give him/her direct questions to complete an information about the mechanism of injury, time when an injury happened and possible previous treatment, tetanus vaccination. We are also interested about the dominant hand; we complete information about occupation and eventualy patient’s hobbies. We continue with taking a personal history, when we specifically ask whether patient‘s hand was previously injured or operated, we complete history about other diseases, drug history, allergies, abusus including smoking, alcohol and drugs. In women we should not omit to ask about possible pregnancy in relation to the possible application of local anaesthetics, antibiotics, analgesia and other drugs which can mainly in first three months influence the develepment of foetus.

Physical examination

We start physical examination by inspection. We are looking for variation from normal shape and position of hand. The pathological position and alteration of movement can be caused by luxation, fracture, injury of tendon or nerve system but also due to pain. An alteration of perfusion on hand periphery can be caused not only by vessel injury of hand but also by centralization of the blood circulation during a shock. The presence and position of scars give us information about previous injuries and operations. An alteration of hand function does not always need to be due to the new injury, but it could have been already present before an injury!!! We continue with the examination by palpation which informs us about tenderness, pathological movement and crepitations in fractures. Examination of skin sensitivity rules out an injury of sensitive nerves.

Basic rules of first aid in hand injury

a) Stop the bleeding (the best is the compressive bandage, in case of unsuccessful attempt we should apply tourniquet on the arm. It is necessary to put there information about the time of application, after 1.5 hour the tourniquet is necessary to be removed.)
b) Sterile wound dressing
c) Immobilization on splint, cooling down over the dressing
d) Analgetics
e) Transport

Anatomy, physiology, investigations and treatment of the most common type of injuries.

1. Skin injuries

Anatomy:

Skin on the volar side of hand has a thick dermal layer which is firmly fixed to the palmar aponeurosis with vertical fibrous septums between fascia and dermis and therefore is minimally mobile. Palmar aponeurosis creates in palm solid fibrous layer placed between skin with a slim layer of subcutanneous fat tissue and flexor tendons. Skin on the dorsal side of hand has very fine subcutanneous tissue with minimal fixation to the deep layer and therefore is very well mobile. Thin subcutanneous tissue consists of major dorsal venous system for the hand and rich lymphatic drainage. Thus even small injuries on palm side of hand presents with swelling of dorsal side of hand without any injury there.

Treatment:

Treatment of skin injury can be divided according to the location, size and quality of skin shell. We try to use as simpliest procedure as possible to preserve the best quality of skin shell (see Chapter Cover of defects)

1) Healing per secundam intentionem (small defects)
2) Direct suture
3) Local advancement
4) Skin graft
5) Local flap
6) Distant flap
7) Free tissue transfers

2. Muscles and tendon injuries

Anatomy:

Hand movement is possible due to flexors, extensors and small hand muscles.

Flexor aparatus:

Flexors insert by their muscles bellies at medial epicondylus of humer, radius, ulna and interosseal membrane. At the area of distal third of forearm the muscles continue as tendons which are wrapped in a slim sheath - peritenonium which enables tendon nutrition by its vascular perfusion. The nutrition of flexor tendons is maintained by synovial fluid and vascular nutrition of tendon at the site of reinsertionf of tendon to the bone, on muscle-tendon transition point, from vincula. Synovial fluid is produced by cells of synovial vagina which wraps flexor tendons on fingers and partially in palm. Flexor tendons on fingers run through osteofibrous canal which is created from a series of fibrous bands (on fingers A1-A5, on thumb A1, A2). At each tendon in osteofibrose canal is the insertion of usually 3 slim fibrous strips - vincula in which is the vascular nutrition of tendon (see. fig. 1, 2).

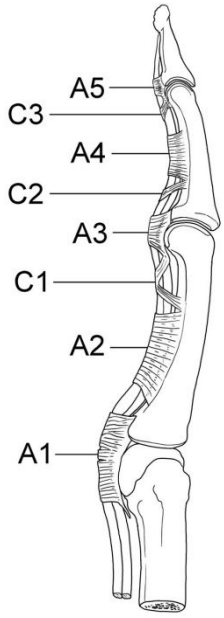


Fig. 1 Fibrous bands on fingers

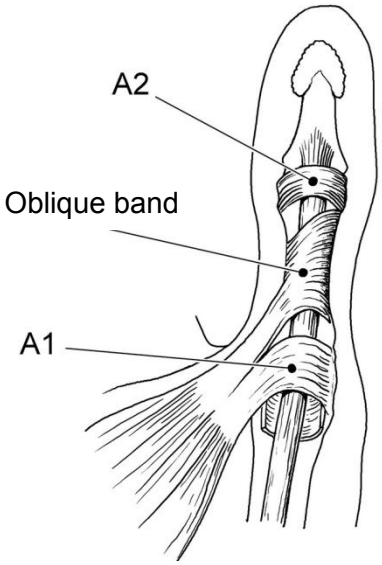
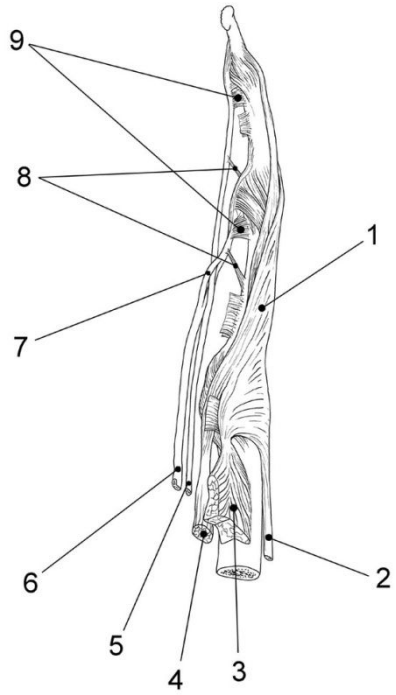


Fig. 2 Fibrous bands on thumb

At II. to V. finger in middle phalanx inserts the superficial flexor muscle *(M. flexor digitorum superficialis).* At the proximal phalanx of finger the flexor divides into two arms (bifurcatio tendineum), between them is going (chiasma tendineum) deep flexor (*M. flexor digitorum profundus)*, which inserts to the distal phalanx. Deep flexor bends the finger in distal interphalangeal joint (DIP), superficial flexor bends the finger in proximal joint (PIP). (see. fig. 3).



Description:

1 – aponeurosis dorsalis

2 – tendon of extensor

3 – m. interosseus

4 – m. lumbricalis

5 – m. flexor digitorum profundus

6 – m. flexor digitorum superficialis

7 – chiasma tendinum

8 – vincula longa

9 – vincula brevia

Fig. 3 Tendons of finger

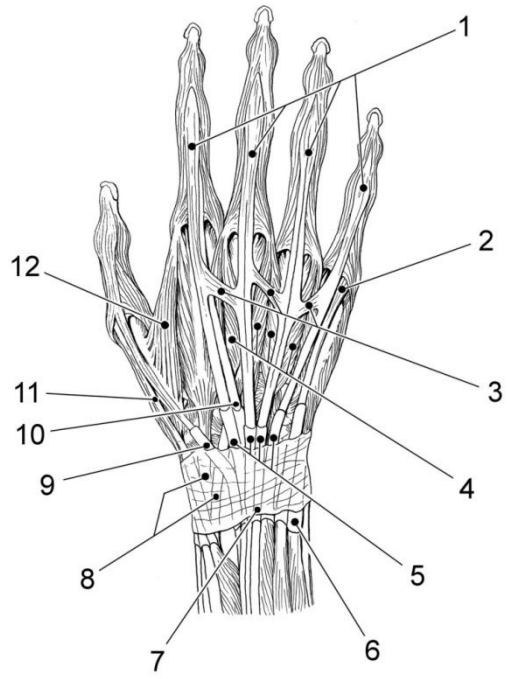
Thumb bends in interphalangeal joint by tendon of long thumb flexor (*M. flexor pollicis longus)* which inserts to the distal phalanx.

All these flexor tendons of fingers and thumb along with median nerve go through carpal tunnel (canalis carpi) on the volar side of wrist and in three layers. Upper level has a superficial flexor for third and fourth finger; middle level consists of superficial flexor for 2nd to 5th finger together with median nerve and long thumb flexor. Deep layer consists of deep flexor tendons for 2nd to 5th finger. Tendons of wrist flexors *(M. flexor carpi radialis et ulnaris)* insert on carpal bones and basis of metacarpal bones on radial and ulnar side. Into the palm aponeurosis inserts *m. flexor palmaris longus.* On tendons of deep finger flexors on palm begin *mm. lumbricales*, between metacarpals begin *mm.interossei palmares et dorsales* and they together insert on the lateral parts of fingers to the dorsal aponeurosis.These muscles do a flexion of proximal phalanx and at the same time also extension of proximal (PIP) and distal interphalangeal (DIP) joint.

Extensor aparatus:

Extensor muscles begin on lateral epicondylus of humer, radius, ulna and interosseous membrane. Muscle bellies start to be tendons in distal third of forearm. Extensor tendons on dorsal side of wrist go below fibrous band *(retinaculum extensorum)* in eight osteofibrous tunnels to the hand. Extensor tendons do not have vinculum. Common extensor for fingers (*m. extensor digitorum communis*) inserts to the dorsal aponeurosis for II. - V. fingers where he creates medial band of dorsal aponeurosis above proximal and middle phalanx at its place of the insertion. Dorsal aponeurosis consists of medial and lateral bands. Lateral bands of dorsal aponeurosis insert in the base of distal phalanx. To the lateral bands insert small hand

muscles which do extension in distal and proximal interphalangeal joints and on the contrary they do flexion of metacarpophalangeal joints (MCP). Each tendons of common extensor are connected between themselves above metacarpals by fibrous bands (*connexus intertendineus*). Index finger and little finger have other single tendon going along with common extensor of fingers (*M. extensor indicis proprius et m. extensor digiti minimi*). Extension and at the same time abduction is possible due to: long thumb extensor(*m. extensor pollicis longus)* which inserts at distal phalanx and does the extention of distal phalanx, short thumb extensor (*m. extensor pollicis brevis*) inserts on the basis of proximal phalanx and long thumb abductor (*m. abductor pollicis longus*) inserts on the basis of I. metacarpal bone. Tendons of wrist extensors (*M. extensor carpi radialis longus et brevis, m. extensor carpi ulnaris*) insert on the basis of metacarpal bones. Extensor tendons have flat shape on fingers and above metacarpals and they change the shape to oval on the wrist. (see. fig. 4).



Description:
1 – dorsal aponeurosis
2 – m. extensor digiti minimi
3 – connexus intertendinei
4 – mm. interossei dorsales
5 – vagina synovialis tendinum mm. extensoris digitorum
6 – m. extensor carpi ulnaris
7 – retinaculum extensorum
8 – tendon and vagina synovialis tendinum m. extensoris carpi radialis longi et brevis
9 – tendon and vagina synovialis tendinum m. extensoris pollicis longi
10 – tendon and vagina synovialis tendinum m. extensoris indicis
11 – tendon and vagina vagina synovialis tendinis m. abductoris longi et extensoris pollicis brevis
12 – m. interosseus dorsalis primus

Fig. 4 Extensors of fingers and its vaginaes synovialis

Examination of function of flexor tendon aparatus

It is necessary to examine hand carefully in case of suspected tendon injury. The result of the examination in more complex hand injuries can be mimicked by pain, bone injury or nerve injury. If we have uncertain clinical examination, there is always indicated the revision of wound. We should always examine both hands to compare the findings.

During the examination of function of deep finger flexor the doctor fix the middle phalanx of patient´s finger and ask her/him to do flexion of distal phalanx. If the patient is able to do this, there is no laesion of tendon. (see. fig. 5).

Long flexor of thumb we examine at the same manner, but we fix the proximal phalanx of thumb. In case of an injury of the short flexor patient is not able to bend thumb in metacarpophalangeal joint (MCP). Function of superficial flexor we examine by putting the hand on the surface with palm facing up. We let the examined finger free, but other fingers are fixed by examiner to the surface with the pressure at distal phalanges. Later patient is asked to bend an examined finger. If the tendon of superficial flexor is without injury, patient can do the flexion of the finger in PIP joint (see. fig. 6).

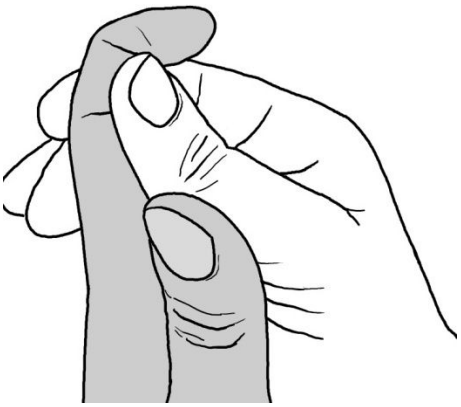


Fig. 5 The examination of function of deep finger flexor

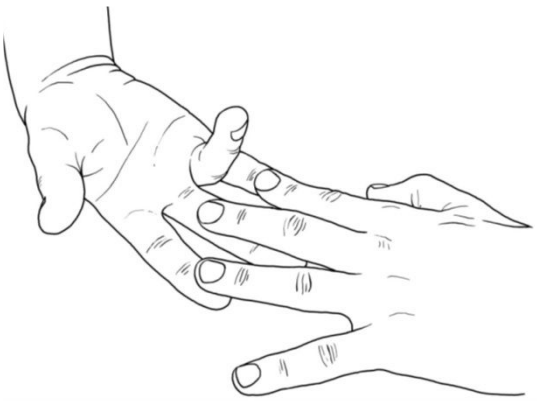


Fig. 6 The examination of function of superficial finger flexor

Classification of flexor aparatus injuries

Each zone of injury requires different approach to treatment and following postoperative care. Thumb and fingers have their own division to the zones.

Zones of injuries on fingers:

Zone 1: distally from the insertion of superficial flexor in the middle phalanx

Zone 2: betweeen first annular band (A1) above metacarpophalangeal joint (MCP) to the insertion of superficial flexor in the middle phalanx

Zone 3: between distal edge of carpal fascia and A1 band

Zone 4: carpal tunnel

Zone 5: proximally from carpal tunnel

Zones of injury on thumb:

Zone T1: distally from interphalangeal junction (IP)

Zone T2: between first annular band (A1) above metacarpophalangeal junction (MCP) to interphalangeal junction (IP)

Zone T3: thenar

Zone T4: carpal tunnel

Zone T5: proximally from carpal tunnel

Treatment of tendon aparatus

Partial tendon injury to the 25% of its circumference is not necessary to be treated by suture, while there is an injury of 25-50% of its circumference, the tendon is sutured by continuous suture, injury above 50% of its circumference we treat with the fixation stitch and the tendon

is sutured by adaptation continuous suture. For the suture of tendon we use atraumatic sutures from monofilament or polyfilament material. There had been described a lot of fixation tendon sutures, its use depends on the practice and experience of a surgeon (see. fig. 7).

Example of tendon sutures:

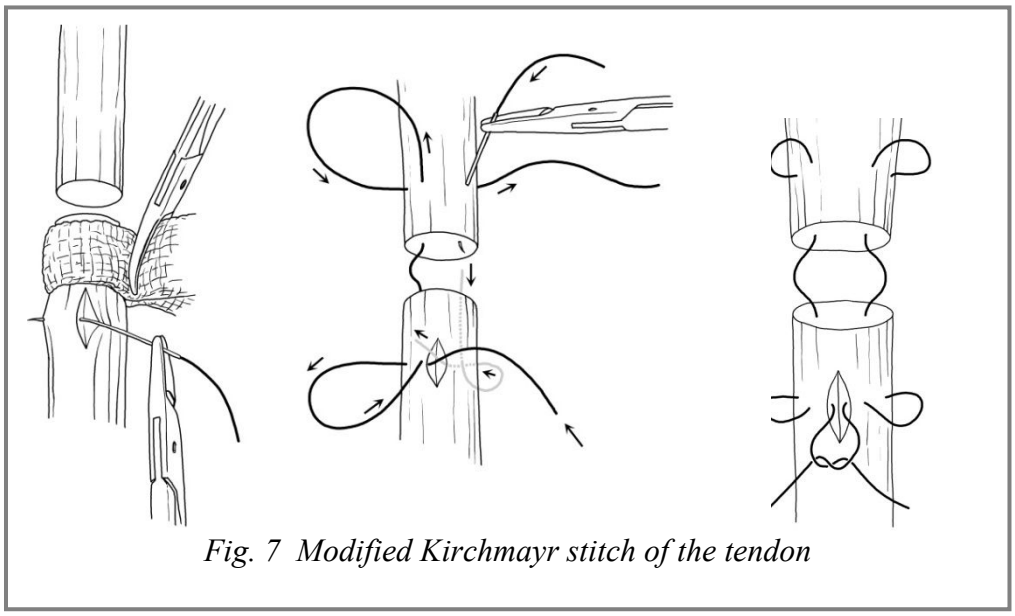


Fig. 7 Modified Kirchmayr stitch of the tendon

Treatment of flexor tendon injuries:

Zone I:

The suture of tendon, if there is an injury of tendon at the area of insertion at distal phalanx (less than 1cm), we do the reinsertion of tendon.

Zone II:

Suture of both tendons is made, very careful adaptation especially in the area of chiasma tendineum. This zone is also called "No-man's land". Results of the suture at this area are the worst (due to small diameter of tendon vagina there are frequent postoperative adhesions)

Zone III:

Suture of both tendons is performed in palm. Results at this zone are very good.

Zone IV:

Injury of tendons in carpal tunnel requires suture as well as revision of median nerve at all times, because nerve is passing along the tendons and can be also injured.

Zone V:

The results of tendon sutures at this area are the best. Problematical is the suture in muscle-tendon junction or suture of muscle itself, because the suture can cut through

Physiotherapy after suture of flexor tendons

The strength of tendons is the smalles between the days 9-15. After 3 weeks we can start with gradual burden of the sutured tendon. According to the beginning we can divide physiotherapy to an early and late. According to the load of tendon by the patient we divide physiotherapy to passive, semiactive, active.

In case of late physiotherapy we start with an exercise after 3 weeks, till then is limb fixed. This method leads to freaquent adhesions of tendon with the surrounding tissue with the necessity of their surgical release. The aim of passive physiotherapy is to exercise small hand joints without active flexion or extension (Duran-Hauser method). Semiactive method of physiotherapy uses the technique of s.c. Kleinert´s dynamic tension. (see fig. 8) The principle of this method is based on the patient providing an active extension of fingers and then release of extension for passive flexion. Passive return (flexion) of fingers to the palm is possible due to elastic tension (rubber band) which is fixed on the nail and wrist. During an active physiotherapy patient actively uses not only extensors but also flexors.

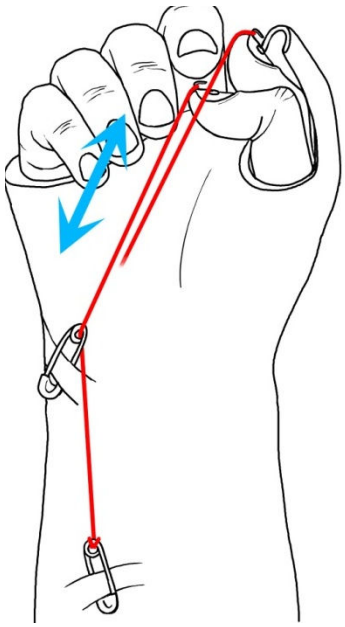


Fig. 8 Kleinert´s dynamic tension

Examination of function of extensor tendon aparatus

In case of an injury of muscle, tendon or nerve which inervates described muscle, the patient is not able to carry out the following movement:

M. extensor communis: extension of MCP during the flexion of PIPand DIP joints (Pic. 9.)

M. extensor digiti minimi: individual little finger extension during the flexion of fingers

M. extensor indicis proprius: individual index finger extension during the flexion of fingers

M. extensor pollicis longus: extension of distal phalanx of thumb

M. extensor pollicis brevis and m. abductor pollicis longus: thumb abduction

Mm. interossei palmares: adduction of fingers towards to the third finger

Mm.interossei dorsales: abduction of fingers from the third finger

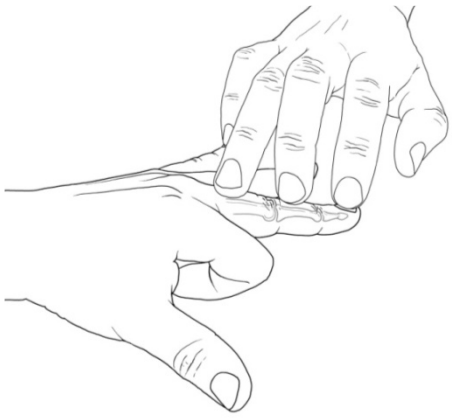


Fig. 9 Examination of m. extensor digitorum communis

Classification of injuries of extensor aparatus

Each zone of injury requires different approach to treatment and also to the following postoperative care. Thumb and fingers are divided into their own zones:

Zones of injury on fingers:

- *Zone 1*: distally from distal interphalangeal joint (DIP)
- *Zone 2*: middle phalanx
- *Zone 3*: proximal interphalangeal joint (PIP)
- *Zone 4*: proximal phalanx
- *Zone 5*: metacarpophalangeal joint (MCP)

Zone 6: metacarpals (dorsum of hand)
Zone 7: wrist (retinaculum extenzorum carpi)
Zone 8: distal wrist (up to muscle-tendon border)
Zone 9: proximal wrist

Zones of injuries on thumb:
Zone T1: IP joint
Zone T2: proximal phalanx
Zone T3: metacarpophalangeal joint (MCP)
Zone T4: I. metacarpal bone
Zone T5: metacarpocarpal joint (CMC)
The other zones are same as zones for fingers.

Treatment of injuries of extensor tendons:
For the suture of tendon is usually used non-absorbable monofilament material. Extensor tendons have flat shape and for the suture are mainly used U shape sutures to prevent stitch from cutting through (zone 1-6). (see fig. 10.) The shape of tendon changes to oval on wrist and foream and we use the same type of suture as on flexors (zone 7-9). (see. fig. 7).

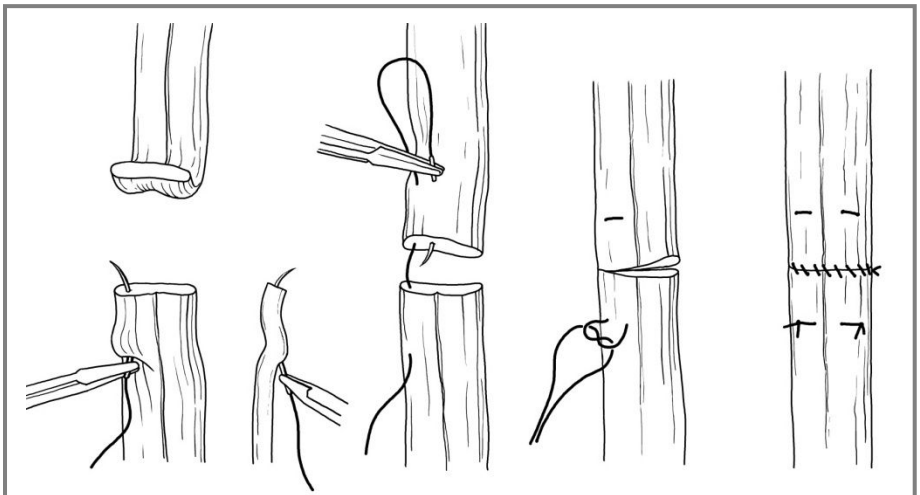


Fig. 10 Suture of flat tendon

Zone 1:
Transsection of tendon leads to the development of permanent flexion of finger in DIP joint (hammer finger deformity). Closed isolated injury of tendon or injury with a small bone fragment we treat conservatively by fixation of distal phalanx in extension on the splint for the period of 6-8 weeks. Bigger bone fragment with the insertion of extensor is sometimes necessary to fix with osteosynthetic material (Kirschner wires, screws, bone suture). In case of open injury we suture at the same time skin and extensor, the time of fixation is the same

Zone 2:
In case of injury of lateral bands at distal part of middle phalanx there will develop the hammer finger deformity. If there is an injury of media band of dorsal aponeurosis at

proximal part of middle phalanx, there will be the deformity of button hole (Boutonniere‘s deformity). We find the typical position of PIP joint which is in the flexion due to the transsected medial band. The tension of non-injuried lateral bands leads on the other way to the hyperextension in DIP joint. Both types of injuries we treat with the suture of tendon and apply and splint for 6-8 weeks.

Zone 3:

Injury of medial band leads to the development of Boutonniere deformity. The treatment is similar to the zone 2.

Zone 4-9:

Suture of tendons is performed with application of splint for 5-6 weeks.

Physiotherapy after treated extensor tendons

Active physiotherapy is very individual, generally starts when the tendon is healed after finished application of splint. Extensor tendons heal in relation to flexors (average is 3 weeks) longer (5-8 weeks). Injury at zone 1 we start to exercise almost at every time after full healing. The tendon is replaced by a scar and needs to have enough time to mature. Passive soft exercise in PIP, MCP joints and wrist is the prevention of tendon adhesions with surrounding tissue and prevents the joint stiffness. At proximal zones we can use semiactive methods of physiotherapy with dynamic tension. The choice of appropriate technique depends on local finding, method of treatment, and compliance of patient.

3. Nerve injuries

Anatomy:

The functional unit of peripheral nerve is axon covered by endoneurium. Group of axons create nerve fasciculus covered by perineurium. Peripheral nerve consists of fascicles which are usually mixed, it means that they consists of sensitive (thinner) and motoric (thicker) fibres. The whole nerve is covered by epineurium, fibrous tissue which consits of vascular and lymphatic circulation.

Hand has 3 main nerve supplies.

N. medianus is located at the volar side of a wrist between tendons of m. palmaris longus and m. flexor carpi radialis, enters to the canalis carpi (below lig. carpi transversum) and to the palm area where is the terminal branching on motoric branch for thenar muscles, sensitive branch for a thumb, three communal digital arteries for 1, 2 and 3 interphalangeal space. Sensitivelly n. medianus covers palmar side of a thumb, 2, 3 and radial half of 4^{th} finger. At the dorsal side inervates in fingers mentioned above the area of distal phalanges. (see fig. 11.) Motoric function of n. medianus is the inervation of all tendons of flexor except ulnar half of deep flexor, m. flexor carpi ulnaris, mm. interossei dorsales and palmares and mm. lumbricales of 4^{th} a 5^{th} finger. The muscles mentioned above have the inervation by n. ulnaris.

N. ulnaris on wrist goes along ulnar artery between tendon of m. flexor carpi ulnaris and m. flexor digitorum superficialis, to the palm enters into fascial canal (Guyon´s canal) outside of

lig. carpi transversum and radially from os pisiforme. After an exit the nerve divides into surficial and deep branch. Superficial branch goes towards 5th and ulnar side of 4th finger which inervates sensitively the the palm and dorsum including dorsal part of hand approximately to 4th metacarp. Deep branch motoricaly invervates in palm small hand muscles except mm. lumbricales for 2nd a 3rd finger which are inervated by n. medianus. (see. fig 11.)

N. radialis inervates motorically the dorsal group of muscles on forearm. From radial volar side of wrist the nerve goes outside of canalis carpi, curls radially at dorsum between m. abductor pollicis longus and m. extensor pollicis brevis. Sensitively n. radialis inervates dorsum of thumb, that dorsal part of hand which is not inervated by n. ulnaris, dorsum of 2nd and 3rd finger including radial half of 4th finger. (see. fig. 11).

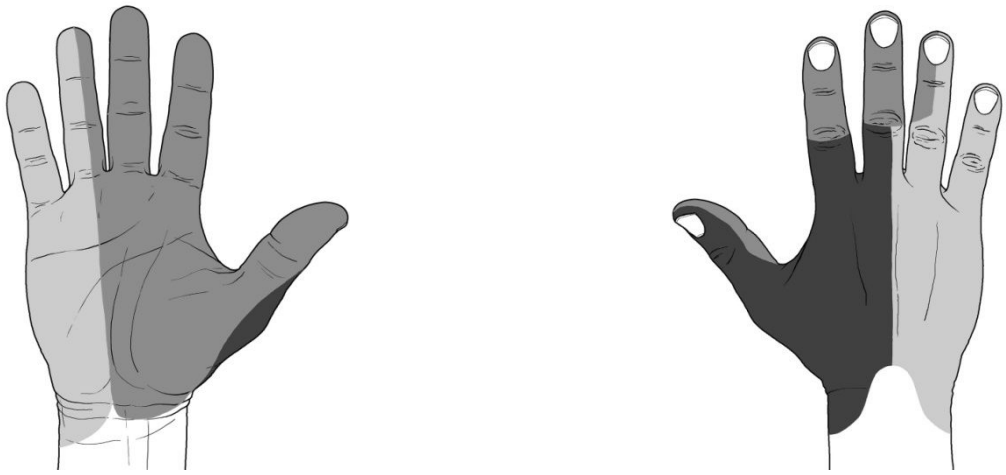


Fig. 11 Sensitive inervation of the hand (black: n. radialis, grey: n. medianus, light: n. ulnaris)

Pathophysiology:

Axon is covered by myelin sheath. Nerve injury leads to s.c. Wallerian degeneration and regeneration. An injured axon with myelin sheath breaks down, and is fagocytated by Schwann cells which also overbridge the nerve defect with the new tissue – Buerger´s bands which are as conductor for penetration of axons. If there do not develop the connection of central nerve stump with peripheral, then will develop neuroma at the end of central nerve stump.

Classification of nerve injuries according Seddon:

1. *Neurapraxis* – the functional injury, axons are not severed, the spontanneous recovery is possible in period around 6 weeks.
2. *Axonotmesis* – axons are severed, sheaths are preserved, Wallerian degeneration and regeneration by distal stump, the correction without a loss within 4-6 months
3. *Neurotmesis* – the complete severance of nerve

Examination:
An examination of sensitive inervation of single nerve branches have to be done before an aplication of local anaesthesia. We examine the patient without his/her eye control with touch by a bud or finger of examiner.

Treatment:
Completely or partially severed nerve we treat by suture. Suture can be done epineurally (only for epineurium) or perineurally (single fascicles). The success of fuction recovery in case of epineural suture is around 75%, in perineural 90-95% (see Chapter - Replantations). An exact adaptation and suture without tension are the main predispositions for success. During an adaption of severed nerve surgeon orientates herself/himself according to the picture of vascular supply which is in epineurium, according to the size and position of fascicles. Nerve defects are overbridged by nerve grafts primarily or are delayed according to the clinical picture. In case of motoric branches the reconstruction is possible approximately within 6 months, later occur the gradual destruction of nerve-muscle plates and transition of nerve impulse is impossible. In case of sensitive branches, mainly in fingers it is possible to suture the nerve in old injuries also after 2 years, later the success of recovery of sensitivity significantly decreases

4. Vascular injuries

Anatomy:
Hand has blood supply from 2 main arteries, a. radialis and a. ulnaris. Both arteries create between themselves in palm two arches, arcus palmaris superficialis and arcus palmaris profundus. From arcus palmaris superficialis which provides the main blood supply for the nutrition of fingers, go to the each interphalangeal spaces of three digit fingers communal digital arteries, which have further branches of single digital artery going on each finger palmary radially and ulnary with digital nerves. The thumb has the supply from its own artery (a. princeps pollicis) being the branch directly from a. radialis or from arcus palmaris profundus. Veins go along the arteries however for the outflow of blood from hand is dominant vein system localized at dorsum of the hand.

Examination of vascular system:

1. *Inspection and palpation* (colour and temperature deviations)
2. *Allen´s test* (On wrist an examiner with the pressure of her/his fingers compresses a. radialis and a. ulnaris, patient makes her/his fingers bloodless by doing several times extension and flexion of fingers. Consequently the pressure is released at one artery and we assess the return of pink colour of the hand. Positive test means good perfusion of the hand during release of only 1 artery)
3. *Doppler investigation*
4. *Arteriography*

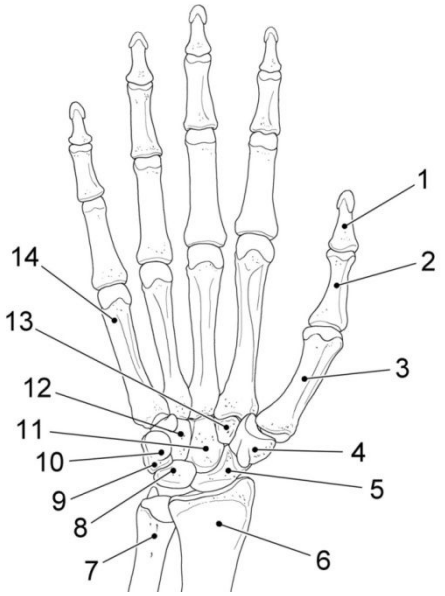
Treatment:
Before the final treatment we try to stop the bleeding with pressure bandage. If this procedure is unsuccessful, we apply the tourniquet. The correct application of tourniquet is very

important to avoid the compression of veins only and development of consequent swelling of hand because the blood flow is not stopped.
Ischaemic changes at hand periphery (cold, paleness, change of capillary filling at nail bed) are the indication for transport of patient to the replantation centre to recover the perfusion - revascularisation by microvascular technique. (see Chapter - amputation injuries, replantations).

5. Skeleton injuries

Anatomy:

Thumb has 2 phalanges, proximal and distal. 2nd-5th fingers have 3 phalanges, distal, middle and proximal. Distal and proximal interphalangeal joints (DIP, PIP) have cylindrical shape allow the movement only palmary and dorsaly. Metacarpophalangeal joints (MTC) have rounded shape and allow the movement also in lateral direction. Carpometacarpal joints (CMC) of 2nd -5th fingers have the minimal function for the movement of hand in contrary to the 1st carpometacarpal joint. The wrist is created by 8 carpal bones which are in two rows. (see fig. 12).



Description:
1 – phalanx distalis
2 – phalanx proximalis
3 – metacarpus primus
4 – os trapezium
5 – os scaphoideum
6 – radius
7 – ulna
8 – os lunatum
9 – os triquetrum
10 – os pisiforme
11 – os capitatum
12 – os hamatum

Fig. 12 Skeleton of the hand-palmar view

Examination:

In case of suspected skeleton injury is except physical examination (inspection, palpation) also always indicated X-ray.

Types of fractures:

Fractures are divided in child and adult; opened and closed; traumatic and pathological; with dislocation or without dislocation of fragments; extraarticular and intraartikular; transverse, oblique, spiral, comminutive, and avulsions.

Treatment of fractures:
If they are dislocated, fractured fragments are necessary to be aligned (especially also minute rotations) and subsequently fixed. Treatment can be conservative (plaster, plastic fixation) of surgical. During surgical fixation of fragments we can use following types of osteosynthesis:

- Kirschner wires (one of the most common osteosyntesis on hand and fingers, an introduction of wires is possible also percutanneously)
- Wire loop
- Cerclage (bored fragments are fixed with the wire loop in shape of number 8.
- Screws.
- Splints
- External fixators

Hand fractures heal during uncomplicated process within 2-3 months.

Fractures of phalanges:
Fractures of nail tuberosity we preserve eventualy we fix by stitches the nail that is used as a biological splint. Unstable fractures of distal phalanx are in most cases fixed in axis by introduced Kirschner wire. Intraarticular fractures of distal phalanx can lead to dislocation of fragments due to the traction of extensor insertion at the base of distal phalanx. The finger is permanently in flexion in DIP joint and creates the deformity of hammer finger. Fractures of middle and proximal phalanges can be dislocated by the traction of inserted small hand muscles. The treatment is based on the reposition and fixation at splint or osteosynthesis with Kirschner wires, small screws, less usually with mini-splints. Comminutive intraarticular fractures of DIP and PIP joint are sometimes necessary to be treated by implantation of artificial joint or permanent immobilization of joint –arthrodesis.

Metacarpal fractures (except thumb):
Non-dislocated fractures we fix at splint for the period of 4 weeks. Non-stable and dislocted fractures after reposition we fix according to the local finding with Kirschner wires, screws, splints, external fixators, wire loops. The special type of fracture is s.c. boxer‘s fracture in the area of neck of metacarp on 4^{th} and 5^{th} finger. For this type of fracture is typical dislocation of head of metacarp palmary. The treatment consists in the reposition of fragments by traction onto the finger in its axis and following fixation of finger in 90 degrees in MCP joints at extension of fingers in PIP and DIP joints.

Metacarpal thumb fractures:
Especially serious are intraarticular fractures in the base of I. metacarp. The break of volar fragment at the base of I. metacarp is called *Bennett‘s fracture*. Comminutive fracture at the base of I. metacarp is called *Roland‘s fracture.* In this fracture are usually broken both condyles of the base of I.metacarp with the fracture line in the shape of letter T or Y. The treatment consists in exact reposition and fixation of fragments. However these injuries often lead to the limitation of thumb movement in carpometacarpal (CMC) joint eventualy to the development of painful arthrosis of joint.

6. The reconstruction of grip function and replacement of hand

The loss injury of a part or the whole hand can mutilate the patient bearing on the function but also an aesthetic aspect. During the reconstruction we aim first of all to allow to the patient the grip function, provide him/her independence

Reconstruction of thumb:

The best functional and aesthetic results have free transfers of fingers or big toe of foot. The sensitivity and movement of reconstructed thumb persists in a different extent. The important aspect is in the similarity of skin cover which is unique for fingers of hand and toes of foot. Thumb bone we can reconstruct with bone or cartilage graft (ala ossis illii or rib). The cover of bone we can create with tubulated flap from groin or by transfer of free fasciocutaneous flap (e.g. from forearm). The thumb reconstruction by transposition of II. or IV. finger on neuro-vascular pedicle is called pollicisation of three digit finger. During amputations of part of thumb only we can improve the grip function by deepening of I. interphalangeal space with Z plasty or Z plasty with the combination of skin graft. The extension of thumb is possible by distraction of I.metacarp by Ilizar method. Its principle is the possibility to shape and also to enlarge originating calus.

The reconstruction of three digit fingers:

Again the best results are from transfers of toes from foot. The most often used is II. toe. In case of missing more fingers we can perform multiple transfers of toes from foot. Missing fingers or their parts are possible to be covered by special tailored stall silicone prostheses. These prostheses have the meaning aesthetic and psychological.

Reconstruction of hand after amputations in wrist and forearm:

Nowadays the most common option of treatment is the use of prostheses. Prostheses can be cosmetic, mechanical (tractions controlled by body movement) or myoelectric (the reading of impulses from muscle stumps). If there is not possible another type of reconstruction, we can still use Krukenberg operation. It is the creation of a cheliform grip between radius and ulna which are from each other partially separated and covered with soft tissues. The next option of reconstruction is its allogenic transplantation. Now however the predisposion of this treatment is imunosupression for ever which is the main limiting factor for this approach.

Amputation injuries of the upper extremity

(classification, definitions and nomenclature)

Miroslav Tvrdek

Amputation is an injury in which all anatomical structures are totally or partially divided, and where the amputated peripheral part shows no sign of a blood suply.
The term **total amputation** is restricted to cases in which there is separation of all structures. **Subtotal amputation** is an injury in which the most important anatomical structures, particularly blood vessels are separated and there is no longer any evidence of circulation in the distal part.

Replantation means the operative restoration of all structures important to the function of the amputated part, including re-establishment of the circulation, following amputation injury.
If important anatomical structures remain intact, and there is a clear sign of residual blood supply, than such a case must be defined as a **serious combined injury with vascular impairment** and following operative restoration is called revascularisation

Revascularization means the restoration of the main vascular connections in case in which some or many of the important structures remain intact and in which is evidence of a circulation. The vascular anastomosis improves the circulation of the peripheral part.
There is the major difference between revascularisation and subtotal amputation, in the latter one, without vascular anastomoses, necrosis of the peripheral part would occur.

Primary treatment of amputation injuries

The initial treatment is primary concerned with maintaining the vital functions of the injured person, according to the rules of general accident surgery – control of respiration, circulation, treatment of shock. It is important that amputated part is found and brought with the patient, a point which is not as obvious as it first appears. Manipulation of the stump such is cleaning, disinfection, clamping or ligation, should be avoided. The injured tissues should be only rinsed with normal saline. In cases of subtotal amputation in the hand, partially amputated parts are covered with saline-moisten gauze and bandage, the injured extremity is immobilised by splint. Devascularized part is surrounded with ice bags. If the amputation is complete a pressure dressing and elevation is always sufficient to stop the bleeding from amputation stump. The amputated part should be only rinsed and wrapped in saline moisten gauze and placed into plastic bag, this bag is than placed to another bag which

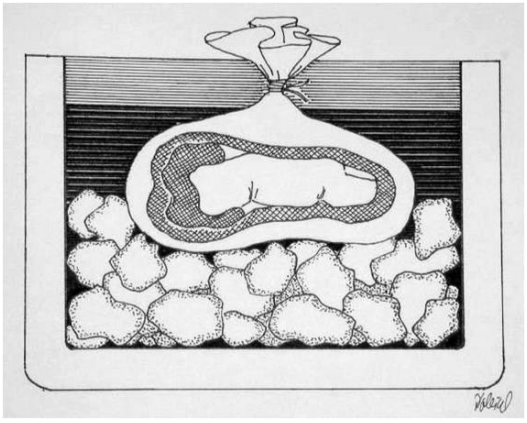


Fig. 1 Dry-cooling of the amputated part

contains water with ice-cubes. This is so-called „dry cooling“at ca. 4^{o} C. This cooling effectively lengthens the survival time and the feasibility of replantation of a digit up to almost 24 hours (see fig. 1).

Indications for replantation

After initial shock following an amputation injury, it is a natural reaction of the most patients to seek replantation at any price. Generally the patient has the misconception that through replantation the amputated part will be restored fully, for example in hand amputation that the appearance and function will return to normal. It must be specifically explained to the patient that this goal is seldom achieved. In many cases, however, the final decision as to whether an attempt of replantation has a good chance of success can only be made during actual operation, and this must be explained to every patient beforehand.

It is essential to discuss with the patient the probable functional result, the necessary treatment plan, including the lengthy operation, time in hospital, post-operative management and incapacity to work.

There is universal agreement that there is a clear indication for replantation in thumb and multiple digits amputation, in middle-hand and hand amputations and in distal forearm amputations. Also, there is always an indication for replantation in children, because of the more favourable results.

Whether replantation should be attempted or not in individual cases varies from person to person. However, certain guidelines based on experience may be summarized as follows:

Age: Children show the best results because of better reinnervation and minor tendency for tendon adhesion. Very good results can be achieved even in adults though they deteriorate significantly with increasing age. This is mainly due to the declining success of reinnervation, more marked adhesions of tendons and joint stiffening.

Patient's general condition: Replantation can be only considered if the other serious injury was ruled out. Sometimes a pre-existing systemic disease, the sequalae of former injuries or mental retardation may also preclude replantation.

Occupation: Loss of one finger, except the thumb, can be very well compensated in many occupations. A manual worker may be almost unaffected by such a loss, whereas a musician would be completely unable to work.

Level of amputation

As well as the severity of tissue damage at the site of the injury (clean cut, crush, avulsion or torn tissue), the level of amputation is very important. The outlook for good reinnervation is better in distal than in proximal replantation because of shorter regeneration distance. On the other hand good flexor tendon function is the exception rather than the rule in proximal finger replantation. Flexor tendon adhesion represents a special problem at this level. The level of amputation is particularly important with regard to the muscle mass contained in the amputated part, which is considerable proximal to the musculotendinous junction in the forearm. In this proximal, so called major replantation is permissible pre-operative ischemic time shorter than for minor replantations because of the very low ischemic tolerance of the muscles in comparison with the other tissues in the extremities. After six hours´ anoxemia

without cooling, considerable irreversible muscular damage can be expected in the case of major replantation.
In adults an absolute and relative indication for replantation by reference to the level of amputation can be following:
Absolute indications are amputation of the thumb, multiple finger amputation, amputation in palm, wrist and distal third of forearm (see fig. 2, 3, 4, 5).
Relative indications are the amputation of the one finger or its part, except the thumb, amputation in the upper levels of the extremity (see fig. 6).
For reasons already mentioned, the indications for replantation in children are far broader.

Operative procedure
Very important part of preparing amputation stumps is meticulous debridement. All foreign bodies and destroyed tissue parts must be removed. All anatomical structures essential to replantation, especially nerves and vessels stumps, must be identified and marked with fine threads. They are than easier to find following osteosynthesis.
Stabilisation of the skeleton is the next step which can be achieved in various ways (cerclage, Kirschner´s wires, small plates or external fixation) and depends of the level of amputation Destroyed joints should be reconstructed, but if the reconstruction is impossible, than arthrodesis should be carried out. In rare cases a primary arthroplasty using a joint prosthesis is indicated.
The further sequence of reconstruction depends on the precise anatomy at the actual level of amputation.
The primary objective, of course, remains to restore blood circulation as soon as possible to the severed part. Reconstruction should start with deep tissues and continue towards the surface, for example tendon suture should be carried out before vessel anastomoses. Than follows reconstruction of the nerves and skin.
As mentioned above, the sequence of particular steps during replantation may vary according to anatomical conditions.
The basic aim is to achieve complete primary reconstruction, i.e., whenever possible all important tendons and nerves should be sutured. Secondary intervention can be complicated because of extensive scarring and with danger for reconstructed vessels.
All structures should not be sutured under tension, since this is one of the most frequent causes of failure.

Postoperative measures
After replantation the extremity is elevated. Elevation promotes venous drainage and helps to minimize postoperative swelling. Hourly surveillance of the replanted part is necessary for early capture of possible circulatory disturbances which may lead to necessity of the surgical revision.
Administration of antibiotics instituted preoperatively is continued for seven days unless complications develop.
Anticogalutation therapy can vary between replantation centers. Some prefer heparinisation, vasodilatation infusions; others use only administration of low-molecular-weight Dextran and acetyl salicylic acid orally

Postoperative complications.

General complications are rare and are usually limited to cases of major replantations. Initially they take the form of severe muscular infection which can be followed by septicaemia. Kidney complications in the form of a crush-syndrome may occur and are caused by heavy muscular contusion.

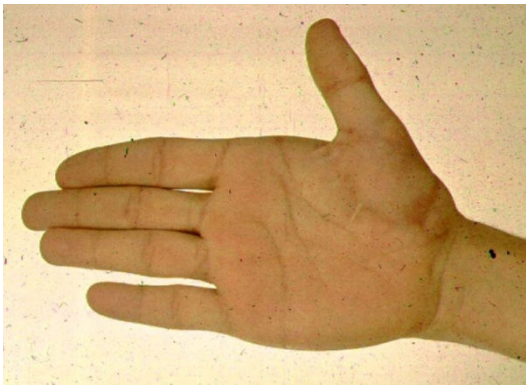
Local complications are any impairment of circulation requires immediate treatment. If the circulation cannot be restarted by immediate removing of the dressing or possibly a few stitches, surgical revision should be carried out without delay. When there is an arterial thrombosis, the digit is pale and empty. There is no capillary filling. In the case of venous thrombosis the replanted part is bluish, congestive and shows an increased capillary filling. Piercing of the skin produces mostly a spurt of bleeding.
Surgically treated vascular trombosis includes thrombectomy and resection of the former anastomosis. In some cases there is possible to perform reanastomosis without tension, but very often vein graft is required.
Pseudoarthrosis is extremely rare and usually results from poor primary osteosynthesis or a postoperative infection.

Secondary operations
The most frequent secondary operation is tenolysis. Due to relatively long period of immobilisation of individual joints by osteosynthesis, extensive adhesions occur in the tendon suture area.
The same is true for surgical mobilisation of joints, capsulotomy is usually performed.
Corrective bone surgery is considered mainly in the case of severe bone angulation and pseudoarthroses.

Figure annex:

Fig. 2a Amputation of the thumb

Fig. 2b Status immediately after replantation



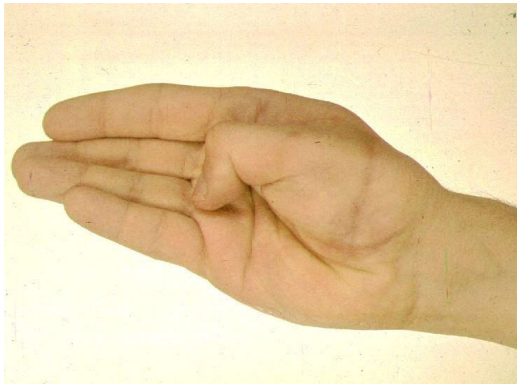


Fig. 2c, d Functional results

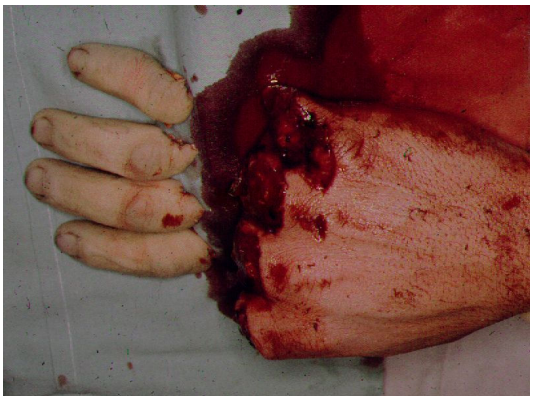
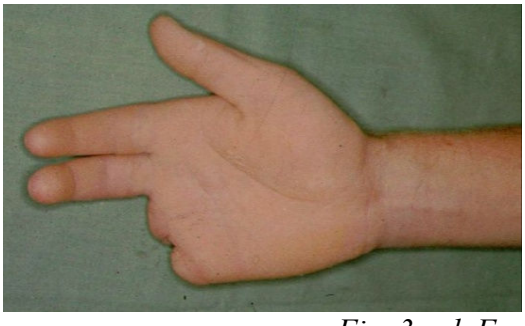


Fig. 3a Multiple finger amputation

Fig. 3b Status immediately after replantation



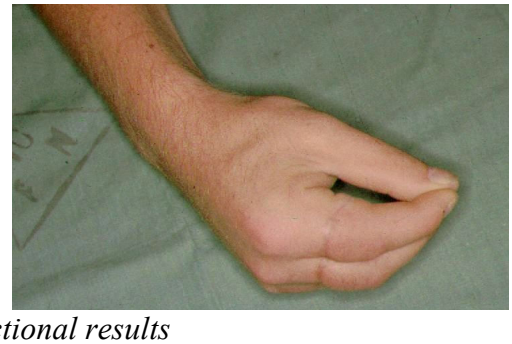


Fig. 3c, d Functional results

Fig. 4a Amputation in the palm

Fig. 4b Functional results

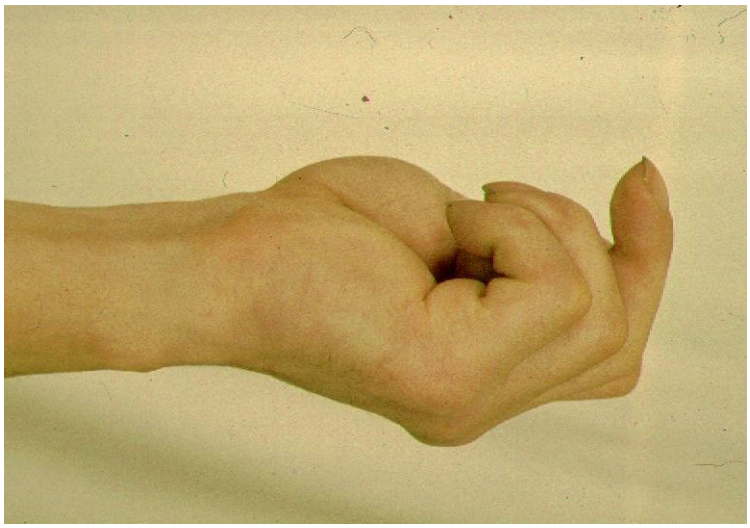


Fig. 4c Functional results

Fig. 5a Amputation in the distal third of forearm

Fig. 5b Status 3 days after replantation

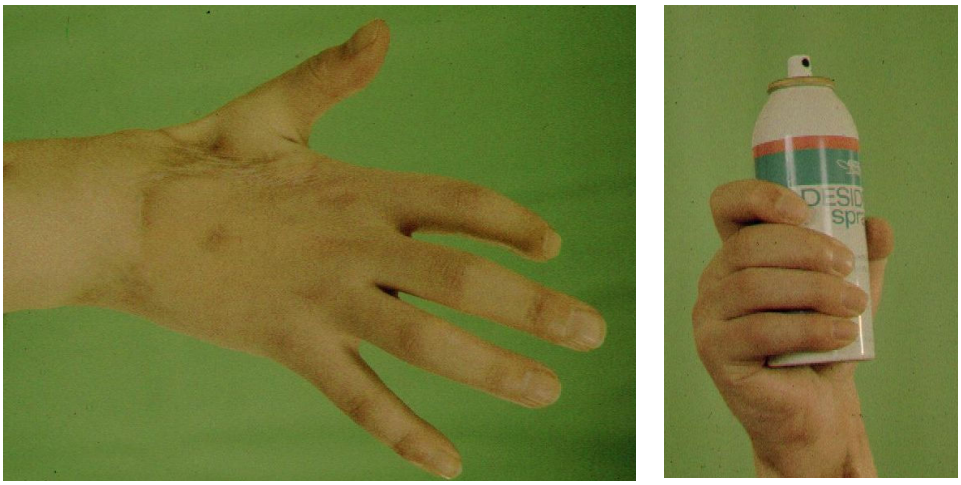


Fig. 5c, d Functional results

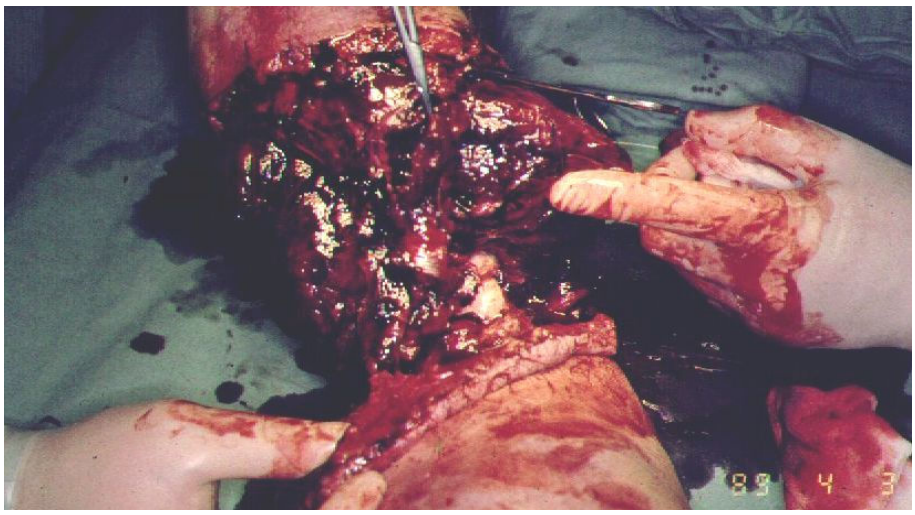


Fig. 6a Subtotal amputation at the level of elbow

Fig. 6b Status 14 days after replantation

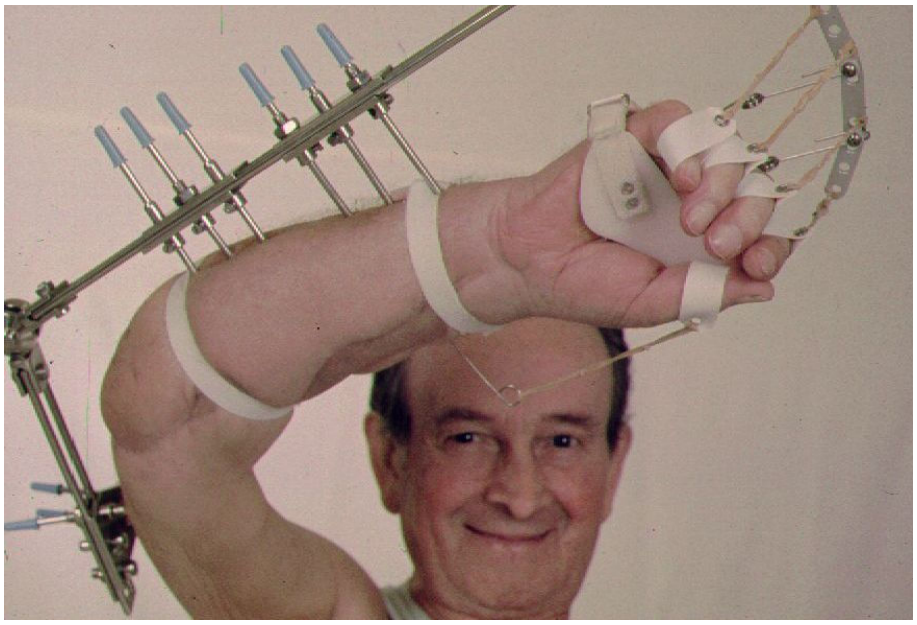


Fig. 6c Status 5 weeks after replantation

Congenital anomalies of the face

Eva Leamerová

Orofacial clefts belong to the the most common congenital anomalies. Approximatelly 1 orofacial cleft occurs in every 550 births. There were born 6 067 798 children during 1961 – 2005 in Czech Republic. Cleft lip or cleft lip and palate were diagnosed in 6747 cases, cleft palate in 4356 cases. Average incidence of cleft lip or cleft lip and palate was 11, 00 and the incidence of cleft palate was 7, 23 per 10 000 live births. There is a lot of factors that increase the frequency of cleft lip/palate, mainly due to lowering of postnatal and perioperation mortality. However, the number of childreen born with a cleft in Czech Republic is decreasing due to liberal attitude to miscarriage, when cleft is diagnosed before birth.

Classification

Orofacial clefts can be divided into typical clefts**;** it is cleft lip [CL], cleft lip and palate [CLP], and cleft palate [CP], and atypical clefts (median, transversal, oblique) and other clefts according Tessier classifcation. Typical and atypical facial clefts can both occur as an isolated anomaly, or in combination with other defects as a multiple congenital anomaly. There are periodic combinations of heredital defects that are called symdroms.

Cleft lip and palate are the most ferquent facial clefts. Their morfologigal character has primarily negative functional effect on swallowing, breathing, biting, and speech formation. Aesthetically it eminently affects the facial triangl, which does the most influence the general facial apperance. In approximately 20% of childreen is the cleft combined with other defects, isolated defect is neither lethal nor combined with mental handicap.

This hereditarry defect is tied together with hypoplasia of ivolved area. Therefore full rehabilitation of these patients needs multidisciplinary treatment, which starts immediatelly after birth and lasts till adulthood. Complex treatment, in dependence on postnatal development, health condition and growth of the patient, participates specialized team, that includes plastic surgeon, stomatologist} orthodontist, maxillofacial surgeon, dental surgeon and prosthetician), speech patologist, phoniatrician, audiologist and not least clinical psychologist. Workgroup includes also pediatrician and anesthesiologist.

However the current medical science is not able to erase the defect completely, it is necessary to carry treatment to result as perfect as possible, because the stigmatised patient s appearence, so called a secondary deformity, and defective spoken utterance, as impaired speech intelligilibity or unpleasant-sounding voice, can cause psychological barrier and insufficient self esteem. These communication disorders may hamper the personal or professional fulfilment in social envirolement and lead to decrease of life quality otherwise completely healthy people

Both parts, look of the patient and his speech, are different courses of communication disturbance. In non verbal communication, the involvement is apparently not so significant. It is closely connected with visibility of the defect. Pathological shape of the orofacial region and paological face-play disturb all three basic canals: gesticulation, face-play and positional. In verbal communication are also involved all main regions, that means voice, speech and

hearing. In voice it is mainly the impaired resonance that leads in impaired articulation. In hearing occurs conductive hearing loss due various origin. Currently 85% professions depend on communication and exchange of information, therefore a care of communication disorders is one of priorities of medicine. Thus the elimination of stigmatizing deformity rate and quality of speech became globally recognized benchmarks of the final outcome of treatment in patients with cleft.

It is obvious that this defect presents health as well as psychological and socioeconomic problems. The issue of the treatment of patients with cleft is considerd worldwide important. Close international cooperation that includes Czech Republic exist in this respect.

Treatment of facial clefts has many years' tradition in Czech Republic, the beginning of it is connedted with the name of academician František Burian.

Morphology

CL can occur as a unilateral (on the left or right side) or as a bilateral anomaly. The line of cleft always starts on the lateral part of the upper lip and continues through the philtrum to the alveolus between the lateral incisor and the canine tooth, into sutura incisiva and ends in foramen incisivum. The clefting anterior to the incisive foramen (lip and alveolus) is also called cleft primary palate. There can be a wide range of severity of cleft lip, from a notch located on one or both sides of the lip to the most severe form, bilateral cleft lip and alveolus that separates the philtrum of the upper lip and premaxilla from the rest of the alveolar arch (see fig. 1-3).

Fig.1 Unilateral cleft lip

Fig. 2 Unilateral cleft lip, jaw and palate

When CL continues from the foramen incisivum further through the sutura palatina in the middle of the palate, a CLP (either unilateral or bilateral) is present. The cleft line may be interrupted by soft bridges (skin or mucosa), hard bridges (bone) or both.

Cleft palate [CP] is ethiologically and embryologically different from CL/P. Several subtypes of CP can be diagnosed based on severity. The cleft of uvula is the minimal form of CP.

Fig. 3 Bilateral cleft lip, jaw and palate

Cleft of the soft palate is more severe form of CP. In complete CP there is cleft of the hard palate, soft palate, and cleft uvula. The clefting posterior to the incisive foramen is defined as a **cleft of secondary palate.** (see fig. 4-5).

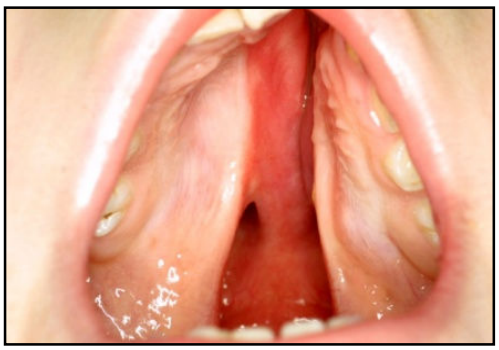


Fig 4 Unilateral cleft palate in complete cleft lip, jaw and palate

Fig. 5 Complete cleft soft and hard palate

Submucous cleft palate

In some patients, the cleft of the soft palate is covered by mucosa and forms a so-called submucous CP. The most usuall is submucos cleft of the soft palate with or without a notch into the hard palate. There are 3 typical findings associated with submucous cleft palate, bifid uvula, thin membranous central portion of the soft palate and diagonal ridges located lateral to it. Those are the levator muscles that have been shifted from their normal transverse orientation to a longitudinal position. The muscles, presumably important for normal speech, insert aberrantly on the bony free edge of the hard palate instead of forming a complete muscular sling in the soft palate.

Embryology

In facial morphogenesis, neural crest cells migrate into the facial region, where they form the skeletal and connective tissue and all dental tissues. Vascular endothelium and muscle are of mesodermal origin.

The upper lip develops from medial nasal and maxillary processes. When processes at 30-37days gestational age do not fuse together an open space (cleft) between them persists. It results in CL. The cleft may affect only the upper lip, or it may extend more deeply into the maxilla and the primary palate. The secondary palate develops from 2 palatal shelves.They are initially in vertical position with the tongue between them. At 7 weeks gestational age tongue moves down and palatal shelves get into the horizontal position and fuse in the middle and form the hard and soft palate. Fusion of palatal shelves continues usually until the 12th week.

When palatal shelves do not fuse together, cleft palate develops. It can occur in a number of ways:

- Defective growth of palatal shelves
- Failure of the shelves to move into a horizontal position
- Lack of contact between shelves
- Rupture after fusion of shelves

CL can be diagnosed by performing ultrasound in the second trimester of pregnancy (see fig. 6).

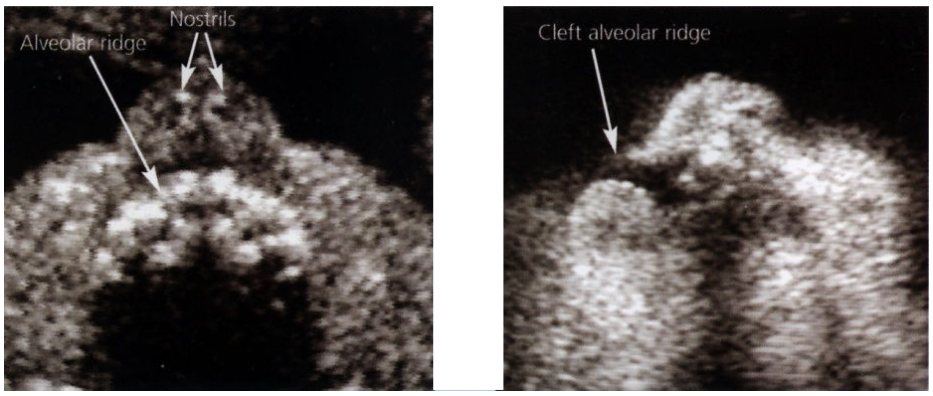


Fig. 6 US of aflicted fetus

Usually, it is not possible to diagnose a CP by an ultrasound; however, an experienced physician may catch an atypical movement of the fetal tongue in a lateral view. Recently is also used 3D imaging.

Frequency and recurrence

In general, all typical orofacial cleft types combined occur in white populations with a frequency of 1 per 500-550 live births. The reported data vary according to the investigator and the country.

The sex ratio in patients with clefts varies. In whites, CL and CLP occurs significantly more often in males, and CP occurs significantly more often in females.

There is a different prevalence rate of clefts in different racial groups. The lowest rate is for blacks. A high prevalence of CL/P was found for the Japanese population, and the highest prevalence was found for the North American Indian populations. In isolated CP no remarkable variation among races was found.

Genetic factors (ie, genes participating in the etiology of nonsyndromic orofacial clefts) are passed to the next generation, thus creating an increased risk for such anomaly in offspring. The risk of recurrence also differs with respect to proportion of genetic and nongenetic factors.

From a clinical point of view, 2 factors are most important when evaluating the risk of recurrence for CL/P - the sex of the individuals (ie, patient and individual at risk) and the severity of the affect in the patient (eg, unilateral vs bilateral). The risk of recurrence for CP seems to be influenced only by sex. The risk is highest for daughters of fathers affected with a CP and lowest for sons of mothers affected with a CP.

Etiology

Most orofacial clefts are caused by the interaction between genetic and environmental factors (multifactorial causes). **Genetic factors create susceptibility for clefts.** When environmental factors like viral infection (eg, rubella) and teratogens (eg. steroids, anticonvulsants), during the first trimester interact with a genetically susceptible genotype, a cleft develops during an early stage of development.

The proportion of environmental and genetic factors varies with the sex of the individual affected with cleft. In CL and CLP, it also varies with the severity and the unilaterality or bilaterality of the cleft anomaly, with the highest proportion of genetic factors being in the subgroup of females with a bilateral cleft and the smallest in the subgroup of males with a unilateral cleft.
A higher proportion of environmental factors indicates a lower risk of recurrence and also gives a better chance to act in prevention, because the only etiological factors that can be changed are environmental factors.
Clefting of the lip and/or palate is associated with more than 300 syndromes. The overall incidence of associated anomalies (e.g. cardiac) is approximatelly 30 percent (more common with isolated cleft palate).
Midfacial development involves several sets of genes including those involved in cell paterning, proliferation and signaling. Mutation in any of these genes can change the developmental process and contribute to cleft development. Some of these genes include the DIX gene, sonic hedgehog (SHH) gene, transforming growth factor (TGF) alfa and beta and interferon regulatory factor (IRF6) gene.
Also, gene-gene interactions have been examined. A complex interplay of several genes, each making a small contribution to the overall risk, may lead to formation of clefts.
Evaluation of gene-environment interactions is still in a preliminary stage. Folate-metabolizing enzymes such as methylenetetrahydrofolate reductase (*MTHFR*), which is a key player in etiology of neural tube defects, and *RFC1* are considered candidate genes based on data that suggest that folic acid supplementation can reduce incidence of nonsyndromic cleft lip and palate.

Treatment

Multidisciplinary team

Most individuals with CL, CP, or both and individuals with other craniofacial anomalies require the coordinated care of providers in many fields of medicine and dentistry
A team for the multidisciplinary treatment of a child with an orofacial cleft includes the following specialists:

- Pediatrician
- Plastic surgeon
- Otolaryngologist
- Geneticist
- Speech pathologist
- Orthodontist
- Maxillofacial surgeon
- Psychologist

Neonatal care

- Prevention of aspiration because of communication between oral and nasal cavities.
- Special training for parents how to feed a child with a cleft and nasal regurgitation.

- Beware of airway obstruction, it can appear at infant with Pierre Robin anomally, in which cleft palate is combined with micrognathia or retrognathic mandible.

30% of patients with cleft palate may have other anomalies (major or minor) and may represent 1 of 300 known cleft syndromes. Therefore, a neonate with an orofacial cleft should be seen by a medical geneticist as soon as possible.
Each case is different. A child with a severe cleft may do very well, while a child with a much less severe condition may have many problems. An individual approach is necessary.
Each baby born with orofacial cleft should be referred to the cleft center as soon as possible. Specialists will evaluate the finding of examination of the baby, lay down a treatment plan, and continuously revise individual procedures and treatment during follow-up visits.
Treatment of CLP anomalies requires years of specialized care (especially surgical, dental, and speech therapy). As otitis media is very common among children with cleft palates, involvement of an otolaryngologist is important. Some children continue to have Eustachian tube dysfunction after their palates are closed and need continuos otolaryngologist care.

Feeding
Because of feeding problems and other difficulties most children with CLP have problems with weight gain.
The majority of children born with CLP are unable to be breastfed. Those with CP cannot produce the negative pressure necessary for suction. Mothers of children with a unilateral CL may succeed with breastfeeding when the child is positioned so that the cleft in the lip is obstructed by the mother's breast.
No single right or correct method of feeding exists. Parents with help of the health care provider should choose the method that is best for their infant.
Gaining weight and preventing aspiration and ear infections are the most important parts of caring for neonates with a cleft during their first days and weeks of life.

Surgical treatment
No single treatment concept exists, especially for a CLP. The timing of the individual procedures varies in different centers and with different specialists.

Usuall surgical procedures for a child with a CLP are:
- Surgical repair of the cleft lip

The ultimate intent is the visual apperance. The optimal age of the surgical repair is discussed all the time. Some centres perform the procedure in early neonatal age. The advantage is mainly in psychological and social acceptance of the child in the family and its neighbourhood with induction of considerably better relationship. Disadvantage is in early stress of the child by surgery procedure. Also there is not an exact evaluation of the early lip reconstruction on the development ofthe maxilla yet.
- Surgical repair of the cleft papate

The ultimate intent is the speech.

Secondary surgical procedures depend on the severity of the fault and postnatal development together with the previous treatment success:

- Reconstruction of maxilla alveolus defect by bone grafts
- Closure of oronasal fistule
- Correction of the shape of the nose and lip
- Lenghtening of the palate or pharyngeal flap/pharyngoplasty
- LeFort I maxillary osteotomy or distraction osteogenesis of maxilla

The most common treatment protocol presently used in most cleft treatment centers:

- Newborn - Diagnostic examination, general counseling of parents, feeding instructions, genetic evaluation and specification of diagnosis; empiric risk of recurrence of cleft calculated; recommendation of a protocol for the prevention of a cleft recurrence in the family.
- Age 3 months – Surgical repair of CL(lip and nose)

Usualy pediatricians use a rule of "three 10s" as a necessary requirement for identifying the child's status as suitable for surgery (ie, 10 lb, 10 mg/l of hemoglobin, and age 10 weeks).

- Age 9-12 months - Surgical repair of CP with eventual placement of ventilation tubes into eardrum Anatomical differences predispose children with CLP and with isolated CP to ear infections. Therefore, ventilation tubes are placed to ventilate the middle ear and prevent hearing loss secondary to otitis media with effusion (OME). Repeated hearing testing is recommended.
- Age 1-7 years - orthodontic treatment , rehabilitation of speech by foniatry and speech therapy.
- Age 7-9 years reconstruction of the alveolus by alveolar bone graft.
- Older than 8 years - orthodontic treatment continues.
- Corrective surgical procedures if necessary.

Intraoperative details

The ideal lip repair results in symmetrically shaped nostrils, nasal sil, alar bases, well defined philtral columns, natural appearing Cupid's bow. A functional muscle repair should result in a normal lip at rest and in animation. Many surgical procedures for the repair of uni and bilateral cleft lip are well described. The most used are: **Tennison-Randall triangular flap repair** and **Millard rotation-advancement repair**. The common goal is achieving symmetry and restoring the continuity of underlying orbicularis muscle. All attempt to lenghten the philtrum by interposing tissue from the lateral lip element into the medial lip element through various combinations of rotation, advancement and transposition flaps- for example (see fig.7).

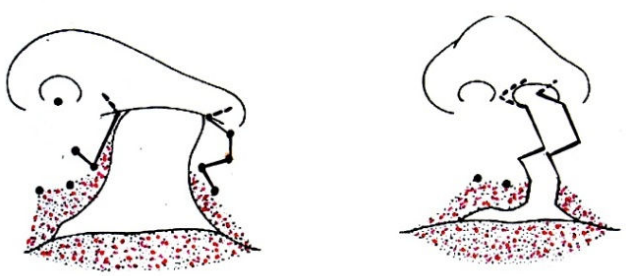


Fig. 7 Sketch of Tennison-Randal repair

The main goal of the reconstruction of the palate is the speech formation; secondarily it is the closure of the connection of the nasal and oral cavities. Although separation of the oral and nasal cavities is advantageous to normalize feeding and decrease regurgitation and nasal irritation, it is not absolutely necessary for feeding. Functional repair of the soft palate musculature through the repositioning of the abnormally-oriented and attached muscles together with rehbilitation facilitates the normal speech development.
Palate repair with repositioning of the palatal musculature is advantageous to eustachian tube function and ultimately to hearing. Because the levator and the tensor veli palatini have their origins along the eustachian tube, repositioning improves function of these muscles, improves ventilation of the middle ear, and decreases serous otitis, which further decreases the incidence of hearing abnormality. Palate repair alone does not usually completely correct this dysfunction and additional therapy frequently includes placement of ear tubes as necessary
From the above mentioned results the importance of cleft palate reconstruction. There exist parallel defects and diseases physical or mental, however, when this surgical procedure can be inefficient stress for a patient. For major physical defects the surgery represents unproportional risk and by mental defect there is no efect for verbal communication because the patient is not able to train the speech.

The basic surgical techniques for **cleft palate** repair includ the following**: 2- flap,von Langenbeck, Schweckendiek**, **3-flap Wardill/Kilner/Veau** (V-to-Y), and **double reverse z-plasty (Furlow)** palatoplasties (see fig. 8a, b).

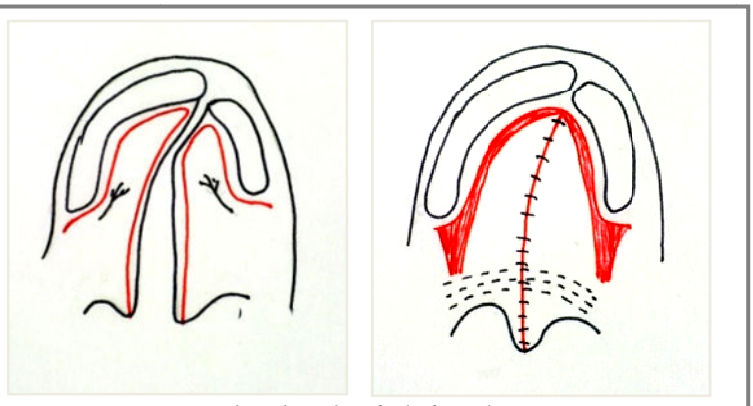


Fig. 8 a, b Sketch of cleft palate repair

There are three factors that are considered necessary for satisfactory function of the soft palate for speech: adequate length, adequate mobility, and conformity of the dorsal surface to the pharyngeal wall.
A great deal of debate exists regarding the timing of the repair, whether early closure of the hard palate is harmful to facial growth. The facial growth distortion appears to be secondary to surgical interventions. In the past, many surgeons believed that hard palate repair should be delayed until after eruption of the molar teeth. Currently, most centers focus on completion of the cleft palate before the patient is 12 months.
Multiple studies have demonstrated that the cleft palate maxilla has some intrinsic deficiency of growth potential. This intrinsic growth potential varies from isolated cleft of the palate to

complete cleft lip and palate. This growth potential is further impaired by surgical repair. Any surgical intervention performed prior to completion of full facial growth can have significant deleterious effects on maxillary growth. Disagreement exists as to the appropriate timing of surgery to minimize the harmful effects on facial growth and on what type of surgical intervention is most responsible for growth impairment. The formation of scar and scar contracture in the areas of denuded palatal bones are most frequently blamed for restriction of maxillary expansion.

Approximately in twenty percent of children with cleft lip palate, another surgical procedure may be necessary if the speech remains affected and has a nasal quality.
The surgery to correct speech is performed no earlier than three to four years of age.This operation is augmenting the reconstructed palate by pharyngeal flap, which does lenghten the palate and holds the tissues of the palate backwards and upwards. It is called pharyngoplasty or pharyngeal flap.

When a submucous cleft is present, the indications for surgery concern velar competence. Often, the decision to repair a submucous cleft palate is deferred until the patient is aged 4-5 years, when speech development is sufficient to determine the degree of hypernasality and the effect of the cleft on intelligibility. Cleft repair at this age may involve a pharyngeal flap, depending on the amount of velopharyngeal incompetence present.

Subsequent surgical procedures in patients with cleft lip and palate

Markéta Dušková

Primary reconstruction of the lip and nose as well as the reconstruction of palate are the essential surgical procedures in every patient with cleft lip and palate. Although they cannot be described as vitally indicated, but significantly affect the viability of the child. They bring an acceptable appearance, food intake, speech formation, and improve the condition of the respiratory tract. However, surgical intervention may also relate to other morphological problems that are associated with a defect, or arising in connection with development. These operations belong to so-called secondary treatment and contribute to improvement of the life quality of the patient with cleft. Realisation of these surgeries depends on the severity of the defect and postnatal development together with the success of previous surgical and orthodontic treatment. The most common include the reconstruction of maxillary alveolar process and the correction of secondary deformity of the centrofacial area.

There is a defect of maxilla alveolus in 70% patients with CLP. It is logically connected with defect of dental ridge and its development. It is usually present in a form of phistula that connects nasal and oral cavity. The surgery is peformed between the age of 6 and 12, prefarably 7 -9 , and represents reconstruction of alveolus defect by bone grafts together with closure of oronasal phistula. Bone graaft serves as a leader for highly placed teeth in the place of the cleft and subsequently for their correct reposition by orthodontic treatment. Analogous operation is possible to peform at the end of the development of the centrofacial area, when the tooth in the original defect can be missing, and the reconstructed defect can serve as a bed for dental implant.

Fistula may also be present in a connection of primary and secondary palate. It represents the communication between the mouth and nasal cavities. It is the cause of troublesome intrusion of liquids and air in both directions and thus also contributes to chronic inflammation of the site. Closure is made by the reconstruction of the nasal and oral mucoperiosteum, usually at the cost of material addition by tongue flap, preferably at the time when the shape of the upper jaw is stable yet.

As mentioned above, the cleft is not only an inborn defect, but also there is consecutive hypoplasia of centrofacial region, especially maxilla. In severe defects develops severe

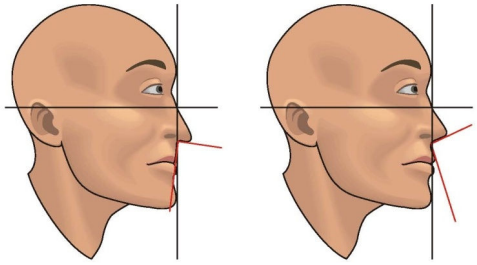


Fig. 9. The principle of correction of secondary lip and nose deformity according Duskova is the cranial rotation of nasolabial angle toward to the aesthetic lines of the face.

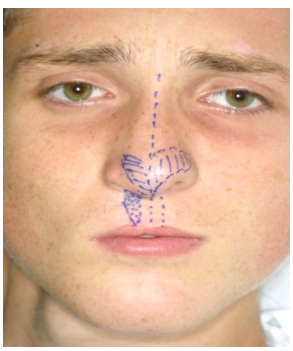


Fig. 10 Preoperative markings

disorder of jaw relationship and hypoplasia of maxilla is amplified by excessive growth of manible. The development of the soft tissues is also impaired. Mimic muscles have pathological attachment. Septum and nasal tip cartilages used to be less or more dislocated and thir shape is changed. This all is a base for so called secundary deformities. In the case of skeletal defect, that means serious failure of jaw relationship, it is necessary to solve the problem of the skelet, at 12/14 years of age distraction osteogenesis of maxilla or at the age of 17 by Le Fort I maxilla osteotomy with advancement of the maxilla forward. It is possible to perform the final correction of the lip and nose (not earlier than at the age of 15 in girls and at the age of 16 in boys) in the case where the skeletal defect is not crucial. The purpose is to shift the function of affected centrofacial area and anthropological facial parameters to normal, thus to eliminate an appearance stigmatized by cleft.

Fig. 11 - 14 Adolescent with complete left-sited cleft lip and palate before final surgical correction of lip and nose shape (figures on the left) and after this operation, including the teeth reconstruction using dental implant (figures on the right).

Congenital anomalies of upper limb and hand

Andrej Sukop, Eva Dřevínková

Incidence of congenital anomalies of hands is approximately 1 in 500 to 750 healthy newborns. Men are more affected then women. Approximately 50% of anomalies are bilateral and 25% of them are parts of syndromes.

Basics of embryology:

Timescale of antenatal development of hand:

Day 0-1: syllepsis
Day 8: embedding of ovum
Day 30 (week 4-5): development of arm bud
Day 41: differentiation of finger rays
Day 52: arm flexes the elbow
Day 56 (week 8): upper limb is a well differentiated part

Etiology of congenital anomalies is often unknown. The genetic as well as environmental factors (such as drugs, radiation, hormones, alcohol, virus infections, pesticides or herbicides) can participate in the origin of deformities. Since eight weeks after pregnancy the effect of these agents is minimal due to completed diferenciation of an upper limb. Pregnancy is usually diagnosed not earlier than 6-8 weeks after fertilisation. Therefore, the possibilities of prevention of environmental factors are minimal.

There are lots of different classifications of congenital anomalies. The Swanson classification from 1968 based on embryology study is used worldwide.

I. *Failure of formation*
   A. Transverse arrest
      The hand development can be stopped at any level from the shoulder to the phalanx of a finger. (Amelie - shoulder, Acheira - wrist, Adactyly – metacarpal bones, Aphalangia – absent phalanges of fingers in a different extent).
   B. Longitudinal arrest
      - Radial ray deficiency
      - Ulnar ray deficiency
      - Central ray deficiency (cleft hand)
      - Intersegmental (intercalated) type (phocomelia)

II. *Failure of differentiation (separation)*
   A. Soft tissue (Arthrogryposis, soft syndactyly, trigger digit, camptodactyly, clasp thumb...)
   B. Skeletal (Clinodactyly, osseous syndactyly, synostosis...)
   C. Tumours

III. *Duplication (in the extent of the whole limb; mirror hand, polydactyly...)*

IV. *Overgrowth (in the extent of the whole limb; macrodactyly)*
V. *Undergrowth (in the extent of the whole limb; brachymetacarpia, brachysyndactyly, brachydaktyly...)*
VI. *Constriction ring syndrome (from gentle strings on the skin to the intrauterine limb amputations in different extent)*
VII. *Generalized abnormalities and syndromes (Apert's syndrome, Poland's syndrome...)*

Timing of surgery

Timing of treatment is very individual. It is necessary to ensure the normal development and growth of a limb. In general, an earlier reconstruction means in practice better adaptation to the reconstructed part. The optimal situation is considered when the most of extensive operations is performed in a preschool age, especially with regard to the grip function of a hand. It is necessary to assess and to be aware of general and local changes of a growing organism (release of scars, etc.).

Radial dysplasia

Radial dysplasia occurs in 1 in 30.000-1:100.000 healthy newborns. More than half of patients have both limbs affected; more often it is a right hand. Men are affected more often than women. This type of abnormality is always combined with a thumb anomaly. The extent of anomaly can vary; from hypoplastic thumb with a short distal radius to the complete absence of radius including muscles, radial artery, superficial branch of radial nerve and abnormal development of medianus nerve.

Treatment

The type of treatment depends on the extent of disorder. When no further options of conservative management are available, the most frequent surgical procedures are: stabilization of wrist, improvement of grip by tendon transfers, thumb reconstruction, improvement of hand position by osteotomy of ulna, radialization or centralization of ulna in relation to the carpal bones (shift and fixation of ulna to the radial side).

Ulnar dysplasia

Ulnar dysplasia occurs in 1 in 100.000 healthy newborns, men and women are affected equally, but the anomaly of the left hand is more often. Anomaly can be represented from hypoplasia of fingers and ulna to the complete absence of ulna including muscles. This abnormality is often combined with other hand anomalies (syndaktyly, thumb anomaly and anomaly of first interphalangeal space...)

Treatment

Splinting, physiotherapy, thumb reconstruction, depression of first interphalangeal space, stabilization of wrist, tendon transfers to improve a grip and stabilization of wrist, radius osteotomy.

Cleft hand

Cleft hand is developed due to the defect in formation of a central part of hand and forearm. There are absent one or more middle phalanges with a different extent of absent metacarpal

bones which are creating the groove in a palm. We can often find syndactyly between deviated fingers.

Treatment

An improvement of grip function by the separation of each finger, release of joint contracture of MCP and PIP joints. An improvement of aesthetic appearance by surgical closure of deep cleft of palm.

Phocomelia

It is defined as an absent part of any segment of the upper limb. The proximal type has the connection of a hand with a forearm which is directly connected with a trunk. The distal type has a connection between a hand and an arm.

Artrogryposis

Arthrogryposis is a syndrome of unknown origin and is typically represented by joint contracture in a different extent. There are two forms of this anomaly: neuropathic and myopathic. Muscles are atrophic and infiltrated with fat tissue, the anterior grey matter has lower amount of cells which have smaller size. Patients with arthrogryposis have a typical clinical picture: internal rotation and adduction of shoulder, elbow extension, forearm pronation, wrist and finger flexion, clasp thumb. Patient‘s intellect is not affected.

Treatment

Application of splint, physiotherapy-stretches, release of joint contractures, muscle-tendon transfers, osteotomy.

Syndactyly

Syndactyly is one of the most common congenital anomalies of a hand after the polydactyly. Syndactyly is twice more frequent in men than in women. The most common part affected is usually third interphalangeal space of the hand. Incidence is 1 in 2000 healthy newborns. Etiology is unknown, only 20% of them have been proven to be of a familiar origin. Syndactyly is often combined with many syndromes (Apert´s syndrome, Poland´s syndrome, symbrachydaktyly…). Syndactyly can be: 1. simple when there is not present the separation of soft tissues or, 2. complex when there are also affected bones. Acrosyndactyly is described as a syndactyly of last finger phalanges but proximal phalanges are free. The complete syndactyly is defined as a syndactyly from the proximal phalanges to the distal phalanges. Incomplete syndactyly has the extent of syndactyly which ends on the middle or proximal phalanx. There can be affected only one or more interphalangeal spaces and this anomaly can be unilateral or bilateral.

Treatment

Surgical finger separation and creation of interphalangeal space with skin flaps using original connection of fingers and using skin grafts in a whole thickness. Surgical procedures are often performed not untill a preschool age (better identification of neurovascular pedicles, the cooperation of a child during the change of dressing). Only in cases when the growth causes worsening of finger position, the surgical procedure is indicated earlie (in infant period) to ensure the normal finger development.

Trigger digit

Differences in the size of annulus and the diameter of flexor tendon cause the alteration in a normal finger movement. Severe abnormality has a fixation of finger in flexion or extension and finger cannot move to a normal extent. Thickening of flexor tendon in front of tendon annulus is called Notta´s node. Any finger can be affected, in children it is most often a thumb.

Treatment

Surgical release of A1 annulus leads to complete correction of status.

Clasp thumb

Thumb is permanently in flexion in palm, a child cannot do an active extension. Flexion position of thumb is normal in children to the sixth week after labour. The cause of extension deficit is usually an absence of muscle extensor pollicis longus. Sometimes the anomaly can be combined with a flexion contracture in MCP joint. Anomaly needs to be distinguished from a thumb hypoplasia or a mild form of radial club hand.

Treatment

Splinting, if the treatment is not successful, the possibility is tendon transfers to ensure a thumb extension (m. extensor digiti minimi, m. extensor carpi ulnaris, m. flexor digitorum superficialis...)

Thumb hypoplasia

An alteration of thumb development can have a different clinical picture. Classification of Blautha describes 5 degrees.

I. Smaller thumb with all structures,
II. Hypoplasia of thenar muscles, metacarpal bones and phalanges,
III. Absence of thenar muscles, very reduced I.interphalangeal space, partial aplasia of I. metacarpal bone,
IV. Floating thumb (without metacarpal or muscle tendon structures),
V. Absence of thumb

Treatment

Treatment always depends on the degree of alteration. The main reconstruction procedures include: deepening of I. interphalangeal space, stabilization of MCP joint, improvement of flexion and extension by tendon transfers, pollicisation by II. finger or transfer of toe from foot. It is recommended to manage the treatment in the first year of a child when the full thumb functions are normally developing with a fixation of grip stereotypes.

Camptodactyly

Campodactyly is defined as a congenital flexion deformity of PIP joint. It is frequent abnormality affecting approximately 1% of population. The little finger is the most common affected. The distinct incidency is the most often in two periods - after the birth or during adolescence. The cause of flexion contracture is caused by a dysbalance of strength between flexors and extensors.

Treatment

Mainly splinting, surgical treatment is indicated in cases of progressive forms of contractures and in failure of conservative management (disconnection of insertion of lumbrical muscles, disconnection of superficial flexor, tendon transfers, osteotomy, arthrodesis).

Clinodaktyly

Clinodaktyly is caused by hypoplasia of radial side of middle phalanx. The wedge shape of base of middle phalanx causes the deviation of a finger. The little finger, ring finger and proximal phalanx of thumb are the most common ones affected.

Treatment

Splinting, correction osteotomy when is performed the wedge resection of middle phalanx of finger without damage of a growth zone.

Synostosis

Radioulnar synostosis is a rare anomaly represented by fibrous and bone connection of ulna and radius. The connection can be localized distally, centrally or proximally. Men and women are affected equally. Synostosis is a cause of fixed forearm in a different degree of pronation.

Treatment

Most of the patients adapt themselves to anomaly. Surgical treatment as a separation of bones is indicated only when forearm is fixed in full pronation.

Tumours

Congenital hand tumours can affect vascular system (haemangiomas, lymphangiomas, vascular malformations), neural system (neurofibromatosis, neuroblastomas), connective tissue (ganglioma, fibromas, lipomas, histiocytomas, sarcomas), skeletal system (osteochondromatosis, enchondromatosis).

Polydactyly

Polydactyly is the most common congenital anomaly of upper limb and is often part of many syndromes. Stelling classification describes 3 types of polydactyly:

I. Incomplete finger created only from soft tissue connected with a small pedicle.
II. Complete finger.
III. Complete finger + metacarp.

The thumb is the most common one affected.

Treatment

Removing of finger, eventually of a whole ray with metacarp.

Macrodactyly

Anomaly occurs in 1 in 50 000 healthy newborns. Macrodactyly presents with an excessive growth of finger or fingers - gigantism. It affects mainly index finger and middle finger. Distal parts of hand are worse affected than proximal ones. Different types of macrodactyly are described: *static type* which is apparent immediately after the birth and is enlarging with a

growth of organism. *Progressive type* is represented by isolated fast growth not untill a childhood course.

- *Primary macrodactyly* has unknown etiology. We can find the largest changes at the area of nerves and soft tissues which are infiltrated by lipofibromatous tissue.
- *Secondary macrodactyly* can be caused by neurofibromatosis (hyperplasia of connective tissue of nervous system in Morbus Recklinghausen), vascular malformations, congenital lymphoedema, enchondromatosis (skeleton hyperplasia).

  Treatment

  Surgical reduction of soft tissues. Corrective operation of skeleton (osteotomy), intervention to the growth zones in bones (epiphysiodesis). It is very often necessary to repeat surgical procedures.

Brachydaktyly

Fingers affected by this anomaly are shorter. It can affect all phalanges of fingers or only some of them.

Treatment

Majority of patients do not require treatment due to normal hand function. Distraction osteotomy is used rarely, potentially a prolongation with interposition of bone graft.

Symbrachydaktyly

Symbrachydaktyly has a typical clinical picture of short fingers and stiff joints with syndactyly. But the clinical pictures can be various - from shorter fused fingers with all phalanges to complete absence of fingers, metacarpal and carpal bones (triphalangia, diphalangia, monophalangia, aphalangia, ametacarpia, acarpia).

Treatment

Mild forms do not require treatment and in more complicated forms we try to reconstruct the grip function of hand by deepening of I. interphalangeal space, transfers of toes from foot to hand, distraction osteotomy.

Amniotic band syndrome

This anomaly can affect all parts of upper limb, the most common are distal parts (fingers, forearm). Patterson classification divides amniotic bands in 4 groups according to the affection:

I. Circular groove
II. With distal oedema
III. With acrosyndactyly
IV. Intra-uterine amputation

Treatment

Deep grooves can lead to the compression of neurovascular pedicles which threaten the development of a limb. Therefore the operation is performed early after the birth. The method used for release of circular fibrotic bands is multiple Z plasty.

Poland‘s syndrome

Poland‘s syndrome is a combination of any type of hand anomaly with the defect of pectoral muscle. Incidence is 1 in 20 000 healthy newborns. The right side is affected twice more often than the left. Beside the pectoralis muscle also other muscles at the same area can be affected, like m. pectoralis minor, m. latissimus dorsi, m. serratus anterior as. Sternum and ribs can be deformed. Breast with a nipple areola complex can have a different degree of hypoplasia to aplasia. Very common hand anomalies combined with a Poland‘s syndrome are brachydactyly, syndactyly, symbrachydactyly.

Treatment

Correction of hand deformities. Correction osteotomy in patients with severe chest deformities. Latissimus dorsi muscle or TRAM flap pedicled or free transfered are very often used to replace soft tissues of the chest wall. The reconstruction of hypoplastic or completely non-developed breast in women is done with combination of musculoskeletal flap of latissimus dorsi muscle and synthetic implant or only with patient tissue; either free transfer or pedicled TRAM flap. Sometimes it is necessary to correct the shape and volume of normal breast.

Skin tumors, diagnostics, surgical treatment

Michaela Čakrtová

The skin is the largest organ of the body. Because it interferes with the environment, skin plays an important role in protecting the body against pathogens. It is also a barrier between external and internal damages in a bodily defence. Skin tumors are relatively common and their incidence has been increasing. Skin tumors are divided into benign and malignant tumors according to their ability to spread.
Malignant skin tumors are predominantly caused by an ionizing radiation, particularly by UVB radiation. The other cause of skin tumors is a virus effect /HPV viruses/ and an imunosuppression. The important role plays also a skin phototype.

Skin Phototype	Typical Features	Tanning ability
I	Pale white skin, blue/hazel eyes, blond/red hair	Always burns, does not tan
II	Fair skin, blue eyes	Burns easily, tans poorly
III	Darker white skin	Tans after initial burn
IV	Light brown skin	Burns minimally, tans easily
V	Brown skin	Rarely burns, tans darkly easily
VI	Dark brown or black skin	Never burns, always tans darkly

People with pale skin, red hair and blue eyes have significantly higher risk of skin cancer. The other group of people with higher risk of skin cancer includes these with a serious blood dinase (leukemia) or permanent imunosupression (after organ transplantation).

Benign tumors

Benign tumors can be present at birth, later they can involute or grow with the body. The other group is represented by acquired benign skin tumors.
Benign tumors include:

- Epidermal tumors – seborrhoic keratosis
- Follicular tumors - trichoadenoma
- Sebaceous tumors- sebaceous adenoma
- Sweat gland tumors - syringoma
- Cysts- milium, dermoid cyst
- Neural tumors - neurofibroma
- Hemangiomas and vascular malformations
- Fibrous tumors – fibroma,
- Histiocytic tumors
- Adipocellular tumors - lipoma
- Myogenic tumors- leiomyoma
- Osteogenic tumors- osteoma cutis
- Hematopoetic tumors- lymphocytoma cutis

Benign tumors do not spread over the body and they are always encapsulated. The surgical treatment is usually required when the tumor causes pain or pressure, dysfunction, itching, or cosmetic changes.

Fibroma

It is tumor mainly composed of fibrous or fully developed connective tissue. It arises from a mesenchymal tissue.

There are two types of a fibroma: a hard fibroma /fibroma durum/
and a soft fibroma / fibroma molle/

The hard fibroma consists of many fibers and a few cells/dermatofibroma/. The soft fibroma /skin tags, fibroma pendulans/ mostly consists of cells loosely connected with fibrous tissue. Skin tags are localized predominantly at the neck, armpits and groins.

The other types of a fibroma include the cystic fibroma, angiofibroma and the myxofibroma.

The malignant form of the fibroma is called the fibrosarcoma.

Usual surgical treatment of benign fibromas is the excision.

Lipoma

Lipoma is a tumor composed of fat cells. It is a soft, lobed, well-defined, and movable towards surroundings and a painless tumor. Most of them occur on the trunk, thighs and forearms. It could be solitary or multiple. The surgical extirpation is required when the tumor causes pain, limits movement or grows. The malignant form is called the liposarcoma.

Hemangioma and vascular malformation

Hemangioma is an abnormal build up of blood vessels in the skin or internal organs. These tumors spontaneously involute during the infancy. Hemangiomas are formed either during pregnancy or appear during first weeks after birth.

Hemangiomas occur 3 times more often in females than in males and occur predominantly in Caucasians. Low birth infants or premature infants have a 26% chance of developing a hemangioma. They are also common in twin pregnancies.

Most of them are located on the face, neck and the liver. They can grow up to18 months and then begin to fade away. This involution can last from 3-10 years.

When a child has more than 3 hemangiomas, the ultrasound should be done of the entire body to rule out internal lesions (liver, brain).

Types:

- *Capillary hemangioma* – appears at birth or early in life, has a strawberry like appearance, enlarges during first year of life and then starts to involute. It is localized in the top of skin layers.
- *Cavernous hemangioma* – appears in infancy and persists. They are deeper in the skin and have a nodular purplish appearance.

The development of haemangiomas is characterized by 3 phases. Both types undergo a rapid growth phase in which the volume and size increase rapidly. The phase is followed by the rest phase and finally an involutional phase in which the hemangioma begins to disappear.

Complications of hemangioma include a bleeding and an infection. Some hemangiomas tend to ulcerate after a period of a chronic irritation combined with an infection.
Most hemangiomas disappear without treatment, leaving minimal visible marks. When the hemangioma is located on the face and interferes with vision, breathing or causes cosmetic problems the involution is supported terapeutically. The treatment includes the injection of corticosteroids directly into the lesion or the pulse dyed laser has been used to reduce hemangiomas , predominantly strawberry like color caused by superficial capillaries. Surgical treatment is a reduction of visible redundant scar after the involution.
The malignant form is called hamangiosarcoma.

Kasabach-Merritt syndrome – is a rare life threatening disease. It is caused by trapping and damaging of platelets in the tumors called amangioma or hemangioendothelioma.

Fig. 1. Combination of capillary and cavernous hemangioma before and after regression with subsequent excision of redundant skin.

Hemangiomas, unlike vascular malformations, are with endothelial hyperplasia.

Vascular malformation

Vascular malformations are tumors with enlarged or abnormal vessels present at birth and essentially permanent. These include port-wine stains /capillary vascular malformations/, masses of abnormal swollen veins /venous malformations/, and arteriovenous shunts.

Port wine stain (naevus flammeus) is a vascular birthmark, which consists of dilated capillaries in the skin. Its color varies from pale red to deep purple with the size of few millimeters to several centimeters. It is localized predominantly on the head and the face. It is not hereditary. It concerns both male and female equally with incidence 3 babies in 1000 new births. At first the overlying skin appears flat, over the years it tends to thicken and cobble. If left untreated, it becomes darker.
The cause of port wine stains is thought to be due to damaged nerve supply to the tiny blood vessels. The nerve impulses do not constrict open vessels so they stay open and wide.
The historical surgical treatment includes the excision of the port wine stain with a subsequent dermoepidermal grafting. Currently even the laser treatment may not clear the port wine stains completely and an effect is temporary. Repeat treatments are often needed. The best

results are achieved on babies, with small, pale stains localized on the face. The treatment is done under the general anesthesia. Usually up to 10 treatments are needed.

Sturge - Weber Syndrome – is a congenital disease of unknown origin. It is characterized by a port wine stain localized on the forehead, the upper eyelid and the brain. The port wine stain causes the calcification and the atrophy of the brain. The symptoms include seizures and glaucoma.

Klippel - Trenaunay Syndrome - is a congenital disease of unknown cause. It is a combination of a port wine stain, soft tissue and bone hypertrophy /excessive growth/, venous malformations, and lymphatic anomalies. It is usually present in only one limb, however, it may occur in multiple limbs, head, trunk, or internal organs.

Venous malformation

Venous malformation is always present at birth and manifests during childhood or early adulthood. It is a hereditary condition caused by genetic abnormality on the chromosome 9p.
It is an abnormality of larger, deep veins, which does not involute but grows slowly with the body. The cause is an error in the endothelial development, which stays flat with slow turnover. The lesion is soft to touch as the blood comes out with compression. The color can vary from deep purple/ superficial lesion/ to pale / deep lesion/.
The purpose for treatment is usually the pain. The method of choice remains a sclerotherapy, a laser treatment or compression garments. Surgery is indicated in isolated lesions after the sclerotherapy.

Arteriovenous malformation

Arteriovenous malformation is a complex mass of arteries and veins. They are usually present at birth or they can be acquired following trauma to the affected area. They occur in two grades: low and high. The low-grade malformation grows slowly with the child and the high grade expands rapidly causing pain or bleeding. It can eventually become life threatening. They occur mostly on the head, the neck and the face. The sign of arteriovenous malformation is a vivid pulsation when touching the lesion.
Surgical treatment is complicated and unless the nidus is removed, the lesion can re-grow. The best option is a combination of the surgical removal and a subsequent embolisation.

<u>Lymphatic malformation</u>

Lymphatic malformation is also called a cystic hygroma, hemangiolymphangioma, or lymphangioma. It is a sponge-like mass of abnormal channels and spaces containing fluid /lympha/. The lesion can occur commonly in the head and neck area, grows with the body and does not regress. Lesions occur in two forms: a macro-cystic or a micro-cystic form. The treatment depends on the form, localization and the size. Surgery, laser treatment or sclerotherapy are used to remove these lesions.

Congenital melanocytic naevus

It results from proliferation of benign melanocytes in the dermis, epidermis or both. It is located predominantly in the area of the head and neck. They are often large in diameter and may have excess hair, called hypertrichosis. The congenital melanocytic nevus appears similar to nevi, developed after the birth, but the neval cells are found deeper into the dermis surrounded by neurovascular bundles, hair follicles and sebaceous glands in the birthmark.
Classification of congenital nevus according the size:

- *Small* - up to 2 cm in diameter
- *Middle* - ranging from 2 to 20 cm
- *Giant* - more than 20 cm

The risk of developing malignant melanoma is about 5-15 % in the giant congenital nevus. It is possible to perform curettage of nevus immediately after the delivery, when the layers of corium are separated in a straight line. One week later this option is lost due to the development of the skin. Next surgical treatment includes partial excisions with advancement flap and direct suture, or an excision and a closure of defect with dermoepidermal graft or excision and closure of defect with unrolled skin flap obtained by an application of skin expanders.
The smaller lesions are treated individually. They must be checked every year. The surgical treatment is required when the nevus is localized in the areas badly visible (hair), areas of a mechanical irritation or areas exposed to the sun (face). The treatment includes an excision or partial excisions (usually one session in a half year depending up the maturation of the original scar).

Fig. 2 Congenital melanocytic hairy naevus.

Acquired pigmentous naevus

These naevi arise after the birth. Acquired pigmentous nevus is characterized as a benign overgrowth of melanin-forming cells. These cells begin to appear in skin during infancy with the maximum growth between 12 and 30 years of age.
Histologically they are divided into junction nevi, compound nevi and intradermal nevi according to the localization of nests of nevus cells. The special group of acquired pigmentous nevi represents a **dysplastic naevus.** It is an atypical nevus with an irregular border, indistinct margin and mixed brownish to pinkish, coloration. They are characterized by intraepidermal melanocytic dysphasia. The laesion is usually bigger than 7 mm. It is often a precursor of malignant melanoma. The patients with recognized dysplastic nevi should be

Fig. 3 Dysplastic naevus.

dispenzarized. The surgical excision is required when the nevus changes the color, starts to grow or itches.

The other group represents a **sebaceous naevus.** It is an epidermal nevus, which contains an overgrowth of sebaceous glands. It is predominantly localized on the scalp, face and neck. It grows larger during puberty or an early adult life, sometimes becomes nodular and tends to develop a basal cell carcinoma. Surgical approach is complete excision.

Spitz naevus is a benign compound nevus in children or young adults characterized with very fast growth. It is usually up to 1 cm in diameter, dark –brown colored, of a smooth elastic consistency.
Surgical treatment includes a total excision.

Seborrhoic keratosis

It is a benign skin growth that originates in keratocytes and is seen more often as people age. It appears in various colours from light brown to black, is round or oval in shape and has a waxy, scaly, slightly elevated appearance. They range in size from very small to more than several centimeters in diameter, appear singly or in clusters.
They are localized mostly on the face, neck, and the trunk. They can be itchy and also the biopsie with the assurance of diagnosis may be a purpose of surgical treatment with an excision, curettage or a cryosurgery.

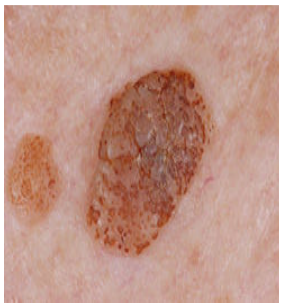


Fig. 4 Seborrhoic keratosis

<u>Precancerosis</u>

Keratoakantoma

It is a rapidly growing squamous tumor, which usually occurs on the sun-exposed skin. Its tissue is similar to that of a squamous cell carcinoma, but keratoakanthoma may regress spontaneously. It acquires the size up to 1 cm in diameter and has a "volcano-like" appearance. The tumor affects almost only whites and most often men. Keratoakanthoma should be surgically removed completely.

Actinic keratosis

Actinic keratosis is a UV light-induced lesion of the skin, which may progress to an invasive squamous cell carcinoma. Actinic keratosis arises on fair-skinned people in areas of a long – term sun exposure, such as the face, scalp, ears, neck and forearms. Actinic keratoses range from rough spots of skin elevated to hyperkeratotic plaques several centimeters in diameter. They can be dark or light, tan, pink, red, usually with an erythematous base covered by scale (hyperkeratosis).
Actinic keratoses are more common in patients aged 50 and more.
The treatment includes a total excision of the lesion. When the lesion is wide and spread, cryosurgery, laser or medical therapy with 5-fluorouracil is the method of choice.

Bowen's Disease (squamous cell carcinoma in situ)
Bowen's disease is a precurser of a squamous cell carcinoma, which eventually develops in 5% of Bowen's disease. It occurs on sun-exposed areas usually at elderly people. The other reason is a wart virus or arsenic. It is usually a red, scaly patch. The most common treatment is a surgical excision.

Leukoplakia
Leukoplakia is a white or gray spot localized on mucous membranes - cheeks, lips or genitalia. It is caused by chronic irritation of the mucosa, at oral cavity and lips usually by smoking. It appears mostly in men after 40 years of age. It can develop into a squamous cell carcinoma.

Cutaneous horn
It is a projectile, dense and hyperkeratotic nodule with horn shape. It occurs on sun- exposed areas such as face, neck, and ears. Total excision is required, as one third of the tumors tend to have malignant potency.

Malignant tumors
Skin malign tumors generally develop in the epidermis. There are basic three types of skin malign tumors, named after the type of skin cell from which it arises:

I. *Basal cell carcinoma* - originates in basal cells-stratum basale
II. *Squamous cell carcinoma* - originates in keratocytes in the epidermis
III. *Melanoma* - originates in melanocytes

Other types of skin malign tumors include: dermatofibrosarcoma protuberans, Merkel cell carcinoma and Kaposi's sarcoma.

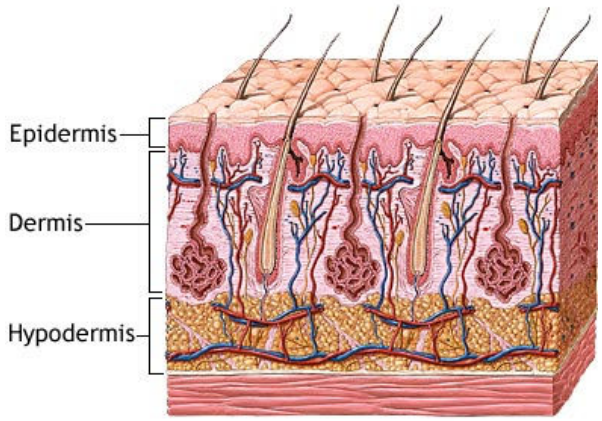


Fig. 5 Skin layers

The cause of skin malign tumors is mostly associated with a chronic irritation. This includes the overexposure to UV-radiation, chronic non-healing wounds or burns. The genetic predisposition is also important.

Basal cell carcinoma (BCC)
Basal cell carcinoma is the most common type of skin cancer in humans. The tumors are slow growing and rarely metastasize (the incidence of metastases is less than 0.1%). If untreated they can lead to a local destruction. The tumor is localized on sun-exposed areas such as the face, ears, neck and shoulders or within the hairline and hair. There is a relationship between basal cell carcinoma and pilosebaceous unit. The tumors usually arise from basal cells of epidermis or the outer root sheath of a hair follicle.

The risk factors of developing BCC include: a male over 50 years of age, an overexposure to the sun, an exposure to artificial UVA and UVB radiation /sun tanning /, exposure to chemicals as arsenic, X-ray treatment, an exposure to ionizing radiation, an immunosuppresion, xeroderma pigmentosum, Gorlin's syndrome and a previous history of nonmelanoma skin cancer. The risk of development a new BCC is 50% at 5 - years period with previous skin nonmelanoma cancer.

Xeroderma pigmentosum – autosomal recessive disease caused by the inability to repair UV-induced DNA damage. It results in multiple BCC, SCC and malignant melanomas.

Gorlin's syndrome (basal cell nevus syndrome) - is autosomal dominant disease which results in the early formation of odontogenic keratocysts, palmoplantar pitting, intracerebral calcifications and anomalies in ribs.

Types of BCC:

I. Nodular – the most common form, presents as a shiny, pearly bump or nodule, flesh-coloured, translucent with teleangiectases.

II. Sclerosing – a scar-like tumor with indefined borders rarely with ulcers. The tumor cells induce the production of collagen by fibroblasts.

III. Superficial – it is usually a reddish patch or plaque, sometimes with crusts which can itch or hurt. It often appears as multicentric spot with areas of normal skin intervening among areas with tumors.

IV. Pigmented – the variant of nodular BCC with brown or black spot areas within the tumor, very similar to malignant melanoma, contains clusters of melanocytes.

V. Cystic – very similar to nodular form, often presents as gray-bluish cyst-like tumor with liquid inside.

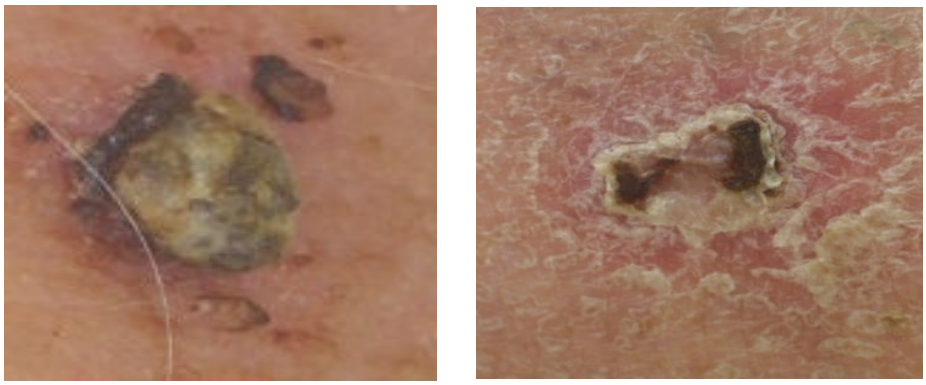


Fig. 6 Basal cell carcinoma (superficial type)

Surgical treatment

The goal of surgical excision is a complete removal of the tumor with adequate margins with the best possible cosmetic result. In most circumstances, a margin of 3-4 mm of skin without visible change is removed.

Microscopically controlled surgery is the treatment of choice in young patients with BCC or elderly patients with a recurrent or an invasive tumor. Although it is time consuming it results in the highest cure rate and spares as much uninvolved skin as possible. The tumor is excised and then examined under the microscope. The defect after the excision is usually left without suture under the adhesive dressing until the result of a histological examination is assessed. If the margins are free of tumor, it is possible to close the defect. The choice of approach mainly depends on size of the defect, localization of the defect, gender of the patient, age of the patient, health condition of the patient, and last but not least surgeon's experience and skill.

The treatment with curettage, a laser therapy or a cryotherapy has a lot disadvantages. The most important disadvantage is an inability to control the tumor's invasivity and the complexity of excision. These types of therapy have significantly higher incidence of recurrence.

Squamous cell carcinoma (SCC)

SCC is the second most common form of the skin cancer. It originates in epidermal keratocytes. SCC carries a high risk of metastasis and so each tumor requires an evaluation and a treatment. The risk factors of development of SCC include: a male over 50 years of age, a phototype I, II, a long lasting sun- exposure, an exposure to chemical carcinogens, an exposure to ionizing radiation, a chronic wound or non-healing burns, a chronic immunosuppression, or HPV viruses. Some tumors can occur de novo or they can arise from precancerosis such as actinic keratoses. They can grow invasively, spread to regional lymph nodes or distant parts of the body, predominantly to lungs.

The tumor is often found with irregular borders, red, pink, or light brown color, elevated, or can be ulcerated. Microscopically, tumor cells destroy the basal membrane and form sheets, which invade the dermis. Tumor cells transform into keratinized squamous cells and form round nodules with laminated layers called "keratinous pearls".

Types of SCC:

A) ***SCC in situ*** – the tumor involves full thickness of epidermis without invasion to dermis. Bowen disease is a subtype of SCC characterized as sharply demarcated, pink plaque.

B) ***Typical SCC*** – The characteristic SCC includes a pink to red elevated papule, plaque or nodule with a sharp rim or irregular border, sometimes scaling, ulcerating or crusting. In 70% occurs on sun- exposed areas such as the face, ears, neck or upper extremities.

C) ***Marjolin ulcer*** – this SCC arises from chronically scaring or ulcerating skin, predominantly burns. It can occur after 20-30 years of scaring as a red or pink nodule, which spreads rapidly.

D) ***Anogenital SCC***- it may manifest as a moist, red plaque, often visible on gland penis or vulva. The symptoms include itching, hurting or bleeding.

E) ***Verrucous SCC*** – it includes the exophytic, verrucous or plaque lesions, which can be described as "cauliflower-like". It is localized in an anogenital region, an oral cavity or a plantar foot.

Histological classification divides squamous carcinomas into well differentiated and poorly differentiated (anaplastic) tumors. In well-differentiated carcinomas, tumor cells are pleomorphic, atypical, but resembling normal keratocytes from a prickle layer. Poorly differentiated squamous carcinomas contain more pleomorphic cells and no keratinization. Poorly differentiated carcinomas are more invasive with a rapid growth, which tend to spread metastases early.

Fig. 7 Squamous cell carcinoma (typical type)

Staging

I. Tx – primary tumor cannot be assessed
II. TO- no evidence of primary tumor
III. Tis – carcinoma in situ
IV. T1 – tumor less than 2 cm in greatest diameter
V. T2 – tumor 2-5 cm in greatest diameter
VI. T3 – tumor greater than 5 cm in greatest diameter
VII. T4 – tumor with deep invasion into cartilage, muscle, or bone

Surgical treatment

Most of the skin cancers can be treated by surgical excision in toto, making sure that the margins are free of the tumor. For low-risk lesions / less than 2 cm in diameter, well-differentiated / it is recommended the free tissue margin 4 mm, for high –risk lesions it is recommended 6 mm of tumor-free tissue. The depth of the excision should always include the portion of a subcutaneous fat.

The generally accepted 5-years cure rate for a primary SCC is 92% if treated with a standard excision.

Non-surgical treatment

Non-surgical treatment includes a topical chemotherapy, photodynamic therapy, radiotherapy, and a systemic chemotherapy.

The topical chemotherapy and photodynamic therapy are used in premalignant lesions and carcinomas in situ. Radiotherapy is a primary option treatment in patients in whom surgical treatment is not feasible or as an adjuvant therapy for those with metastatic SCC. Systemic chemotherapy is used exclusively for patients with metastases.

Malignant melanoma

Melanoma is a malignant tumor of pigment-producing cells / melanocytes/ which are localized in the skin, in the uvea, the ears, GI tract, leptomeninges, oral and genital mucous

membranes. It is less frequent than the other types of skin cancer but it causes the greatest number of skin cancer-related deaths worldwide.
Malignant melanoma is more frequent in males and Caucasians. However some authors present higher incidence in females in ratio 1:1.5 (Krajsová, Bauer: Kožní nádory, 2000.) The exposure to an ultraviolet radiation / UVA and UVB/ is one of the major contributors to the development of melanoma. UV radiation causes damage to the DNA of cells, thymine dimerization, which if not repaired can create mutations in the cell's genes. There fore as a risky environmental factor it is a sun exposure, predominantly the sun exposure and sunburns during the childhood. Many researches claim, that the sunscreen, which prevents from sunburns, can even increase the melanoma risk.
The risk factors include a family history and an inherited phototype I, II. The family history of melanoma rapidly increases the risk of developing melanoma in children. There have been found mutations in genes on chromosome arms 1p, 9p and 12q in melanoma-prone families. Also persons with multiple dysplastic nevi or persons born with giant congenital melanocytic nevus or xeroderma pigmentosum are at increased risk of developing melanoma.

Review of Risk factors

- Positive familiar history
- Phototype I, II or sun exposure
- Dysplastic nevi / more than 5
- Acquired nevi / more than 100/
- Giant congenital nevus in adult hood / more than 20 cm in diameter/
- Prior nonmelanoma skin cancer
- Male sex, Caucasian
- Age over 50 years
- Presence of xeroderma pigmentosum

It has shown that only 40% of melanomas come from preexisting nevi and 60% of them develop de novo.

Signs and symptoms

- Asymmetry
- Border irregularity – the edges are notched or ragged
- Color variegation – the color is not uniform, varies from light brown to dark brown, some spots are white, blue or red
- Diameter- moles greater than 6 mm are more likely to be melanomas than smaller moles
- Evolution- changes in the mole during the time are characteristic, elevation – the mole is elevated above the skin. These factors are critical for nodular or amelanoblastic melanomas as they do not fit to the criteria above.

Types of melanoma

Superficial spreading melanoma (SSM) - 70% of melanoma cases

It is the most common type of melanoma. It occurs between 30-50 years mostly on the trunk in men and on the legs in women. It manifests as a flat or slightly elevated light –to- dark brown lesion with irregular pigmentation including black, pink, or white spots. At first it grows horizontally invading the dermis after a period of many months or years. It is generally greater than 6 mm with asymmetric borders.

Nodular melanoma – 15-30% of melanoma cases

It is an aggressive, rapidly growing tumor. It manifests as a red or dark brown papule or nodule, which often bleeds or ulcerates. It can be also amelanotic. It does not show typical melanoma signs, so it may elude an early detection. Histologically, it lacks a horizontal growth phase.

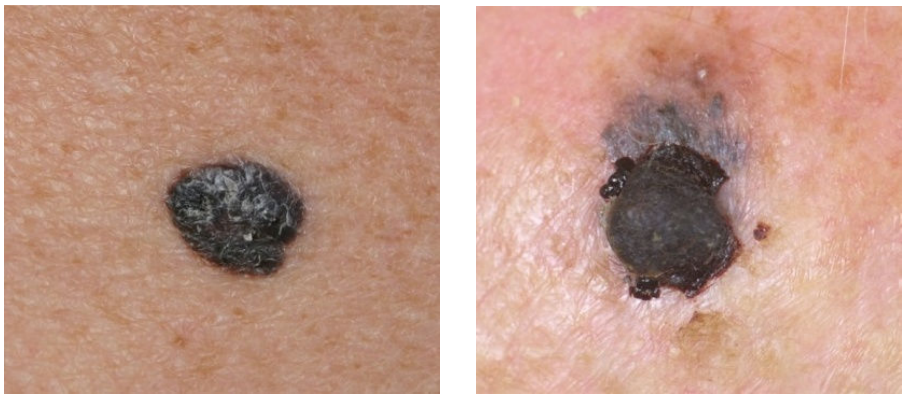


Fig. 8a, b Malignant melanoma (nodular type)

Acral lentiginous melanoma – 2 - 8 % of melanoma cases

It occurs predominantly in dark – skinned individuals (Afro-American, Hispanic or Asian population) and because of delayed diagnosis, may show a worse prognosis. It occurs on the palms, on the soles, or beneath the nail plate (subungual variant). Subungual melanoma manifests as a nail discoloration or a longitudinal pigmented band within the nail plate, it causes the nail disruption and loss of the nail. Pigment spread to the proximal or lateral nail folds is called the Hutchinson sign, which is a hallmark for acral lentiginous melanoma.

Lentigo maligna melanoma

It is a tumor of elderly people with a typical localization on the head, neck, and arms. It grows slowly over 5-20 years from a precursor, in situ lesion called melanosis circumscripta Dubreilh. The lesion is usually large (more than 2 cm in diameter), present for 10 - 15 years with light-to-dark brown pigmentation. The progression to lentigo maligna is characterized by the development of black nodules within the tumor.

Fig. 9 Lentigo maligna melanoma

Rare forms of melanoma

Desmoplastic melanoma – it occurs on the head and neck as an amelanotic or pink-to-red nodule, it is locally invasive and tends to have recurrence.

Next types are clear cell sarcoma / melanoma of soft parts/, mucosal melanoma, and uveal melanoma

Diagnosis and prognosis

The detailed diagnosis is based on histopathological type of MM:

- Melanoma in situ
- Malignant melanoma
- Superficial spreading melanoma
- Nodular melanoma
- Lentigo maligna melanoma
- Acral lentiginous melanoma
- Desmoplastic melanoma
- Epitheloid cell melanoma
- Spindle cell melanoma
- Balloon cell melanoma
- Blue nevus, malignant
- Malignant melanoma in giant pigmented nevus

Breslow's depth is one of the three most important predictive factors in melanoma. The other two are T staging and ulceration. There is also Clark classification according the invasion of tumor to particular level.

Breslow

Thickness of tumor → Percentage of affected with 5 year survival

<1mm → 95-100%
1-2mm → 80-96%
2.1-4mm → 60-75%
>4mm → 50%

Clark classification

I:	Confined to epidermis (in situ); never metastasizes; 100% cure rate
II:	Invasion into papillary dermis; invasion past basement membrane (localized)
III:	Tumor filling papillary dermis (localized), and compressing the reticular dermis
IV:	Invasion of reticular dermis (localized)

V:	Invasion of subcutaneous tissue (regionalized by direct extension)

Breslow, which is more accurate for the prediction, usually replaces the Clark classification; however the pathologist usually presents both.

Staging

Stadium	TNM klasifikace	Histologické/klinické rysy
0	Tis N0 M0	Intraepithelial/in situ melanoma
IA	T1a N0 M0	≤1 mm without ulceration and Clark II/III
IB	T1b N0 M0	≤1 mm with ulceration or Clark IV/V
	T2a N0 M0	1.01-2 mm without ulceration
IIA	T2b N0 M0	1.01-2 mm with ulceration
	T3a N0 M0	2.01-4 mm without ulceration
IIB	T3b N0 M0	2.01-4 mm with ulceration
	T4a N0 M0	≥4 mm without ulceration
IIC	T4b N0 M0	>4 mm with ulceration
IIIA	T1-4a N1a M0	Single regional nodal micrometastasis, nonulcerated primary
	T1-4a N2a M0	2-3 microscopic positive regional nodes, nonulcerated primary
IIIB	T1-4b N1a M0	Single regional nodal micrometastasis, ulcerated primary
	T1-4b N2a M0	2-3 microscopic regional nodes, nonulcerated primary
	T1-4a N1b M0	Single regional nodal macrometastasis, nonulcerated primary
	T1-4a N2b M0	2-3 macroscopic regional nodes, no ulceration of primary
	T1-4a/b N2c M0	In-transit metastasis and/or satellite lesion(s) without metastatic lymph nodes
IIIC	T1-4b N2a M0	Single macroscopic regional node, ulcerated primary
	T1-4b N2b M0	2-3 macroscopic metastatic regional nodes, ulcerated primary
	Any T N3 M0	4 or more metastatic nodes, matted nodes/gross extra capsular extension, or in-transit met(s)/satellite lesion(s) and metastatic nodes
IV	Any T any N M1a	Distant skin, subcutaneous, or nodal mets with normal LDH levels
	Any T any N M1b	Lung mets with normal LDH
	Any T any N M1c	All other visceral mets with normal LDH or any distant mets with elevated LDH

5 year survival rate is almost 100% at stage 0, more than 95% at stage IA, 90% at stage IB, 78% at stage IIA, 65% at stage IIB, 45% at stage IIC, slowly decreasing to stage IV, where the survival rate is about 10-19%.

Surgical treatment

Surgery is a mode of treatment in a localized melanoma. The margin of excision of uninvolved skin varies from the depth of the tumor invasion. For melanoma in situ it is recommended to have the margin 5 mm, for melanomas up to 1mm of depth it is 1 cm. For melanomas with deeper invasion it is 2 cm. The excision should contain an epidermis, a dermis and a subcutaneous fat down to the fascia of muscles. The defect can be sutured primarily with an appropriate drainage. If the primary closure is not feasible, skin grafting or skin flaps are used.

The sentinel node biopsy is provided when the tumor invades more than 1 mm of the skin depth, tends to ulcerate or shows a spontaneous regression. It can be done primarily with the tumor excision or subsequently after the tumor excision and histological evaluation. The subsequent lymph node biopsy may not overlap 14 days period after the tumor excision. Lymph node mapping is done by lymphoscintigraphy when the radioactive trace is injected around the tumor or the excision scar immediately before the surgery. The detection is made with a probe directly at the operating site. The lymph node is examined for a presence of micrometastases, if present; a completion lymph node dissection is performed.

The sentinel node status is a predictive factor for the recurrence and it is the most powerful predictor of a survival in melanoma patients.

Non –surgical treatment

The only adjuvant therapy which is used at high-risk melanomas (stage IIb, IIc and III) is the interferon alpha-2b treatment. No survival benefit has been demonstrated for adjuvant chemotherapy, radiotherapy or vitamin therapy. Melanoma vaccine seems to be an attractive option for a melanoma treatment in the future.

Follow up

The patients with diagnosed melanoma should be regularly checked at least once a year. They are usually under the control of the oncologist or dermatologist. He provides check up of the skin, lab tests, a chest X-ray and an ultrasound of visceral organs. Locoregional and visceral metastases can be predominantly localized in lungs, a liver and CNS.

Dermatofibrosarcoma protuberans

Dermatofibrosarcoma protuberans is a locally aggressive tumor with a high recurrence rate. It originates from fibroblasts in dermis and invades deeper subcutaneous tissue as fat, fascia and bone. It shows intermediate- to- low-grade malignancy. It occurs most often in adults aged 20-50 years. Initially it starts as a skin – colored or slightly reddish papule resembling a keloid. The tumor may gradually enlarge into a lumpy nodule or cluster of irregular nodules. The size is often more than several centimeters in diameter, bumpy, firm, with dark red or brown color.

The surgical excision with a 2 cm wide margin of macroscopically uninvolved skin is recommended

Merkel cell carcinoma

Merkel cell carcinoma originates in touch receptors of the skin. The receptors are mainly localized on the lip, the hard palate, the palms, the finger pads, the proximal nail folds and dorsa of the feet. It is a rare and aggressive type of skin cancer. The risk factors include: an age over 65 years, a phototype I, II, an overexposure to the sun and a chronic immunosuppression. It does not have a distinctive appearance. The tumor appears as a painless, firm, rapidly growing, red or purple colored tumor. It occurs mostly on the face and the neck. The tumor makes metastases in regional lymph nodes.

The surgical excision with at least 2 cm margin is usually indicated. The other therapy includes a sentinel lymph node biopsy or adjuvant radiotherapy.

Kaposi's sarcoma

It is a tumor caused by Human herpes virus 8 (KSHV). It is not a true sarcoma, but cancer of lymphatic endothelium that forms vascular channels filled with blood. That gives a tumor a characteristic appearance of a red or purple papule, often formed as multiple blotches. It does not hurt but it can swell due to inflammation. It is usually localized on lower limbs, a face, a mouth or genitalia. Sometimes it can occur also in the gastrointestinal tract. The prevalence of the tumor relates to the immunosuppression. The most common immune system problem that contributes to Kaposi's sarcoma is a infection with the human immunodeficiency virus (HIV).

Types of Kaposi's sarcoma include an epidemic (AIDS-related) type, a classic (Mediterranean) type, an endemic (African) type and an iatrogenic (transplant associated) type.

The treatment of choice includes radiotherapy, a cryosurgery or a surgical excision. The tumor is not curable, but it can be effectively palliated for many years. The therapy of internal lesions or widespread lesions includes an interferon alpha or a paclitaxel.

Summary

Skin is the largest organ of the body. Skin tumors are divided into benign and malignant forms. The benign form includes birthmarks and acquired tumors such as a fibroma, a lipoma, and nevi. Skin cancer is ranked among the most frequent cancers in the world, and the incidence is rapidly increasing. The malignant forms are usually sun – exposure depending. There is the increasing incidence among Caucasians living near the Equator. Basal cell carcinoma and squamous cell carcinoma are tumors of elderly people after 20 - 30 years of a sun overexposure. The potency of metastases is low. The most dangerous skin cancer is a malignant melanoma. It can occur in young adults in the sun –exposed areas predominantly on a back in men and lower limbs in women. The result can be good when diagnosed early, but late diagnostics indicates a bad prognosis. The melanoma can spread through lymphatic and blood vessels system. It tends to metastasize early. Each birthmark or acquired naevus,

which tends to change, should be examined thoroughly to prevent a risk of developing a malignant melanoma.

Reconstruction of the face

(with the exception of congenital malformations).

Markéta Dušková

Appearance of the face is one of the most important human features. It is a significant part of our identity and because it exists essentially naked, unhidden by clothing, a facial deformity can be a terrible source of unhappiness, embarrassment, or insecurity. There fore facial appearance has got such an impact to our emotional situation, self-esteem, also self-confidence in the society, and thus the quality of our life.

Because the human percepception is three- dimensional and in addition perspective, facial contour and relief makes a first impression. Both are influenced by size and contour of skeleton, thickness of skin and volume of soft tissues according to an individual disposition and presentation, style of living, hormonal influence, and natural aging. The commonly accepted ideal is youth and beauty, which are done by the features of facial aesthetic subunits , mainly by distances, curves, angles, proportions, size, however the whole face must act as an integrate, harmonious, and well balanced complex. Mimics, hair style, dressing, jewellery, and make up also play an own role.

People have tried to define a beauty since Ancient Egypt. In Ancient Greece it was a concern of a sculptor Polyclitus and a mathematician Euclidos. Pythagoreis figured a beauty geometrically as so called golden proportions and relations. The expression kalokagathia connected beauty with good while the stigma suggested the evil. During the Renaissance Period next artists as Alberti or Dűrer interested in human attractiveness. Leonardo da Vinci made probably the first sketch depicted the facial triangle, also called golden triangl, which is still understood as the most impressive part of the face and which displays the main role in appearance and communication (see fig. 1).

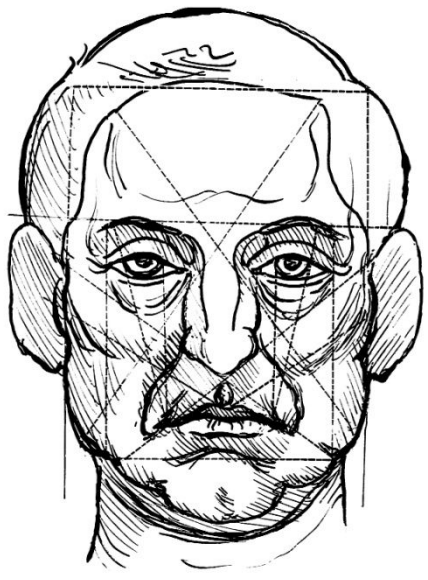


Fig.1 Facial triangle by Leonardo da Vinci

The aesthetic and functional zoning is the basic step for consideration of reconstruction. In modern time we recognize face as a broken terrain with well defined aesthetic units: forehead, nose, eye and orbita, cheek, upper lip, lower lip, chin and lower jaw, auricle, and neck (see fig. 2).

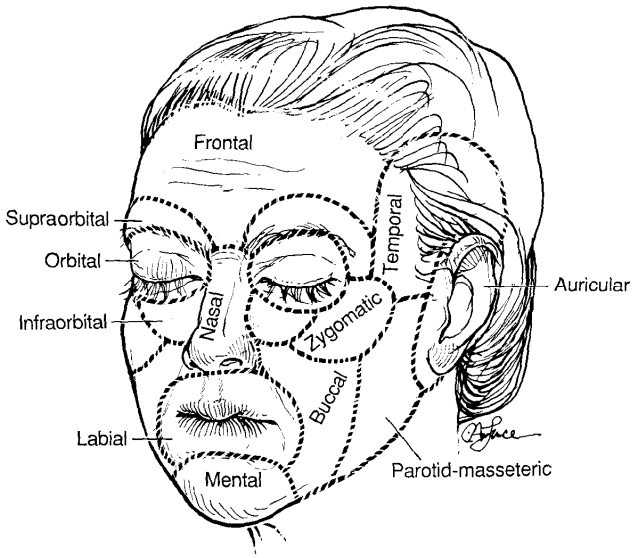


Fig. 2 Aesthetic subunits of the face

Mutaz Habal described cohesion among hard tissues, soft tissues, function, appearance, and Hale Tolleth and Edward Terino characterized beauty as a balanced relationship among

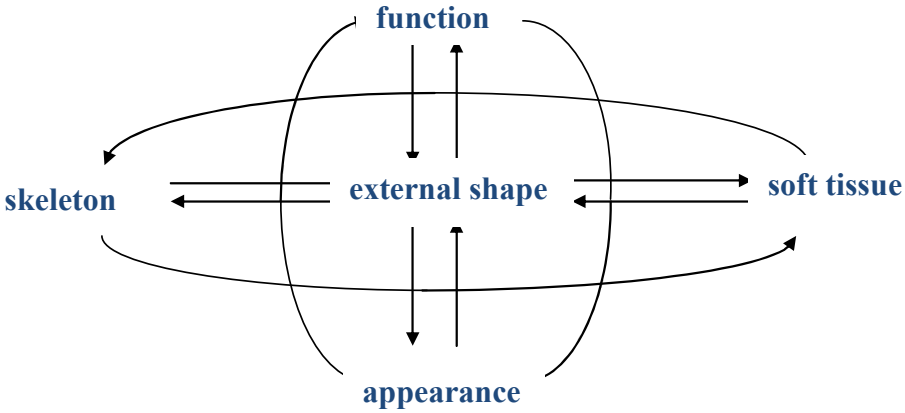


Fig. 3 Cohesion of components by Mutaz Habal

skeleton, features and soft contour of the face. Edward Terino emphasized a relief of the face

Paul Tessier (1917-2008) was the first plastic surgeon, concerning and solving life threatening defects and deformations with regard to function, shape and appearance. He qualified the defects, when pure skeleton defects and pure soft tissue defects exist more exceptionally, while most often are combined defects of hard and soft tissues. He also established the priority of hard tissue reconstruction. He as a first understood there are facial disfigurations with acceptable function but deeply cutting down the quality of life.

An indication for facial reconstructions are congenital faults (see the Chapter Congenital anomalies of the face) and acquired deformities, which may be posttraumatic and/or

pathologic origin. Thanks to advancing medical care a number of such cases are constantly increasing.
As mentioned above the missing part may be soft tissue or skeleton, but more frequently we see the combined defects. In addition the situation can be changed by different parallel complications (severe scars, inflammation, hypoplasia, changes due to irradiation, due to the failure of supply, due to degeneration, due to unwanted reaction or side effect of pharmaceuticals etc).

The choice of approach for face reconstruction must be based on with meticulous assestment of the afflictions and detailed examination of particular person.
Knowledge of medical history and current health condition are the first steps. They limit the choice of treatment approach. Particular method may present the unacceptable burden for the patient due to parallel diseases (cardiovascular system, pulmonary system, central neural system, metabolic problem, psychiatric illness). As well as it is necessary to consider certain rather risky aspects (smoking, alcoholism, addiction drugs, toxic products).
After taking the medical history of the patient we continue with patient's subjective complain, concern, and expectation with regard to the disorder and treatment. This evaluation must concentrate to patient feeling. It is based on the individual disposition and presentation.
Then we evaluate the savor of objective expression of plain face and during the mimicking. There are three main categories according the impact for the social life:

1. Minimal disorder, which does not invite
2. Damaged parts of the face, but no involvement of facial triangle, which do not disgust
3. Disfigurement, caused complete inability of social life, which may mean the social death

After establishment of basic predictions mentioned above, we have to assess anatomically the defect itself (size, features) and the relationship between defect and the rest of the face. According to function we evaluate the sensitive and motoric function (inspection, palpation, EMG):

1. No disorder
2. Light problem
3. Function failure

We have to assess which tissue is involved and how:

- Soft tissue: thickness of skin, volume of soft tissues, surface of soft tissues
- Hard tissue: size, contour of skeleton
- Both types

Diagnosis must be established and defined in details. It is necessary to consider three-dimensional facial reconstruction technique.
We use direct examination (inspection, palpation) and additional examinations (CT, MRI, 3D CT, 3D MRI, plaster casts, photos, photo-simulation, stereotactic lithography etc.).

We make the anthropological measurements of all aesthetic facial subunits (mouth, nose, eyes, eye brows, front, cheeks, chin, jaw definition and relationship, bite, etc.) the distances, angles, curves, position to aesthetic lines of the face with regard to age, race, gender, and/or ethnic background (see. fig. 4).

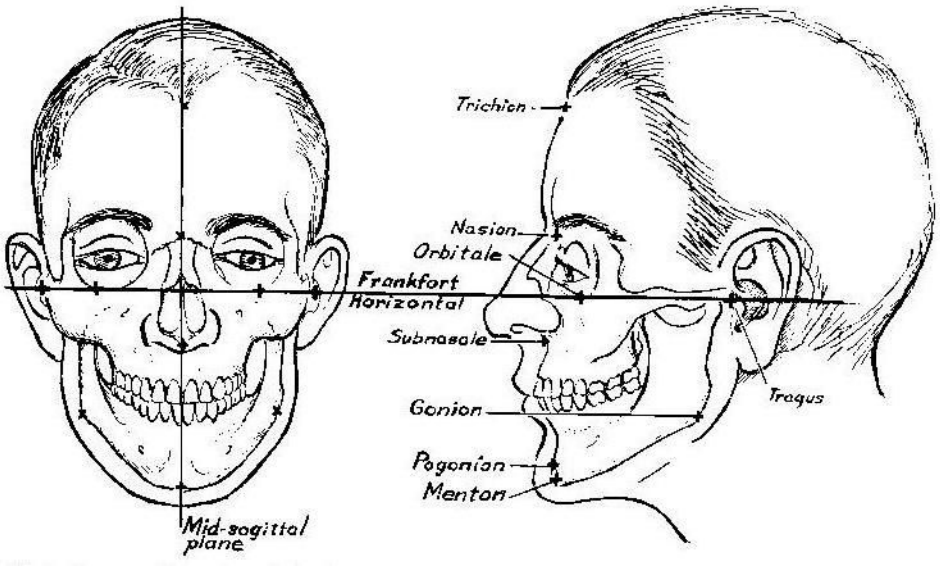


Fig. 4 Anthropometric measurements of the face
A – frontal view: Frankfurt horizontal and middle sagital plane
B – lateral view

Bone tissue repair

The defect of hard tissue is the first step of reconstruction. Elaborateness of particular method and the outcome are in direct proportion, from limited effect of epithesis over compromise of covered implants till complex perfection of distraction osteogenesis. The defects of the nose, malar area, chin, and front head are very visible and apparent as the contour of skeleton is covered by thin layer of soft tissue only.

Shape of bone defect and options of reconstruction

- Cavity (bone cyst) - filler
- Gap (cleft defect of maxilla alveolus) - filler or bridge implant
- Contour defect (surface irregularities after injury or surgery, stp resection for tumor, small size of the framework) - onlay structure, free osseous flap, bone shift, distraction osseogenesis (all these options improve the existing contour or expanding on the boundary and thus giving the patient a normal facial balance)

Material for bone tissue repair

According to the source we differentiate two main types of material: natural and synthetic.
To the natural ones we include the autologous bone graft, coming from the same individual (from Peter to Peter), allogenic bone graft is from the other individual of the same species (from Paul to Peter), and xenogenic bone graft which is from the other individual of the other species (from animal to Peter).

Autologous bone grafts are still the golden standard for the clinical application. Autologous bone graft may be classified according to morphological type into the cortical type, that dives strength, and cancellous type presenting vascularisation. Next classification is according to the origin as the enchondral bone like iliac crest, tibia, radius, ulna, rib, and membranous bone like parietal bone or mandible.
Bone formation proceeds as osseoconduction, which is resorption of graft and gradual ingrowth of bone. Osseoinduction is a process when nondifferentiated mesenchymal cells induced by BMP produce the osseoblast cells in graft. Osseogenesis means real bone formation resulting in live bone tissue covered by periosteum.
Synthetic bone substitutes are different upon to their reaction with the tissue of the defect at the site of contact (biocompatibility) as biotolerated, bioinert, and bioactive (osteoconduction and osteogenesis) (see. fig. 5).

Some of bone substitutes may be unresorbable, which are relatively stable and lasting for ever, the others are resorbable, which serve as a carrier only because they are dissolving during the time.

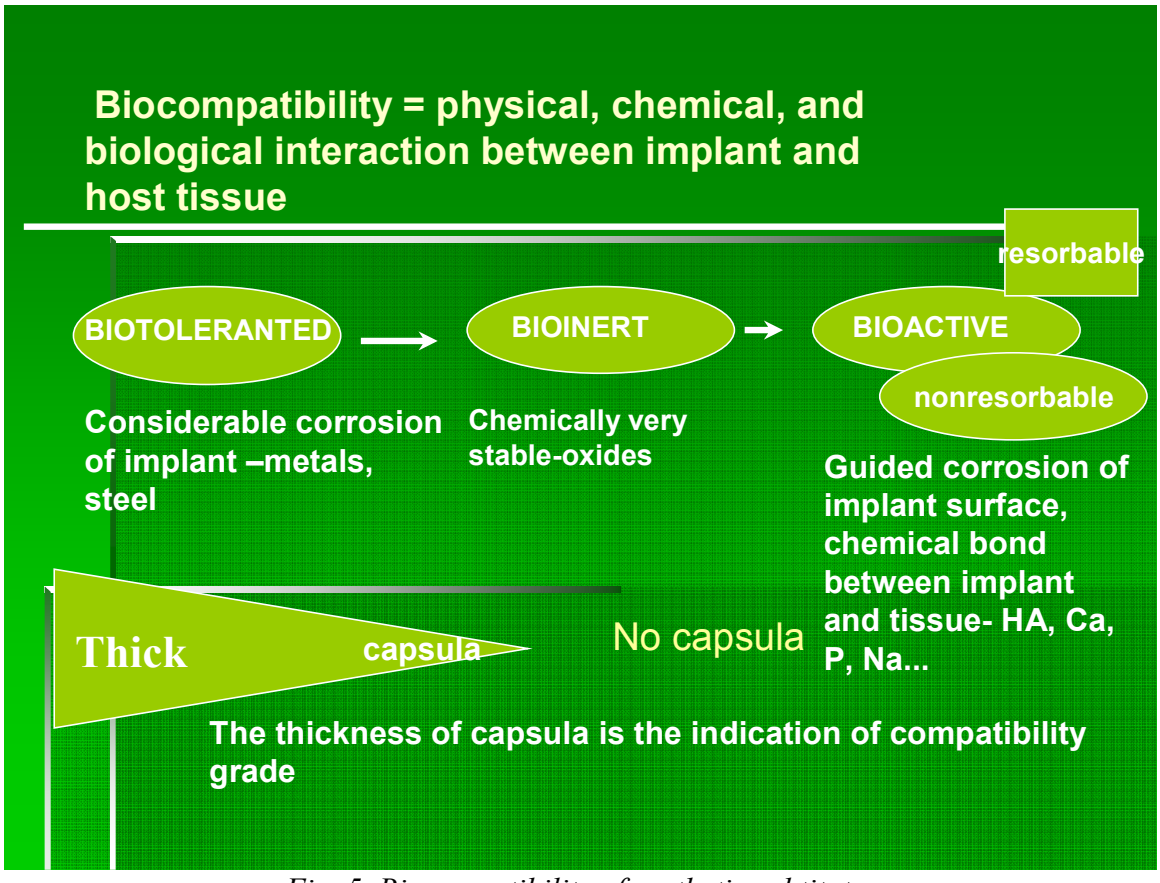


Fig. 5 Biocompatibility of synthetic subtitutes

Now the most used materials are titanium (see fig. 6) and porous polyethylene (see fig. 7).

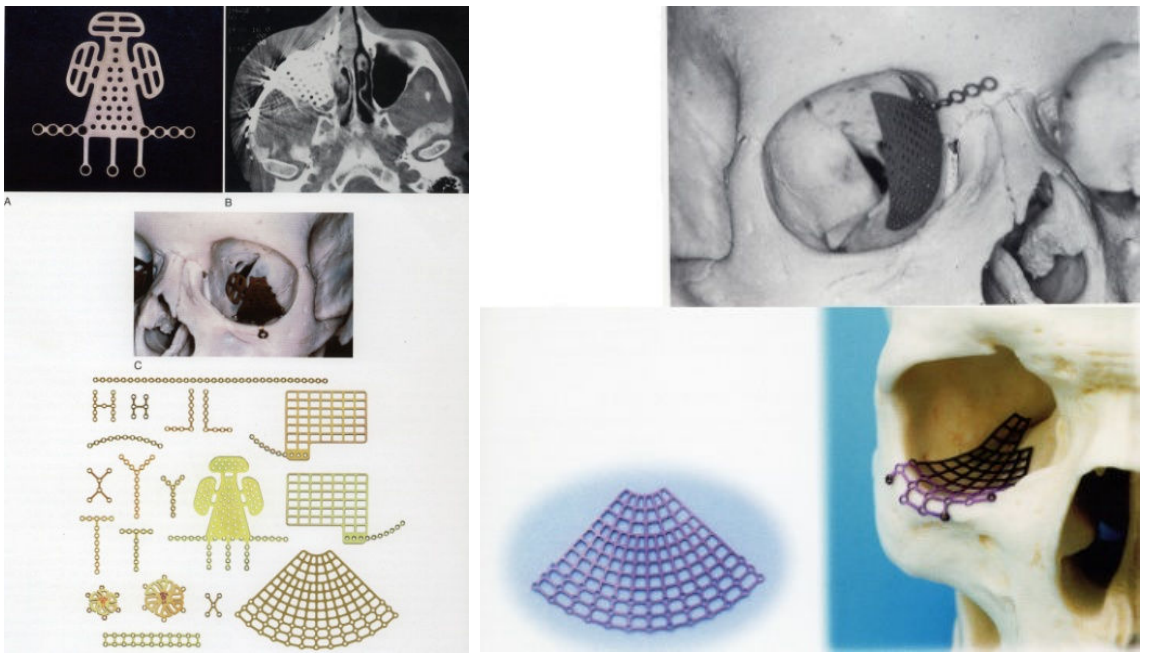


Fig. 6 Titanium mesh

Fig. 7 Porous polyethylene (Medpor ®)

Surgical success
depends on the characteristics of recipient bed and graft or implant. The main are viability resp. vascularity of recipient bed, volume of graft, its viability and ability for revascularization, contact between substitute and bone and periosteum, migration and ingrowth ability of osteoblastic cells into the implant, sufficient soft tissue coverage, following mechanic load, and possibilities of shaping and handling.

Disadvantages, risks, complications

Autologous bone grafting presents a higher load by the demanding surgery for the patient. They are subject of resorption, mainly when they are under the pressure.

Allotransplats are nearly out of the use due to ethic and legal aspect. Their resorption and failure of embedment is more pronounced than in autologous grafts.

Xenotransplants evoke the immune response, are subject of strong resorption, and present the risks of animal infection.

Synthetic substitutes are always a foreign body, however they may be advantageous approach for contour disorders especially in patients with serious parallel problems and/or exhausted by the previous treatment.

Their most frequent complications are the extrusion and disintegration that can be influenced specifically by particular biocompatibility:

I. Biotolerated materials produce atrophy of surrounding tissues,
II. Bioinert ones make capsulation
III. Bioactive ones with chemical bond onto live tissue may succumb to change of composition and structure

Future can be seen in tissue engineering bringing functionally adaptive bone with possibility to create and control the shape of new tissue compatible with natural biomechanical function.

Soft tissues repair

The repair of soft tissue is frequently underestimated. However soft tissue envelope may scar and retract. This lack results in distortion of the new shape of skeleton.

Remarkable challenge for the plastic surgeons is to solve the complex problem of the cover with regard to the color, texture, regularity and flow of surface and contour, volume and thickness, mobility function and mimics, and also sensitivity.

According to defect characteristics, patient condition and expectation, surgeon skill and equipment we can use:

I. Primary closure with the advancement of wound edges
II. Skin grafts
III. Local flaps
IV. Regional flaps
V. Free flaps

Also but rarely we use tissue expansion and exceptionally there is option of distant flap.

Advancement of wound edges and shift constitute a mobilization of the defect walls and direct suture together. The prediction of this approach is the extensibility and sufficient amount of the surrounding tissue.

Skin grafts are used for larger and shallow defect. We use full thickness grafts more frequently then the split ones. The preauricular area, the dorsal side of the auricle, the upper eye lid is the most used donor sites. Surgery is easy, without any complicated requirement either for the patient either for surgeon. The possible main disadvantages are the shrinkage

with surface irregularities, discoloration, and shortage of volume. As all skin grafts the well-vascularised bed is necessary for intake and good healing.

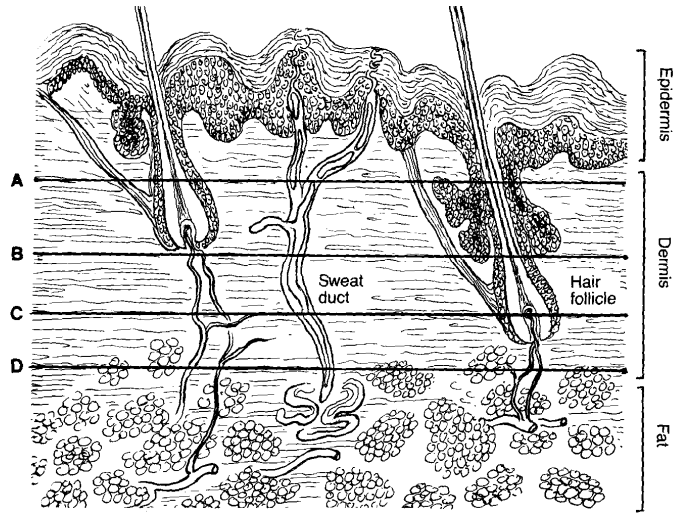


Fig. 8 Basic layers of skin and possible grafts according
A) epidermal
B) thin dermoepidermal
C) thick dermoepidermal
D) full thickness skin graft

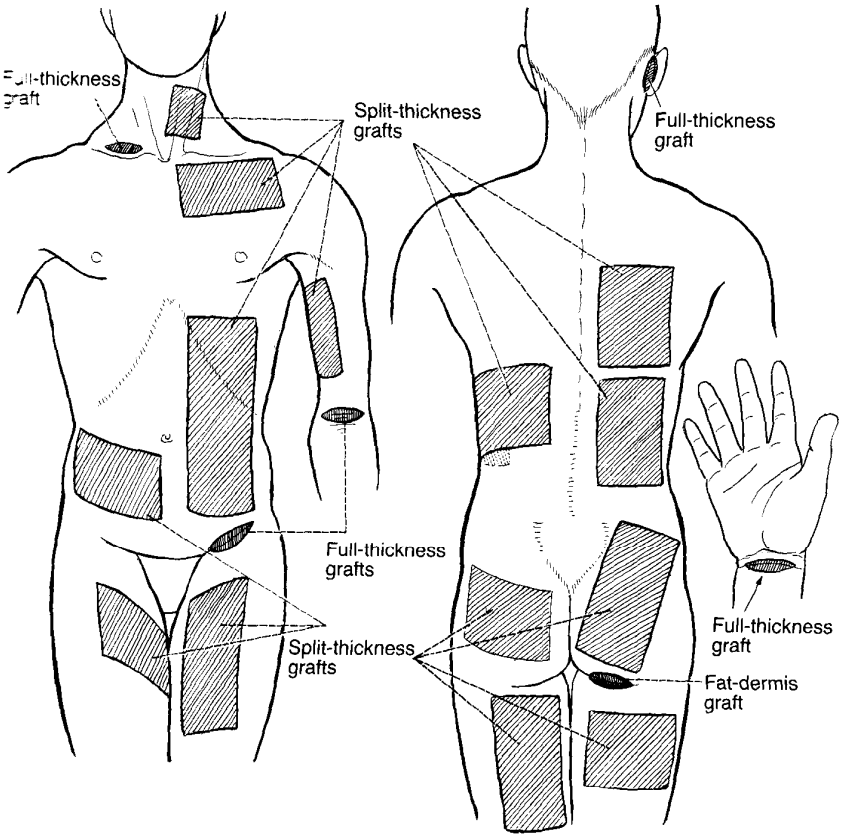


Fig. 9 Possible sites for harvesting of split skin grafts and fullthickness skin grafts

Local flaps may be random (pedicle with corial vascular net) and axial (pedicle with defined vessels), but both bring vascular supply. Due to the rich vascularisation of the face the ratio of flap body and its pedicle may be higher than usually. When considering the design and concept of flaps we must not forget shrinkage, scarring, and possible partial loss. Flaps can be doubled, can be combined with cartilage graft or skin graft. The main clinical indication is the centrofacial area. Main examples of facial local flaps are the nasolabial flap, the forehead flap-see Fig. 10. and 11.- and/or cheek rotation flap.

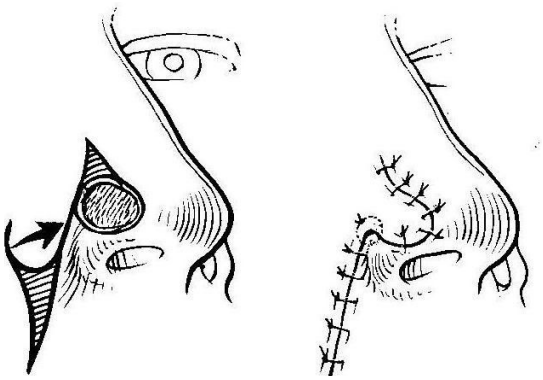


Fig. 10 Sketch of nasolabial flap

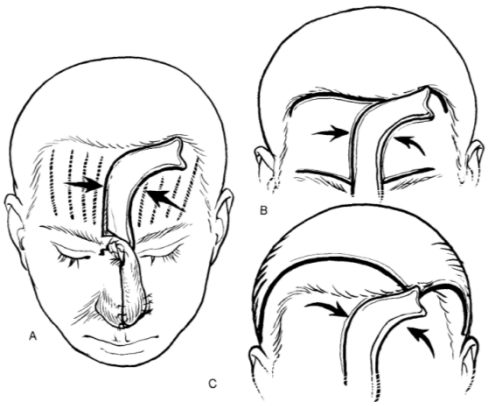


Fig. 11 Sketch of forehead flap

In the case of facial reanimation for the palsy we can use the transposition of local fascial or muscle flaps, i.e. temporalis muscle and masseter muscle.
For details see http://www.entusa.com/facial_flaps.htm

Nasolabial flap (see fig. 12)
Described in detail in 19th century by Dieffenbach, it is still the first option for the nasal reconstruction

Indian front head flap (see fig. 13)
Indian front head flap was described and used 600 years BC by Sushruta, it is still in clinical application, but the technique has been modified. Now Frederick Menick is probably the world leader in nose reconstruction- for details see
http://emedicine.medscape.com/article/1293154-overview

a)

b)

c)

d)

e)

Fig. 12 Clinical example of defect reconstruction using the nasobial flap
a) drawing of tumor excision and proposition of the flap
b) after excision of the tomor, elevated flap with partial suture of secondary defect
c) after first stage
e) healed flap before disconnection
f) after disconnection of the flap

Fig. 13 Clinical example of defect reconstruction using the scalp forehead flap :
a) patient after resection of invazive basocelular carcinoma
b) flap prepared at front head, modelated as a nasal tip
c) after healing of this step
d) after trasfer into the site of application

With the development of microsurgical technique **regional flaps** have got lesser importance for clinical use (deltopectoralis flap, pectoralis flap, trapezius flap) and real distant flaps like arm flap, described and worked out by Gaspar Tagliacozzi in 16th century- see the Chapter Introduction- dropped out of the clinical praxis yet

As the last but not least is necessary to mention the **additional procedures**. Lipofilling gives more volume into the sites of soft tissue lack.
Hair grafts may be used in brow, lashes, moustache, and hair reconstruction.

Complex reconstruction

Major facial reconstruction after head and neck cancer surgery and facial trauma is extremely complex. It often requires transplantation of bone and tissue from distant regions of the body to restore normal function and aesthetics. Currently the free flaps are used for the reconstruction of severe defects. They better meet the need of tissue complexity and 3D reconstruction. Bringing copious amount of well nourished tissue they are able to give new shape stability due to reduction of the tissue lack and the scar pressure in one operation. It is necessary to point out the procedure is demanding with regard to the surgeon experience, skill, and equipment and with regard to the patient load by the surgery. Radial forearm free flap is one, which most frequent in clinical application. In need of bone substitution for the jaw reconstruction we use fibula free flap. In case of reanimation for facial paralysis we use gracillis muscle free flap. There are some more flaps which can be utilized, but they are too bulky and also less matching other characteristics for area need.
For the image see http://www.advancedonc.com/reconstruction.htm

The allotransplantation of the face from the one man (donor) to the afflicted person (recipient) is the latest surgical trend. However the procedure is connected not only with need of the special technique, with ethic and psychological problems, but also with the necessity of immunosuppressant- taking by the patient. This treatment protects the transplanted tissue from the rejection but also there are a lot of side effects to the human organisms. The main ones are increased risk of infection, increased risk of cancer; the minors are loss of appetite, nausea or vomiting, increased hair growth, and trembling or shaking of the hands. Unlike transplants of solid organs such as the heart, these types of transplantation aren't life-saving. Nevertheless the severe disfiguration can mean a consequence of the social disabling as far as social death.

In conclusion stigmatized appearance is a reason of psychological barrier and insufficient self esteem, causing communication disorders and hampering the personal or professional fulfillment in society. It means a decrease of life quality. The more perfect elimination of functional problems and aesthetic problems, the better chance is to increase emotional stability and self-confidence, and thus also the quality of life in affected individuals.

Aesthetic plastic surgery

Markéta Dušková

Reconstructive surgery is performed on abnormal structures of the body, caused by birth defects, developmental abnormalities, trauma or injury, infection, tumors, or disease. It is generally performed to improve function, but may also be done to approximate a normal appearance. The corrective reconstructive surgery may even prevent further damage or deterioration of health.
Aesthetic surgery, on the other hand, is performed to reshape normal but unwanted structures of the body. The main purpose is the improvement of such appearance that is according its owner beyond the average level toward some aesthetic ideal. The outcome is supposed to induct the feelings in a sense of the increase of self-esteem and confidence in the self-fullfilment in the social envirolement and thus also quality of life. Problems that address aesthetic plastic surgery, are congenital and acquired cosmetic defects.

An adjective "cosmetic" describes beauty, aesthetics, or appearance, especially concerning the human body.
Aesthetics mean:

I. *(used with a sing. verb)*
    a. The branch of philosophy that deals with the nature and expression of beauty, as in the fine arts.
    b. In Kantian philosophy, the branch of metaphysics concerned with the laws of perception.
II. *(used with a sing. verb)* The study of the psychological responses to beauty and artistic experiences.
III. *(used with a sing. or pl. verb)* A conception of what is artistically valid or beautiful: *minimalist aesthetics.*
IV. *(used with a sing. or pl. verb)* An artistically beautiful or pleasing appearance

There are two traditional views concerning what constitutes aesthetic values. The first finds beauty to be objective, that is, inherent in the entity itself. The second position holds that beauty is subjective, in that it depends on the attitude of the observer.

The development of a better social life, changes in professional and private needs, the possibility for greater self-confidence – all are factors which may increase a person's demands on their appearance. The feeling that they look well brings about higher self-esteem, which may contribute to some extent to an easier achievement of success and feeling of overall satisfaction.
As a result, even the indication range of aesthetic surgery has changed. Formerly promoted opinions that surgeons decide what is considered a defect and whether an operation is done no longer hold true.

To znamená, že člověk je operován tehdy, pokud má sám potřebu kosmetické úpravy a chirurg je schopen jeho představu změny technicky realizovat. Profesionálním úkolem operatéra je konzultace = porada, která se skládá z vyšetření a vysvětlení různých možností řešení, jejich důsledků či případných komplikací.

Currently, the feelings of individuals and their realistic expectations in accordance with a surgeon's capability are the recognized criteria in decision-making for or against an operation. This means that a person is operated on when he/she feels a need for a cosmetic modification and when a surgeon is capable of technically realizing his/her idea.
The professional task of the surgeon is to provide a consultation consisting of an examination and an explanation of various treatment options, including their sequlae or possible complications.

The following list gives an orientation of indications:
Signs of aging in the face; drooping eyelids; lip size and shape; protruding or deformed ear lobes; nose deformity; post-traumatic and post-operative deformities of the facial skeleton and soft tissues; size, shape and position of breasts; slack and sagging abdominal wall; local excess of adipose subcutaneous tissue; benign skin tumors; and scars and scarring deformities.

Aesthetic plastic surgery deals with both inherited and acquired cosmetic defects. Apart from purely cosmetic defects, which are often mistakenly considered to be the only subject matter of the discipline, plastic surgeons also deal with conditions affecting the mental state and somatic functions of patients.
Traditionally, the face or hands are the most frequent sites. These body parts have the strongest social impact and logically dominate the aesthetic impression. However, social development has lead to an expansion of aesthetically important areas to include almost the entire body.
The following list gives an orientation of indications:
Signs of aging in the face; drooping eyelids; lip size and shape; protruding or deformed ear lobes; nose deformity; post-traumatic and post-operative deformities of the facial skeleton and soft tissues; size, shape and position of breasts; slack and sagging abdominal wall; local excess of adipose subcutaneous tissue; benign skin tumors; and scars and scarring deformities.
The pace of life and demands of professional and private interests of patients have led surgeons to develop procedures that reduce the operative burden with either equivalent or even improved effect. A shorter convalescence, a reduced number of complications, and lower overall financial costs are thus achieved. Such stimuli are reflected in both biological research and technological development.
Technical progress and biological discoveries of recent years have brought important changes in methods and have enlarged the possibilities of aesthetic plastic surgery.
An increasing public interest in this field is obvious. The decision-making of any prospective client should be based on realistic demands and expectations, followed by a surgical intervention performed by a skilled expert. The facility used must be able to provide for quality pre- and post-operative care.

It is necessary to acknowledge the fundamental difference between an average surgical patient and a patient who is demanding an improvement of their looks. The difference lies in the reason for the operation.

Typical surgery patients, who suffer from grave bodily troubles that endanger their lives, follow a psychological path which enables them to understand and respect the pain associated with their operations, the limitations of their post-operative condition, experiencing a longer convalescence, and possibly even complications or death related to their underlying disease.

Contrary to this typical situation, there are individuals who undergo surgical interventions while in good health, who expect mental satisfaction after the removal of the cosmetic defect and an ensuing improvement in their quality of life. The burden of the defect and the desire to remove it is confronted with the experience of post-operative pain, fear, the length of healing and recovery, and also the financial expenses. Such a confrontation may not always elicit a positive reaction from every patient. This confrontation may then bring about an immediate denial reaction followed by a discrepancy between the experienced unpleasant perceptions and the reality of the expected benefit. As a result, there may be even a greater dissatisfaction with both the surgeon and the outcome, even though the latter is objectively not poor. Such a development is more pronounced the less realistic the pre-operative expectation was, for instance in terms of improving a relationship, achieving a job, etc.

Long-term experience is a basic requirement for good diagnostics and communication between an aesthetic plastic surgeon and a patient. A natural necessity is the capacity for deep empathy of the physician with a client's opinion, which at the same time serves as a defense against unrealistic and non-feasible demands on the patient's side.

The notion of an ideal condition being the unity of physical and mental well-being makes it evident that good results of these operations may markedly contribute to a patient's improved quality of life and thus to a feeling of complete health.

In the Czech Republic the aesthetic plastic surgery belongs to plastic surgery according to the postgraduate training. This educational system assures the quality of medical care.
In the Czech Republic there are 4 steps of training:
At first a plastic surgeon trainee starts with theoretical studies and watching the surgeries. Then she/he assists to senior surgeon.
She/he continues with operating under supervision and assisting to senior surgeon.
Finally she/he carries the surgery alone.

The training of plastic surgery lasts at least 5 years and must be provided at accredited sites, where the trainee is going through all parts of plastic surgery. To become a fully board qualified plastic surgeon; one must pass the qualifying examination, which is oral and practical. To application form for the examination the candidate must attach references of main tutors and a list of performed surgeries. There are types and number of compulsory

operations. Further training, experience, and specialization are required for certification in aesthetic plastic surgery.

All surgeries have the risks and complication. No surgery can be underestimated and understood as a small one without any hazard. The aesthetic plastic procedures are not the exception. Always they must be performed lege artis- see Introduction to the surgery.

In practice necessary pre-op prepare is the same for all types of surgeries.

- Patient must be in a health condition best as possible.
- The pre-op examination: ECG, tests of blood and urine, examination by physician is inevitable.
- Patient must inform a surgeon (medical staff) about his/ her medical history, current health condition, and medication.
- It is forbidden to use any pharmaceutical increasing the bleeding for example: acetylosalicylic acid, antiflogistics, e vitamine, hormones, etc. without acknowledgement of surgeon.
- A day before surgery we recommend copious amount of nonalcoholic drinks and light food. Complete body wash is a matter of course.
- In day of surgery a **patient must not drink and eat since the midnight,** if the surgeon does not fix differently

The main complications and risks are the bleeding, infection, unwanted injury of operating field structures, tromboembolism, also it necessary to mention tissue necrosis and hypertrophic or unsighted scarring. Particular problems come from the synthetic implants that are always the foreign body. Their main disadvantage is the temporary endurance which ends with their disintegration. Specific problem of aesthetic plastic surgery is dissatisfaction of patient with regard to the aesthetic outcome. It may appear even if the objective result looks good. This complaint can come from the unrealistic expectations or even from pathologic desire for physical perfection.

Body dysmorphic disorder (BDD) (previously known as dysmorphophobia is sometimes referred to as body dysmorphia or dysmorphic syndrome) is a psychological disorder in which the affected person is excessively concerned about and preoccupied by existed or imaginary defect in his or her physical features (body image). BDD is a chronic illness, and symptoms are likely to persist, or worsen, if left untreated.

A basic change of appearance may also have an important impact to the patient psychology however not always a positive one. The prevention of risks and complications consists in surgeon skill and experience, mainly detailed examination of patient including analysis of her/his grounds for surgery, meticulous surgical technique, well-carried pre and post op care, and compliance of the patient with surgeon and medical staff.
The pillow of understanding between patient and surgeon is the informed consent confirmed by the signature of both. This document describes the options of problem solution, chosen approach, its characteristics, postoperative care and recommendation, possible risks, and

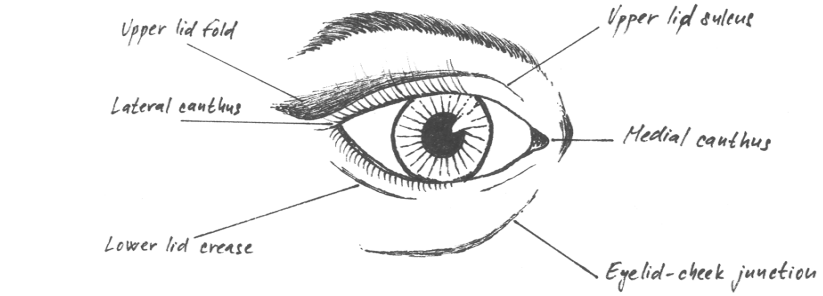
complications. All expenses of treatment are usually paid by the patient, only the unpredictable complication suddenly coming from the patient health condition are covered by health insurance providers. Financing and payment should be divided from the medical part of this issue by the different agreement or contract.

We divide the surgeries as a minor (low number of risks and complications, short operating time, requiring less equipment and having relatively short learning curve) and major (more possible risks and complications, operating time more than one hour, requiring special equipment and longer experience with perfect skill), in aesthetic plastic surgery, however, we cannot classify the operation as an easy, because as mentioned above a patient considers the surgery without any health or life threatening reason. He (she) expects an improvement of appearance with proper sequels like better self esteem and life quality.

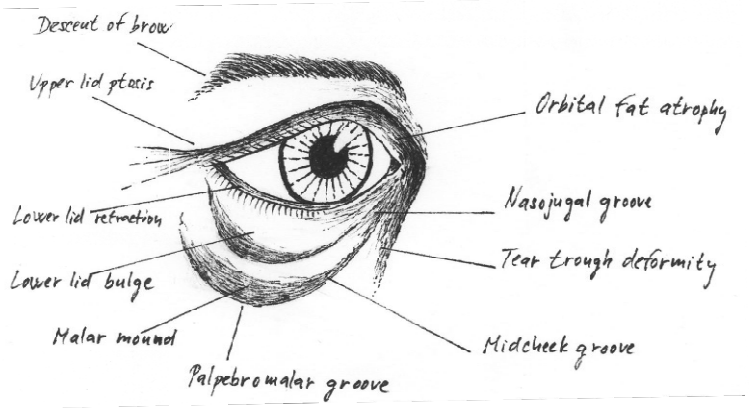
Minor surgery may be represented by:

Eyelid surgery (blepharoplasty)

This procedure corrects drooping upper lids and puffy bags below the eyes by removing excess fat, muscle and skin. Its length is usually 1 - 2 hours. We use usually local anesthesia, but general is also possible. The surgery can be made as outpatient procedure, however overnight hospital stay is recommended. Side effects are temporary swelling, bruising, hypoesthesia, itching, tearing, redness, and sensitivity to light, permanently scars. Among the risks are hematoma, temporary blurred or double vision, blindness (extremely rare), inflammation or infection are the risks. After operation we recommend the upright position, cooling of operated site over dressing, fluids in the dose 60 - 80 cc /kg of weight and day, first day after surgery liquids only, later regular food, medicaments by individual direction and schedule. We usually remove stitches 3 - 4 days after operation. During recovery is possible reading after 1 - 2 days, gentle press massage of scars daily since the fifth day after operation, return back to normal activities after 4 - 7days; however the swelling lasts several weeks. Duration of results is 6 - 8 years (see fig. 1, 2).



a)



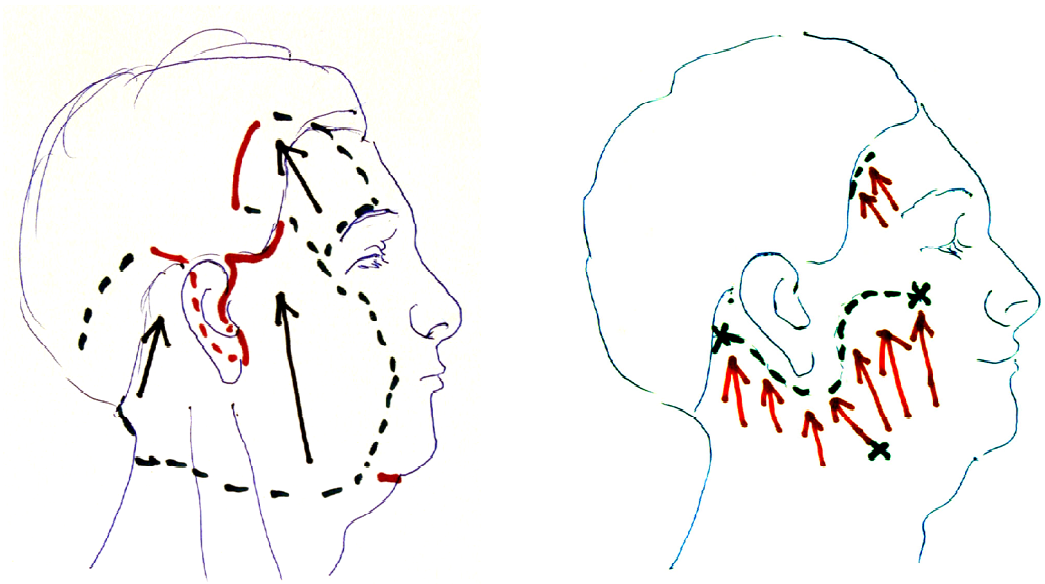
b)

Fig. 1 Sketch of orbita (Bayer)

a) early adulthood
b) aging eye: excess of the skin, herniation of fat from orbita, declined external corner, deepening of lower lid

Fig. 2 Clinical example of upper blepharochalasis before and after blepharoplasty

Major surgery is for example *facelift (rhytidectomy)*:
Procedure improves sagging facial skin, jowls, and loose neck skin by removing excess fat, tightening muscles and redraping skin. Its length is usually 3 - 4 hours.
We use usually local anesthesia with sedation or general. Short stay in a hospital (2 - 3 days) is recommended. Side effects are temporary bruising, swelling, numbness and tenderness of skin, tight feeling, dry skin, and permanent are scars, possibly movement of hair line.
Risks are bleeding, excessive scarring, injury of the nerves that control facial muscles or/and feeling (n. facialis, n. trigeminus), infection.
After operation we recommend the upright position, cooling of operated site over dressing, fluids in the dose 60 - 80 cc /kg of weight and day, first day after surgery liquids only, 2nd-5th day mixed food, later regular food, medicaments by individual direction and schedule, antibiotics systematically as a prophylaxis. We remove stitches 5 - 12 days after operation. During recovery the gentle press massage of scars may be done daily since 12th day after operation, return back to normal activities after 2 - 3 weeks. Swelling may last several weeks. Patient must limit exposure to sun for several months to prevent the skin discoloration. We can expect the duration of results for 6 - 8 years (see fig. 3, 4).



a) *b)*

Fig. 3 Sketch (Dušková)

a) skin mobilisation
b) fastening of the aponeurotic systém during the facelifting

a) *b)*

Fig. 4 Clinical example of aging facial and neck profile before (a) and after (b) surgery

Next common and frequent surgeries are:

Forehead lift (brow lift) minimizes forehead creases, drooping eyebrows, hooding over eyes, furrowed forehead by redraping skin and removing excess muscle tissue, it can be endoscopically assisted.

Dermabrasion mechanically scrapes of the top layers of skin using a high speed rotary wheel, softening skin irregularities (fine wrinkles, scars).

Nose surgery (rhinoplasty) reshapes nose by reducing or increasing size, or removing hump, or narrowing the width, and / or straightening the axis.
For details see http://emedicine.medscape.com/article/1292616-overview

Otoplasty reshapes lops of ears by remodeling cartilage framework and / or reducing size.

Facial implants change or enlarge the facial skeleton using the synthetic implants.

Liposuction and lipofilling (body contouring): using tube (canula) and vacuum device we remove unwanted fat deposits in subcutaneous tissue that do not respond to dieting and exercise, especially location - chin and neck, abdomen, buttocks, hips, thighs, knees, back, as the opposite we can aspire the some amount of fat and graft it as the cells clusters into the

depressions of the contour or even enlarge particular sites of patient's concern (breasts, buttocks).

Abdominoplasty (tummy tuck) flattens abdominal wall by removing excess fat and skin and by tightening of muscles.

Breast Enlargement (augmentation mammaplasty) enhances the size and shape of breasts using synthetic implants or autologous fat or synthetic injectable filler.

Breast Lift (Mastopexy) raises and reshapes sagging breasts by removing excess skin and repositioning remaining tissue and nipple.

Breast Reduction (Reduction mammaplasty) raises and reshapes sagging large breasts by removing excess skin and gland tissue and repositioning remaining tissues.

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