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Editorial

Dear readers,
It is a great honour to welcome you to the first issue of the next edition of Acta chirurgiae plasticae. This is the 67th edition of our journal. I am glad that we are able to maintain the tradition of the journal and keep you informed about its further development. Gradually we have managed to implement the journal's website www.achp.cz, we have fixed and improved our new editorial system for article submission – Open Journal System: https://redakce.carecomm.cz/achp/.

Two years ago I wrote in my editorial that we are living in revolutionary times. Artificial intelligence is getting smarter and making fewer mistakes. I asked ChatGPT, what is Acta Chirurgiae Plasticae? I got the following answer:

"Acta Chirurgiae Plasticae is a scientific journal focused on plastic, reconstructive, and aesthetic surgery. It publishes research articles, clinical studies, and case reports on surgical techniques, innovations, and advances in the field. The journal is based in Europe and has contributions from international experts in plastic surgery."

I could hardly describe our journal better.

Two years ago I wrote about innovator Elon Musk's warning to be very cautious about the use of artificial intelligence, and in his opinion these technologies could be the humanity's biggest existential problem in the future. I confess that I don't know what or who is the humanity's biggest problem now after 2 years of experience with GPT and Elon Musk and other current world leaders.

But what I do know is that we have now augmented our editorial team with twelve young collegues who will act as co-editors of individual journal articles to make the review process of submitted articles to our journal as short as possible. Their names can be found on the journal's homepage. I look forward to working with them and believe that we will again move forward in the production of our journal and that the expedited review process will please authors and readers alike.

I firmly believe that this issue of the journal will also bring you new professional knowledge and suggestions for practice. Whether it be the information about the possibility of single stage feminizing genitoplasty procedure in patients of ambiguous genitalia or about the preferences of the Czech women in cosmetic surgery services or a paper about the confirmation of better perfusion after a double vein anastomosis using analysis of flap sugar. New options for reconstruction of the inner lining of the nose are also inspiring, comparing the effectiveness of lymphovenous anastomosis and vascularized lymph node transfer in lymphedema treatment. The issue also includes a bibliometric analysis of the 50 most cited papers in dynamic facial reconstruction, a paper on regenerative medicine tactics and case reports concerning infratemporal fossa tumors or elevation of vitamin B12 levels attributed to biopolymer implants.

Have a pleasant reading and keep us in your favor!

Assoc. Prof. Zdeněk Dvořák, MD, PhD

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Experience with pediatric and adult cases of ambiguous genitalia reconstructed with a single stage feminizing genitoplasty procedure

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Summary

Background: The surgical procedure of feminizing genitoplasty aims at restoration of normal anatomy and function in various cases of disorders of sexual development with ambiguous genitalia. **Material and methods:** Between April 2021 and May 2023, 23 patients underwent a single stage feminizing genitoplasty procedure at the department of plastic and reconstructive surgery. All the patients underwent clitoroplasty with partial glans preservation, omega flap vaginoplasty and labioplasty. Cases with only clitoroplasty were excluded from the study. Of these 23 patients, 17 had congenital adrenal hyperplasia and the rest 6 had varying degrees of androgen insensitivity syndrome. The age of the patients ranged from 4 to 23 years and all were raised as females. The mean operating time was around 120 to 150 minutes and average hospitalization period was 7 to 8 days. At follow-up evaluation, no major complications were observed. In all cases the vaginal introitus was located in the physiological position and was of varying size and elastic. **Conclusion:** This procedure of single stage feminizing genitoplasty enables reconstruction with good cosmetic and functional results not only in children but also in adults presenting with ambiguous genitalia.

Keywords

congenital adrenal hyperplasia – omega flap vaginoplasty – clitoroplasty – androgen insensitivity syndrome – feminizing genitoplasty

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Introduction

Disorders of sexual development (DSD) are congenital conditions characterized by atypical development of chromosomal, gonadal or anatomic sex resulting in ambiguous genitalia. Disorders of sexual development can arise from a varied set of causes. The term DSD encompasses any congenital condition present at birth where the genitalia is atypical in relation to the chromosomes or gonads. The karyotype serves as a prefix to classify DSDs. These conditions are intricate and rare [1,2].

During the neonatal stage, when an infant is born with ambiguous genitalia reflecting a possible diagnosis of DSD, there is a need to provide the family with not only the gender assignment but also a specific diagnosis of the condition [2,3].

The most common reasons for ambiguous genitalia in newborns, comprising more than 50% of all cases, are congenital adrenal hyperplasia (CAH) and mixed gonadal dysgenesis. The global occurrence of CAH and mixed gonadal dysgenesis is 1 : 15,000 and 1 : 10,000, respectively, although it varies significantly among different populations and countries [4]. DSD nomenclature categorizes these etiologies into groups which includes 46XX DSD, 46XY DSD, DSD related to sex chromosomes, XX or XY disorder of gonadal development, XY persistent Müllerian duct syndrome and malformation syndrome. [5] In patients presenting with DSD, there is usually a spectrum of disorders with the most common abnormality being enlargement of the clitoris and varying extent of fusion of the labio-scrotal folds, leading to a clinical presentation of ambiguous genitalia after birth. The urogenital sinus (UGS) may be elongated and is often located abnormally on the perineum or phallus. The vagina and urethra open into the urogenital sinus rather than separately on the perineum with the confluence being either low or high. Additionally, there is an absence of labia

minora. These factors result in formation of ambiguous genitalia. The point where the vagina meets the urogenital sinus is a set distance away from the bladder neck. The majority of urethral lengthening occurs mainly distal to the vaginal opening with increasing masculinization, which is known as urogenital sinus lengthening [6].

Among cases of genital ambiguity with a 46 XX karyotype, the most common diagnosis is CAH. Androgen insensitivity syndrome (AIS) is another significant condition resulting from androgen receptor (AR) dysfunction and a 46 XY karyotype, representing a paradigm of clinical disorder [7,8]. CAH or the adrenogenital syndrome is a group of autosomal recessive disorders encompassing enzyme deficiencies in the adrenal steroidogenesis pathway that lead to impaired cortisol biosynthesis. The most frequent cause is steroid 21-hydroxylase deficiency, accounting for more than 90% of cases. This interruption leads to an overproduction of byproducts of steroid metabolism by the adrenal, as a result of feedback via the pituitary. The severity and type of steroid block determines the different changes in glucocorticoid, mineralocorticoid, and sex steroid production that would need hormone replacement therapy for patients [9,10]. The range of symptoms can include neonatal salt wasting and atypical genitalia, as well as hirsutism and irregular menses in adult patients. The androgenic steroids cause varying degrees of masculinization in a female fetus [10]. The diagnosis in a female infant with the adrenogenital syndrome is confirmed by the presence of elevated ketosteroid levels in the urine or increased serum 17-hydroxyprogesterone. Phallic enlargement, fusion of the urethral folds forming a phallic urethra, and the level of entry of the vagina into the urogenital sinus are observed to varying degrees. Additionally, these children lack labia minora, as described above [8].

The complete form of AIS is a disorder of hormone resistance in which an individual with an XY karyotype and testes producing age-appropriate normal concentrations of androgens, is characterized by a normal female phenotype. Pathogenesis of this condition results from mutations in the X-linked androgen receptor gene, which encodes for the ligand-activated androgen receptor – a transcription factor and member of the nuclear receptor superfamily. Partial AIS refers to a phenotype of varying degrees of masculinization of the external genitalia due to partially responsive androgen receptors. Individuals with mild AIS may exhibit signs such as adolescent gynecomastia or fertility issues later in life, and this condition is known to occur in healthy men and boys. Thus, AIS can be defined as a disorder resulting from complete or partial resistance to the biological actions of androgens in an XY individual with normal testes development and production of age-appropriate androgen levels [11].

The objective of surgical reconstruction in patients presenting with ambiguous genitalia is the separation of the urinary and genital tracts allowing for normal voiding, creation of an adequate vaginal introitus and achievement of a near-normal appearance of the external genitalia. Keeping this in mind, surgical interventions should aim to achieve the following goals: (1) removal of the corpora while retaining the glans and its innervation to construct a clitoris with normal sensation; (2) reconstruction of the labia minora from phallic skin and foreskin to create a visually normal introitus; (3) vaginoplasty to establish an adequate vaginal opening onto the perineum [8].

This study takes into account a procedure of single stage feminizing genitoplasty that has been performed to achieve the abovementioned goals.

Materials and methods

From April 2021 to May 2023, a study was carried out in the Department of Plastic and Reconstructive Surgery of our hospital, in which 23 patients who underwent a single stage feminizing genitoplasty procedure for ambiguous genitalia were taken into account. Of these 23 patients, 17 had CAH and the rest 6 had varying degrees of AIS. In the CAH group, four patients were of the salt wasting type. All the patients were referred to the Department of Plastic Surgery following complete evaluation of gender, and chromosomal and biochemical data by endocrinologists. All the patients were raised as girls. It might be pertinent to mention at this stage that pediatric patients with 46 XY DSD and varying degrees of AIS were first referred to the Department of Pediatric Surgery where removal of abdominal and undescended testes were done and subsequently these patients were referred to the Department of Plastic Surgery. Nine patients were in the age group < 12 years, 9 patients were in the age range 12–18 years and 5 patients were aged > 18 years.

Apart from an ultrasound examination of the genital region and abdomen, no other radiographic assessment of the introitus was done. A proper clinical examination was done in all patients and the procedure planned according to the site of confluence. Of these 23 patients, 21 patients had a low confluence while the rest 2 had a high confluence. These patients underwent reduction clitoroplasty with glans preservation, omega flap vaginoplasty and labioplasty in a single stage. The patients were closely monitored during the postoperative period. Regular dressing and surgical site inspection were done while in hospital. For patients with AIS and a blind ending vagina, instructions were given for progressive vaginal dilatation with the option of vaginal lengthening deferred till adulthood.

The patients were then followed up at regular intervals after discharge and the outcome was analyzed based on general appearance, symmetry of labia, position of clitoris, and position of introitus.

Fig. 1a. Preoperative picture with marking in a case of congenital adrenal hyperplasia with ambiguous genitalia.

Fig. 1b. Intraoperative picture of the same case of congenital adrenal hyperplasia with ambiguous genitalia.

Senior author's technique (SA)

The patient is positioned in a lithotomy position. The procedure is begun with marking (Fig. 1a) and then a Foleys catheter is inserted into UGS. An injection of 2% lidocaine with 1 : 200,000 adrenaline is injected into the marked incision sites. The first step involves degloving of the virilized clitoris. The incision is begun at the dorsum of virilized clitoris for degloving, keeping a small part of the inner preputial skin, which would be later used in creation of the clitoral hood. The clitoral skin is then mobilized from the corporal bodies in the subdartos avascular plane dorsally up to the pubic symphysis while the dorsal neurovascular bundles are identified and carefully preserved. The degloving continues preserving UGS on the ventral aspect. Once UGS is separated from the clitoral shaft skin, attention is then directed to the raising of omega flap. The omega flap is raised in the perineal region keeping a moderate thickness of underlying fat to preserve its vascularity and this is separated from the labia majora and the posterior part of UGS (Fig. 1b). Stay sutures are then placed on either side of UGS and it is then mobilized from the corporal bodies up to the level of the bifurcation of the corporal bodies and the pubourethral ligament is identified. In cases of high confluence, the pubourethral ligament might need to be transected to achieve total urogenital mobilization, whereas in low confluence, the dissection stops at the level of the pubourethral ligament. Thereafter, two parallel incisions are marked on the ventral side of corporal bodies on each side till the level of bifurcation. The erectile tissue on both sides is mobilized and excised at the level of the bifurcation, preserving the underlying tunica and the dorsal neurovascular bundle. A rim of erectile tissue is left attached to the tunica to prevent inadvertent injury to the dorsal neurovascular bundle. The glans is preserved in continuity with neurovascular bundle. An assessment of the glans is then made. In

Fig. 1c. Postoperative picture of the same case of congenital adrenal hyperplasia with ambiguous genitalia.

Fig. 2. Preoperative and postoperative pictures showing another case of congenital adrenal hyperplasia with ambiguous genitalia.

patients with oversized glans, an inverted V-shaped resection of the ventral part of the glans is carried out to achieve a normal clitoral shape. The glans is then fixed to the ligated corporeal stumps using plication sutures. With the glans now fixed in its position, the tunics are then next fixed to the pubic symphysis with sutures placed carefully to prevent an injury to the neurovascular bundles. The fatty tissue in the lateral part is then mobilized and used to cover the tunics to mimic a mons pubis.

The mobilized UGS is now entirely free anteriorly. The sinus is further dissected posteriorly. The sinus is now opened and the incision extended ventrally until the entire sinus is open. The vaginal opening is identified. A retractor is inserted in the vagina and further dissection continues posteriorly along the avascular layer between the two layers of Denonvilliers fascia (white plane) of vagina to mobilize the vagina. Adequate mobilization is done especially in cases of high confluence to achieve total urogenital mobilization.

The dorsal portion of the sinus is then opened in the midline to create a mucosa lined vestibule. The splitting of UGS continues till the base of the clitoris is reached, at which point UGS is secured to the clitoral base. At this point, the previously inserted Foley's catheter in UGS is inserted into the bladder. The medial edges of the sinus are sutured to the clitoral hood. The posterior omega flap is now sutured to the posterior wall of vagina, excising any redundant portion. Thereafter, the clitoral skin is used to create the labia minora. The skin is split in the midline. The previously created clitoral hood is now sewn to the clitoral skin which is additionally plicated and the medial edges of the split clitoral skin are then sewn along the lateral margins of the open urogenital sinus to create the labia minora. The distal ends of the split clitoral skin flaps are sutured to the lateral walls of the open vagina.

The V-shaped incisions are now placed at the inferior border of the labia majora and these are mobilized in a V-Y fashion to reach the inferior aspect of the vagina. The dog ears created in the medial margins are excised. The lateral aspect of the labia minora is then sutured to the medial aspect of the labia majora on each side. Mild compressive dressing is applied but we do not use any drains (Fig. 1c).

In adult patients having testes in the inguinal canal or below, a consent for orchiectomy was previously taken and these were additionally removed during the procedure.

Polyglactin 4-0 suture is used throughout the procedure (Fig. 2–5).

Results

This study included 23 consecutive cases of ambiguous genitalia who underwent this procedure of single stage feminizing genitoplasty. Of these 23 patients, 17 had been diagnosed of CAH and the remaining 6 had different degrees of AIS. Their age at surgery ranged from 4 to 23 years (mean age 14) and all of them were raised as girls. There were no significant intraoperative complications. The mean operating time was around 120 to 150 minutes and the average hospitalization period was 7–8 days. All of them received antibiotics for 7 days postoperatively. Genital edema was a common side effect observed during the postoperative period, which resolved spontaneously within 7–10 days. Minor wound disruption over the V-Y advancement flap occurred in a single case that healed adequately with secondary intention.

All the patients were followed up monthly till one year. All the cases had intact glans and normal micturition. At

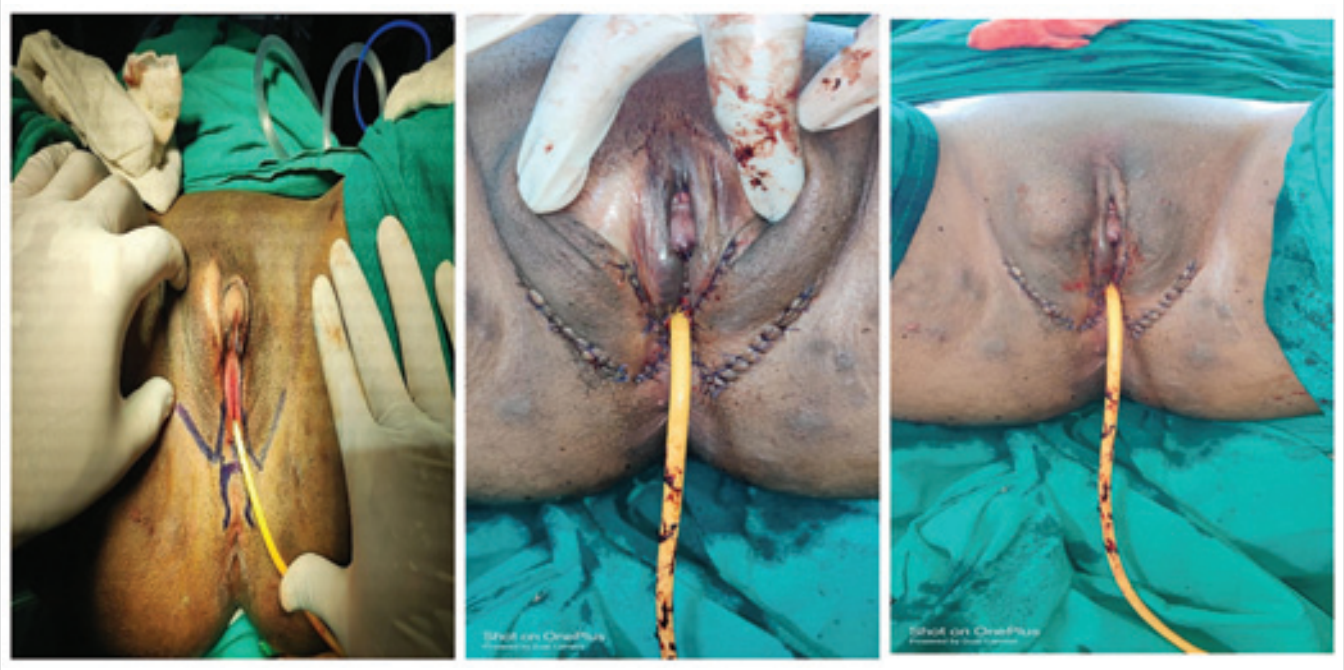

Fig. 3. Preoperative and postoperative pictures of a case of androgen insensitivity syndrome with ambiguous genitalia.

follow-up evaluation, no major complications were observed. In all the cases, the vaginal introitus was in the physiological position and was of varying size and elastic. The symmetry of bilateral labia was maintained. The parents as well as the patients were extremely satisfied with the outcomes.

Fig. 4. The patient shown in Fig. 3 at a one-month follow-up.

Discussion

In the newborn, gender is ascribed by features of the external genitalia and whenever this is abnormal, the neonate is classified as having ambiguous genitalia. Although Anne-Fausto Sterling [12] suggested that the prevalence of intersex might be as high as 1.7%, the true prevalence might actually be around 0.018% when a more precise definition is applied [13].

The optimal gender policy is based on the fact that establishment of socially acquired gender identity generally develops by the age of 2 years and therefore early gender assignment surgery is recommended to promote optimal psychosocial and psychosexual functioning, though this has been challenged by some [14]. However, this is not always achievable in a developing nation like India because of the lack of universal newborn screening programs as well as the lack of awareness in parents [15,16].

CAH is a major cause of ambiguous genitalia. Nowadays, there are several surgical techniques available for reconstruction of ambiguous genitalia. The goal of surgical reconstruction (feminizing genitoplasty) is to separate the urinary and genital tracts to enable normal micturition, create a suitable vaginal opening, remove erectile tissue from the phallus while maintaining the neurovascular supply to the glans, prevent urinary tract complications, and most importantly, achieve a near to normal appearance of the external genitalia.

In the past, different surgical procedures have been performed to fix these anomalies and create a more typical fe-

Fig. 5. Preoperative and postoperative pictures of another case of congenital adrenal hyperplasia with ambiguous genitalia.

male appearance. The initial approach to addressing phallic enlargement involved clitoral amputation [17]. This method was later reconsidered due to concerns that it was overly ablative, leading to the introduction of clitoral recession. Vaginal reconstruction has evolved toward four basic procedures: (1) cut-back vaginoplasty used in simple labial fusion; (2) flap vaginoplasty; (3) pull-through vaginoplasty, thought to be applicable to the high suprasphincteric confluence; (4) complete vaginal replacement used in those with an absent or rudimentary vagina [17,18].

Glassberg and Laugani proposed the removal of albuginea wedges to allow for folding and shortening of the corpora. The drawbacks of these methods may not be obvious until puberty, when sexual arousal can result in painful swelling of the recessed corporeal bodies. An alternative method has been created to preserve the glans, which is analogous to the clitoris, while excising the corpora. Initially, this was done by resecting the entire corpora without preserving the nerve supply to the glans [8]. In recent years, there has been more focus on preserving the nerve supply of the glans via the dorsal nerve of the phallus, a terminal branch of the pudendal nerve. Removal of the corporeal bodies with preservation of these nerves results in a cosmetic reduction in the size of the phallus while preserving the sensation of glans clitoris [8,17]. Passerini-Glazel also developed a new one-stage procedure of clitorovaginoplasty for severely masculinized female pseudohermaphrodites [19].

Our technique of genitoplasty combines modifications of previously reported feminization procedures. The primary objective of any management strategy is to establish a structure that facilitates the development of the affected patient, whether a child, adolescent or adult, into a psychologically balanced and well-adjusted individual who is content with and identifies with the gender assigned [20].

While standard protocols have emphasized the importance of early diagnosis, determining sex assignment, and performing necessary surgery during infancy, some authors have argued in recent years that such surgeries are damaging or disfiguring. They believe that since these surgeries are primarily for cosmetic purposes, they should only be carried out when the patient can provide fully informed consent [21]. Surgical reconstruction for female individuals with atypical genitalia involves decreasing the size of the clitoris and carrying out a vaginoplasty. While most experts concur that a large clitoris should be reduced in size at an early stage of life, there is a debate regarding the appropriate age for performing vaginoplasty. Simple reduction methods for vaginoplasty are sufficient for minor degrees of masculinization, but in more severe cases, these methods can result in the urethral opening being positioned in an unfavorable location within the vagina (female hypospadias). Hendren and Crawford described a technique of vaginal pull-through to address this problem of urinary incontinence, which may be the result when cutback techniques are used for severe cases of masculinization in which the vagina joins the urogenital sinus at or above the level of the urethral sphincter [18,22].

In the past, a two-stage procedure was typically used for genital reconstruction in CAH. The first stage involved the removal or reduction of the clitoris during the neonatal period, while the vaginoplasty was delayed until the child was older. Since 1989, various alterations to the traditional Hendren and Crawford technique have gained popularity and supplanted the original approach to feminizing genitoplasty. It has been observed by many that performing clitoral reduction and vaginoplasty in two stages often results in the loss of the prepuce, which is valuable tissue for reconstructing the anterior vaginal wall. To determine the appropriate type of vaginoplasty to use, it is crucial to differentiate between children with a high vaginal opening connected to the urogenital sinus and those whose vagina is low enough to be accessed by a perineal flap [8,23].

Vaginal stenosis due to fibrosis following vaginoplasty has been men-

tioned by Passerini-Glazel [23]. Such complications have not been experienced in our patients. Our patients who have reached puberty have normal appearance of external genitalia and clitoris along with adequate vaginal opening and normal micturition. In our study, all the patients underwent reduction clitoroplasty with glans preservation, omega flap vaginoplasty and labioplasty in a single stage. In all the cases, the vaginal introitus was located in the physiological position and was of varying size and elastic. The symmetry of the bilateral labia was maintained. The parents were extremely satisfied with the outcome.

Conclusion

This method of feminizing genitoplasty enables nearly all children presenting with ambiguous genitalia to undergo a one-stage reconstruction early in life, with good cosmetic results. It results in the creation of a spacious vaginal opening and a typical female vulva appearance, and the overall anatomical and functional outcomes have been outstanding. Additionally, this procedure can be carried out on individuals across all age groups, including infants.

Conflicts of interest

The authors describe no conflicts of interest.

Financial support

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Declaration

All the procedures performed in this study involving human participants were in accordance with ethical standards of the institutional and/or national research committee and with the Helsinki declaration and its later amendments or comparable ethical standards.

Roles of authors

Neelanjana Paul – surgical assistant, compilation of manuscript; Souvik Adhikari – main surgeon and guide.

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The middle-aged women's attitudes towards (anti-ageing) cosmetic services in the Czech Republic

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Summary

Cosmetic/aesthetic surgery has increased in popularity, reflecting the increased consumer demand. Modern women feel compelled to meet near-impossible standards of beauty. Most of those who undergo cosmetic/aesthetic surgery are (middle-aged) women. Women are often under pressure to meet near-impossible standards of beauty. This study examined cosmetic/aesthetic surgery attitudes and perceptions among 516 Czech middle-aged women. It assessed the perception and attitudes towards cosmetic/aesthetic procedures of middle-aged Czech women and determined the possible factors influencing their level of acceptance through a quantitative survey. The research findings are based on an online questionnaire survey. Based on our analyses, we revealed that acceptance and attitudes towards cosmetic/aesthetic surgery among women can be influenced by the variables such as marital status, place of living, fear of ageing, the importance of physical appearance, occupational status, and partner's influence. This study provided a first general look at the situation around cosmetic/aesthetic surgery in the context of the Czech Republic. However, to gain a more comprehensive understanding of the acceptance and attitudes towards cosmetic/aesthetic surgery in the Czech Republic, further research should be conducted across the country to assess the attitudes of the wider population (for example, different age groups).

Key words

cosmetic surgery – aesthetic surgery – acceptance – attitudes – Czech Republic – middle-aged women

Honelová M, Doseděl T. The middle-aged women' attitudes towards (anti-ageing) cosmetic services in the Czech Republic. Acta Chir Plast 2025; 67(1): 13–21.

Introduction

In recent years, the spectrum of experts has reacted to social changes (for example, an ageing population) and the cultural ideals of society (for example, beauty and youth ideals). These changes have fostered the development and greater availability of cosmetic/aesthetic surgery and new technologies. Cosmetic (also known as aesthetic) surgery "…is where a person chooses to have an operation, or invasive procedure, to change their physical appearance for aesthetic reason" [1]. All these treatments offer different ways to enhance one's appearance and respond to ageing; further, they are perceived as voluntary and unnecessary since they are carried out without injury or disease to improve the health of the body [2]. We have recently witnessed a significant increase in the number of people using these cosmetic/aesthetic surgery procedures. According to the International Society of Aesthetic Plastic Surgery, there were almost 15 million surgical procedures worldwide in 2022 [3].

These statistical data illustrate the desire of many people to improve their physical attractiveness to feel better in their bodies. While cosmetic/aesthetic surgery procedures are currently popular enhancement possibilities worldwide [4], the acceptance and popularity of cosmetic/aesthetic surgery in the Czech Republic provide an incomplete picture of the local trends. On the one hand, many public and private cosmetic/aesthetic surgery clinics are operated in large Czech cities and advertised online. On the other hand, there is no existing official data available on the prevalence and acceptance of cosmetic/aesthetic surgery in the Czech Republic because no national laws require aesthetic surgery clinics gather and publish statistical records of these procedures.

Notwithstanding the lack of official data, cosmetic/aesthetic surgery procedures are becoming more popular in the Czech Republic. According to available information from aesthetic surgery clinics, the number of patients/clients is increasing yearly. Also, our data from

the survey showed that women in our sample, who already have some experience with cosmetic/aesthetic procedures, spent approximately 8,000 CZK per month.

Possible explanations for the increasing demand for cosmetic/aesthetic procedures and products include higher disposable income, advances in the cosmetic industry, the loss of stigma, and how these options are presented in the media and public spaces [5]. Higher disposable income and a decrease in the prices of cosmetic/aesthetic procedures and products have led to many more people being able to afford them as viable options [6,7]. Various factors, such as socio-cultural norms and personal values, shape women's perceptions of cosmetic/aesthetic procedures. Prior research has found that motivations and attitudes toward cosmetic/aesthetic surgery are influenced by basic socio-demographic variables [8,9]. The research also shows that one of the most important factors is gender. Compared to men, women are more likely to report a need for various cosmetic/aesthetic procedures [10–12]. An underlying driver of this need may be social and cultural pressure.

Generally, physical attractiveness and beauty are associated with positive social and cognitive characteristics. Therefore, beauty and the physical attractiveness of the body are of high importance in modern Western societies, predominantly benefitting women in the labour market [13,14] as well as in the education or marriage market [15]. Beauty and physical attractiveness have become important status characteristics for women that help them positively influence the expectations of others [16,17]. Beauty ideals are also often linked to social class; different social statuses and their social, cultural, and economic environments influence the decision to (not) engage in appearance-enhancing practices [8,18]. In particular, socially advantaged women are generally less satisfied with their appearance, which, in turn, promotes greater consumption of enhancement practices [19,20]. Thus, the use of cosmetic/aesthetic practices is not only related to care for appearance and beauty [21] but is also linked to social status, as confirmed by the research results of Vidovićová and Rabušic [22].

As many studies have reported, marital status and education are two other factors that play a significant role in deciding to undertake cosmetic/aesthetic surgery. Ramshida and Manikandan find differences in the use of cosmetic/aesthetic options between unmarried and married consumers of both sexes [23]. Previous studies also showed that the main reason for undergoing cosmetic/aesthetic procedures is to look more beautiful and to compete in attractiveness with older in the pursuit of marriage [24]. In contrast, in Salehahmadi and Rafie's study, the tendency to undergo cosmetic/aesthetic surgery was prevalent among married women and those with an educational level below a bachelor's degree [25].

Middle age is no longer perceived as a passively populated transition space between youth and old age. On the contrary, it is increasingly becoming a dominant and active phase of life. This phenomenon can be called "stretched middle age" [26]. The concept of stretched middle age suggests that the boundaries between the various generations are blurring, creating an indefinite period of stretched middle age (co)formed by technologies such as cosmetic/aesthetic surgery or social scientific influence. Middle-aged women represent an exciting but still insufficiently researched group. Although these women are not perceived by society as "old", their appearance no longer corresponds to ideals of beauty and femininity due to visible wrinkles [27].

Despite the expansion of this medical specialty, little sociological research attention has been devoted to mapping Czech women's perceptions, attitudes and acceptance of (anti-ageing) cosmetic/aesthetic surgery. The study aims to fill this research gap by utilizing a survey of (non)acceptance and attitudes toward cosmetic/aesthetic surgery among Czech middle-aged women.

The Czech Republic is a great example of a country with a mix of cultural influences, and it is not possible to make a clear distinction between "West" and "Central Europe" culture. Exploring attitudes towards cosmetic/aesthetic surgery among middle-aged women with a mix of Western and Central cultural backgrounds can be a way of broadening previously published findings. Considering the increasing popularity of the Czech Republic as a health and medical tourism destination [28,29], it is pretty surprising that no academic research has yet investigated the acceptance and attitudes towards cosmetic/aesthetic surgery among Czech women.

Data and methods

To answer our research question, namely, "What determines attitudes towards cosmetic/aesthetic procedures among middle-aged women?" we used the data from our quantitative survey. Data collection was carried out on the Czech national online panel of respondents of European National Panels s.r.o. This panel has more than 70,000 potential respondents. The sample was taken using the quota sampling method. The sample of respondents was representative of the baseline sample by age, education, settlement size, and region. After data cleaning, the sample consists of 516 respondents. This sample is representative of the core sample by age, education, settlement size, and region. Data collection took place from July 12, 2023, to July 23, 2023.

Measurement instruments

We used different scale types, namely the Acceptance of Cosmetic Surgery Scale (ACSS) developed by Henderson-King and Henderson-King [30].

This scale was used to evaluate participant's attitudes toward cosmetic/aesthetic surgery. The 15-item scale is composed of three 5-item subscales: (1) The intrapersonal factors; (2) the social factors, and (3) the consider factors. Using a 7-point Likert scale, 1 = definitely disagree to 7 = definitely agree, the participants were asked to indicate their level of agreement with 15 statements. The ACSS was modified for Czech speakers. Therefore, the scale was translated from English to Czech following the back translation procedure.

The second scale used was the Multidimensional Body–Self Relationships Questionnaire – Appearance Scales (MBSRQ-AS), particularly its subscales: Appearance Evaluation subscale (MBSRQ-AE) and Appearance Orientation Subscale (MBSRQ-AO). Appearance Evaluation subscale (MBSRQ-AE) with a 7-point Likert scale, 1 = definitely disagree to 7 = definitely agree; higher mean scores across items indicate more positive appearance evaluation. Appearance Orientation Subscale (MBSRQ-AO), a 7-point Likert scale, 1 = definitely disagree to 7 = definitely agree, higher mean scores across items indicate more positive appearance evaluation [31].

Data were collected and cleaned using an Excel sheet and analysed with STATA software. Descriptive analysis employed frequency and percentages to describe categorical data and means and standard deviations to describe continuous data. To show the relationship between variables, we compared means or used Pearson correlation. To determine the statistical significance of our results, we deployed the P-value of correlation and the P-value from the one-way analysis of variance test (ANOVA).

Tab. 1. Sociodemographic information.

		%	N
Total		100	516
Age	35–39	27	140
	40–44	33	171
	45–50	40	205
Marital status	single	20	102
	married	47	241
	cohabitation	18	93
	divorced, widow	16	80
Number of household members	1	10	52
	2	22	116
	3	26	135
	4	32	163
	≥ 5	10	50
Financial status (monthly income of the household, CZK)	≤ 24,999	15	78
	25,000–34,999	13	66
	35,000–44,999	16	83
	45,000–59,999	21	107
	≥ 60,000	25	130
	I do not know	10	52
Type of settlement	big city	20	105
	middle–sized city	16	84
	small city	24	123
	bigger village	12	62
	small village, solitude	28	142
Size of settlement, inhabitants	≤ 4,999 inhabitants	40	208
	5,000–19,999	18	93
	20,000–49,999	11	59
	50,000–99,999	8	41
	100,000 and more	22	115
Region	Prague	13	66
	Central Bohemia	15	77
	Southwest	11	59
	Northwest	10	52
	Northeast	14	70
	Southeast	16	83
	Central Moravia	11	55

Based on previous research, we formulated the following hypothesis:

(H1): Women's attitudes towards aesthetic procedures are not randomly distributed in the population concerned but are structured according to the interaction of objective factors (socio-demographic and socio-economic characteristics, cultural context) and subjective perceptions (attitudes).

Based on the discussion, Hypothesis 1 is derived.

(H1.1): Women's attitudes towards cosmetic/aesthetic procedures depend-

Tab. 2. A summary index – Acceptance of Cosmetic Surgery Scale.

Variable	Min	Max	Mean	SD	N
attitudes	1	7	4.072	1.355	516

SD – standard deviation

Graph 1. A summary index – the Acceptance of Cosmetic Surgery Scale.

ing on their (dis)satisfaction with their physical appearance and its importance in everyday life.

(H1.2): There are differences in women's attitudes towards cosmetic/aesthetic procedures depending on their socio-economic status (income category).

(H1.3): There are differences in women's attitudes towards cosmetic/aesthetic procedures depending on their marital status.

(H1.4): There are differences in women's attitudes towards cosmetic/aesthetic procedures depending on their employment status.

(H1.5): There are differences in women's attitudes towards cosmetic/aesthetic procedures depending on their place of residence (size and type of residence).

Barret and Robbins report that fear of ageing includes fear of a decline in an individual's attractiveness [32]. Fear of loss of attractiveness as part of the ageing process is higher among younger, less educated women, employed women, financially dependent women, women living without a partner (separation), or women living in low-quality relationships. Fear of ageing is also one of the most influential motivations to undergo cosmetic/aesthetic surgery among middle-aged women.

(H2): There are differences in women's attitudes towards cosmetic/aesthetic procedures depending on their fear of ageing.

Research has focused on partner influence. These studies suggest that women supported by their partners are more likely to undergo cosmetic/aesthetic surgery [33].

(H3): Intimate partner influence is a strong factor for women to undergo cosmetic/aesthetic surgery.

The research received ethics approval from the Committee for Ethical Research of the BLINDED FOR REVIEW (number BLINDED FOR REVIEW).

Results

This study included 516 women. Of these, 71 (14%) have already had experience(s) with cosmetic/aesthetic surgery procedures (approx. two procedures per woman), 172 (33%) have no experience but are planning to have the procedure in the future, and 273 have no experience with the procedure and are not considering it in the future. Tab. 1 provides more details about the socio-demographic information.

For our analysis, we created a summary index for the Acceptance of Cosmetic Surgery Scale and Appearance Evaluation Subscale (Tab. 2, Graph 1).

(Dis)satisfaction with own physical appearance and its importance in everyday life

Tab. 3 displays the correlation between (dis)satisfaction with one's appearance and attitudes towards cosmetic/aesthetic procedures. Based on the analysis the correlation was low to non-existent (Pearson's r = 0.0623) and statistically non-significant (P = 0.1576). Thus, we reject part of the hypothesis; there are no differences in women's attitudes towards cosmetic/aesthetic surgery depending on their dissatisfaction with their appearance.

Socio-economic status (income category)

The differences in attitudes towards cosmetic/aesthetic procedures by income category are summarised in Tab. 4. The trend is not entirely clear. Women around the median salary (20,000–40,000 CZK) are slightly more positive, and then there is a kind of increase above 50,000 CZK. According to the ANOVA statistical significance test (P = 0.0589), the differences are close to no statistical significance.

Marital status

Tab. 5 summarizes the differences in attitudes towards cosmetic/aesthetic procedures by marital status. According to the analysis, widows (mean 4.77) and divorced (mean 4.29) women have the most positive attitudes towards cosmetic/aesthetic procedures. On the other hand, married, cohabited, and single women do not consider cosmetic/aesthetic surgery procedures. According to ANOVA statistical significance test (P = 0.3451), the differences are not statistically significant.

Employment status

According to our analysis, the most positive attitudes towards cosmetic/aesthetic surgery are towards occupational status 'Others', but the number of participants in this group is very small. Consequently, the most positive attitudes towards cosmetic/aesthetic surgery are held by the self-employed (mean 4.18) and employed (mean 4.13) women, while the least positive attitudes are held by retired women (mean 3.68). Tab. 6 summarizes differences in attitudes towards cosmetic/aesthetic procedures by economic status of participants.

There was only a minimal effect, and Pearson's correlation r = 0.0585 was not significant (P = 0.1843).

If I look at the three categories (experience with cosmetic/aesthetic surgery) and compare the average the current importance of appearance in employment, it is highest for women who considering cosmetic/aesthetic surgery (mean 5.05), but not statistically significant (ANOVA P = 0.1850) (Tab. 7).

Place of residence (size and type of settlement)

Tab. 8 summarizes the differences in attitudes towards cosmetic/aesthetic procedures by size and type of residence. Women living in solitude areas have the most positive attitudes towards cosmetic/aesthetic surgery, but the number is very small. Women living in cities and towns have the most positive attitudes towards cosmetic surgery. On the other hand, women living in rural areas have the least positive attitudes towards cosmetic/aesthetic surgery.

Tab. 3. The correlation between satisfaction with one's appearance and attitudes towards cosmetic/aesthetic procedures.

Statement	Correlation
Before going out in public, I always notice how I look.	0.2144
I am careful when buying clothes that will make me look my best.	0.1896
I check my appearance in a mirror whenever I can.	0.2177
Before going out, I usually spend a lot of time getting ready.	0.2295
It is important that I always look good.	0.2317
I use very few grooming products.	–0.0896

Tab. 4. Differences in attitudes towards cosmetic/aesthetic procedures by income.

Income category (CZK)	Mean attitudes towards cosmetic/aesthetic procedures	SD	N
≤ 14,999	3.61	1.71	20
15,000–19,999	3.78	1.32	28
20,000–24,999	4.47	1.22	30
25,000–29,999	4.21	1.45	33
30,000–34,999	3.99	1.23	33
35,000–39,999	4.18	1.39	45
40,000–44,999	3.72	1.33	38
45,000–49,999	3.74	1.39	34
50,000–59,999	4.17	1.27	73
60,000–69,999	4.38	1.35	64
≥ 70,000	4.26	1.24	66
I do not know	3.77	1.43	52

SD – standard deviation

Tab. 5. Differences in attitudes towards cosmetic/aesthetic procedures by marital status.

Marital status	Mean attitudes towards cosmetic/aesthetic procedures	SD	N
single	3.99	1.41	102
married	4.01	1.33	241
cohabitation	4.11	1.38	93
divorced	4.29	1.31	74
widow	4.77	1.62	6

SD – standard deviation

According to the ANOVA statistical significance test (P = 0.8282), the differences are statistically insignificant.

Fear of ageing

Tab. 9 summarizes the differences in attitudes towards cosmetic/aesthetic procedures according to attitudes towards ageing. The most positive attitudes are held by people who want to treat old age as a disease, but these are very few in the sample. The most positive attitudes towards cosmetic/aesthetic surgery are therefore those who see old age as part of life, but the difference is only minimal. Most categories have really few cases (Tab. 10).

According to the ANOVA statistical significance test (P = 0.5268), the differences are not statistically significant. Thus, we reject hypothesis H5; there are no differences in women's attitudes towards cosmetic/aesthetic surgery depending on their attitudes towards ageing. Tab. 10 summarises attitudes towards ageing concerning experience with cosmetic/aesthetic surgery procedures of participants.

Intimate partner

As Tab. 11 shows, the correlation between how important appearance is to a partner and positive attitudes toward cosmetic/aesthetic procedures is moderate to strong (Pearson's r = 0.2709) and statistically significant (P = 0.0000). When we look at the three categories and compare the average importance of appearance to a partner, it is quite high for those considering cosmetic/aesthetic surgery and statistically significant (ANOVA P = 0.0005).

If we are looking at the response to the question "Who or what do you think influences people's attitudes towards cosmetic/aesthetic procedures?", 68% of women agreed that a long-term partner influences a woman's attitudes towards cosmetic/aesthetic procedures, and 67% agreed that seeing a new relationship influences women's attitudes towards cosmetic/aesthetic procedures (Tab. 12).

Tab. 6. Differences in attitudes towards cosmetic/aesthetic procedures by economic status.

Occupational status	Mean attitudes towards cosmetic/aesthetic procedures	SD	Total (N)
self-employed	4.18	1.43	26
employed	4.13	1.35	357
non-employed	3.56	1.45	34
retirement	3.68	1.49	18
housewife	4.04	1.23	74
others	4.48	1.52	7

SD – standard deviation

Tab. 7. Experience in comparison with the average importance of appearance in employment.

Experience with cosmetic/aesthetic surgery	Mean importance of appearance in employment	SD	Total (N)
yes	4.59	2.11	71
no, but I consider	5.05	2.04	172
no, I do not consider	4.70	2.36	273

SD – standard deviation

Tab. 8. Differences in attitudes towards cosmetic/aesthetic procedures by size and type of residence.

Size and type of settlement	Mean attitudes towards cosmetic/aesthetic procedures	SD	Total (N)
big city	4.14	1.29	105
medium-sized town	4.19	1.29	84
small town	4.02	1.33	123
bigger village	3.92	1.40	62
small village	4.05	1.46	140
solitude	4.50	1.84	2

SD – standard deviation

Discussion

This article examined attitudes and acceptance towards cosmetic/aesthetic services among the Czech middle-aged women population. We aim to map the situation and acceptance of enhancement options across the specific age group of women in the Czech Republic – women who have undergone anti-ageing procedures, those who have not but are considering them in the future, or those who publicly reject and define themselves against these expanded options. This study's results highlight several exciting findings in the Czech con-

Tab. 9. Differences in attitudes towards cosmetic/aesthetic procedures according to attitudes towards ageing.

Attitudes to ageing	Mean attitudes towards cosmetic/ aesthetic procedures	SD	Total (N)
Old age is the greatest enemy of man and mankind.	3.87	2.09	16
Old age is a disease that we should treat.	4.80	1.93	3
Old age is just a part of life, nothing more, nothing less.	4.13	1.30	223
Old age is a natural thing given by nature.	4.03	1.33	253
Old age is the reward of a long life.	4.36	1.29	15
Old age? I don't even think about it; I don't care.	3.38	2.12	6

SD – standard deviation

Tab. 10. Attitudes towards ageing in relation to experience with cosmetic/aesthetic surgery procedures.

Attitudes to ageing	Yes	No, but consider	No, I do not consider	Total (N)
Old age is the greatest enemy of man and mankind	12.5%	31.3%	56.3%	100.0% (16)
Old age is a disease that we should treat	33.3%	0.0%	66.7%	100.0% (3)
Old age is just a part of life, nothing more, nothing less	14.8%	31.8%	53.4%	100.0% (223)
Old age is a natural thing that is given by nature	13.0%	35.2%	51.8%	100.0% (253)
Old age is the reward of a long life	13.3%	40.0%	46.7%	100,0% (15)
Old age? I don't even think about it; I don't care	0.0%	16.7%	83.3%	100.0% (6)

text and extend previous work on attitudes toward cosmetic/aesthetic services in several ways.

Generally, the results showed that middle-aged women's attitudes and perceptions towards cosmetic/aesthetic surgery are influenced by socio-demographic and personal variables. Previous research has found that women have a more positive attitude toward cosmetic/aesthetic services if they credit physical appearance as having a significant impact on their everyday lives [34]. Brown et al. found that women's lower self-reported physical attractiveness predicts a higher likelihood of undergoing cosmetic surgery [11]. This finding is supported by Delinsky, who shows that a more significant positive attitude toward cosmetic procedures is related to the greater importance of appearance relative to self-esteem and self-evaluation [35]. Additionally, women who are unsatisfied with a specific part of the body have a positive attitude toward cosmetic/aesthetic services [36]. In our study, the correlation between (dis) satisfaction with one's appearance and attitudes towards cosmetic/aesthetic procedures is low to zero. Therefore, the statement that there are differences in women's attitudes towards cosmetic/aesthetic interventions depending on their (dis)satisfaction with their

Tab. 11. Experience with cosmetic/aesthetic surgery and average importance of appearance to a partner.

Experience with cosmetic/ aesthetic surgery	Mean	SD	Total (N)
yes	5.76	1.88	51
no, but I consider	5.88	1.64	139
no, I do not consider	5.16	1.90	224

SD – standard deviation

Tab. 12. Motivations influence attitudes towards cosmetic/aesthetic procedures.

Motivation	Yes	No	Total
new relationship	67.0%	33.0%	100.0% (516)
partner/husband	68.0%	32.0%	100.0% (516)

appearance and its importance in their daily lives was rejected. This result is in contrast with previous research, which has shown that individuals with a negative image of their body have a higher tendency to undergo cosmetic/aesthetic surgery as well as some showed that fear and worries about physical appearance are strong predictors of undergoing cosmetic/aesthetic surgery [37].

In terms of attitudes towards cosmetic/aesthetic services, we selected four socio-demographic factors that we believe may influence women's attitudes, namely employment status [38], place of residence, marital status and economic status (income level) [19]. All factors can influence intrapersonal, social and attitudinal components. Our results showed, the attitudes towards cosmetic/aesthetic procedures by income category are slightly more positive among women around the median salary (20,000–40,000 CZK). There was a slight increase above 50,000 CZK. There are statistically (almost) significant differences in women's attitudes towards cosmetic/aesthetic procedures depending on their socio-economic status. In Saudi Arabia, most people who undergo cosmetic/aesthetic surgery have an average income [24]. Previous research showed that women who are socially advantaged consume enhancement practices more because of their general dissatisfaction with their own appearance [19,20]. Similar results were identified in our study.

According to the analysis, widows and divorced women have the most positive attitudes towards cosmetic/aesthetic procedures. On the other hand, married, cohabited, and single women do not consider cosmetic/aesthetic surgery procedures. The results were not statistically significant, so we had the reject the hypothesis. It was not expected that single women did not consider cosmetic/aesthetic surgery. Previous research indicated that physically attractive women have more success in the marriage market [15,24,39]. Based on this previous research, we expected that women who are in the marriage market would have a more positive attitude towards cosmetic/aesthetic surgery procedures as beauty is perceived as a primary factor and to have a successful marriage, they needed to be as beautiful as possible. In that fact, cosmetic/aesthetic surgery can be perceived as a possibility to attract more people.

We also asked to what extent appearance is important in the current job. The importance of appearance in employment is highest among women who are considering cosmetic/aesthetic surgery, but the differences are not statistically significant. This result supported previous research, which claimed that more physically attractive people are more successful in the labour market (keeping the job and/or promotion). This research supported the idea that physical attractiveness matters in the labour market and affects earnings [13,14]. Women use beauty and physical appearance as a "weapon" to succeed in society.

The hypothesis that "There are differences in women's attitudes towards cosmetic/aesthetic procedures depending on their fear of ageing" was non-significant, and we rejected it; there are no differences in women's attitudes towards cosmetic/aesthetic surgery depending on their attitudes towards ageing. This resulted in contradiction to the previous research, who claimed that fear of ageing is a strong factor undergoing cosmetic/aesthetic surgery [29].

"The influence of an intimate partner is a strong factor for women to undergo cosmetic/aesthetic surgery", we compared the average importance of appearance to a partner. The correlation was relatively high for those considering cosmetic/aesthetic surgery and statistically significant. To complete the picture, we asked the respondents what they thought was the most common reason why women undergo cosmetic/aesthetic procedures. If we are looking at the response to the question "Who or what do you think influences people's attitudes towards cosmetic/aesthetic procedures?", 68% of women agreed that a long-term partner influences a woman's attitudes towards cosmetic/aesthetic procedures, and 67% agreed that seeing a new relationship influences women's positive attitudes towards cosmetic/aesthetic procedures.

Conclusion

The findings presented in this study provide an evidence-based framework that can serve as an essential source of information for scientists and specialists who offer such services in the Czech Republic. Further quantitative and qualitative research is crucial to raise awareness of Czech society's positive and negative attitudes toward cosmetic/aesthetic services. These services are becoming a normative cultural practice and influence individuals and society.

Although this study was interested only in the women population, in the future, involving men in this type of research is also very important; such work is scarce, even taboo, in the sociological field (for an exception, see [40]. The gender imbalance is obvious through analysing the websites for aesthetic surgery clinics. The websites' visualizations and presentations are primarily aimed at women, and many clinics partially or entirely ignore men in their marketing intent [41]. Focusing on men in future research could help to dispel the stereotypical and dominant explanation that cosmetic/aesthetic surgery helps women to solve the "problem" of the gradual loss of physical attractiveness and, further, it would call into question the association of masculinity with disembodiment [40,42].

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Roles of the authors

Michaela Honelová – main author and investigator, review of the literature, acquisition, critical revision of the manuscript, crafting of the manuscript; Tomáš Doseděl – analysis and interpretation of data, crafting of the manuscript, statistical analysis, critical revision of the manuscript.

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Analysis of flap sugar as an objective monitoring of intra-operative flap vascularity following a single vein vs. a double vein anastomosis

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Summary

Introduction: Venous thrombosis is a common cause of flap failure. Performing a second vein anastomosis provides a backup channel for draining. However, this may not be useful in circumstances of vessel kinking and compression. When a flap is compromised, there is a decrease in glucose levels and an increase in anabolic metabolites like lactate. In our study, we measured the ratio of flap/peripheral sugar levels (glucose index – GI) as a metabolic indicator and assessed flap perfusion after the second vein anastomosis. **Materials and methods:** This was a single-centre prospective cohort study. Based on the inclusion criteria, eligible patients reconstructed with a free flap (anterolateral thigh flap / radial forearm flap / fibula flap) were included in the study. **Results:** In our series, the mean flap sugar levels after the first and the second vein anastomoses were 116.60 mg/dL and 131.5 mg/dL, respectively. There was an increase in the flap sugar level after the second vein anastomosis. This increase was found statistically significant (P = 0.009), suggestive of better perfusion. In this study, the flap/peripheral glucose level (GI) ratios after the first and the second vein anastomoses were 0.90 and 0.99, respectively. The increase in this ratio after the second vein anastomosis indicated better flap perfusion after a double vein anastomosis. **Conclusion:** The study concluded that there is a better perfusion after a double vein anastomosis.

Key words

single vein vs. double vein anastomosis – flap sugar – peripheral sugar – free flap – flap metabolism

Sindhuja A, Sahu SA, Mishra JK et al. Analysis of flap sugar as an objective monitoring of intra-operative flap vascularity following single vein vs. double vein anastomoses. Acta Chir Plast 2025; 67(1): 22–26.

Introduction

The 1960s marked the arrival of a free flap technique when Julius Jacobson and Ernesto Suarez perfected vascular anastomosis. Since then, several microvascular advancements have been made to improve the success rate [1]. However, flap failure due to venous thrombosis remains a major complication [2]. To decrease failure due to venous thrombosis, a double vein anastomosis is done; however, its role in the free flap still remains debatable [3]. Theoretically, performing anastomosis of two veins provides a "backup" drainage if one gets occluded. However, even having a backup vein does not decrease the risk of a flap loss in situations like infection, external compression, kinking or thrombosis of the distal vasculature because of an iatrogenic injury or a prolonged ischemia.

A literature search revealed that a single vein vs. a double vein anastomosis in a free flap has been compared regarding flap failure or partial flap necrosis. No study has evaluated flap/peripheral sugar (glucose index – GI) ratio as an indicator in comparing the roles of single and double vein anastomoses. Jain et al. found that the blood glucose level in flaps is reduced in ischemic or congestive conditions using microdialysis [4]. Hence, blood glucose levels are a good monitor of flap vascularity, metabolic activity, congestion and drainage.

In this study, the ratio of flap/peripheral sugar levels (GI) is taken as a metabolic indicator in assessing flap perfusion intra-operatively. Also, the adequacy of drainage is evaluated by the blood glucose level of the flap by comparing single vein and double vein anastomoses [5].

Materials and methods

This prospective cohort study was conducted in our institute. Eligible patients between 18 and 65 years who

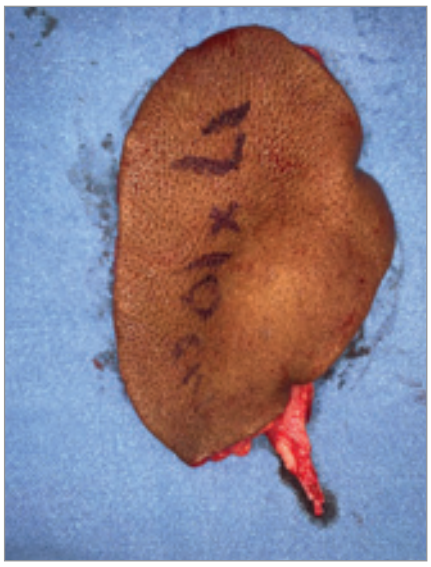

Fig. 1. Anterolateral thigh flap after pedicle division.

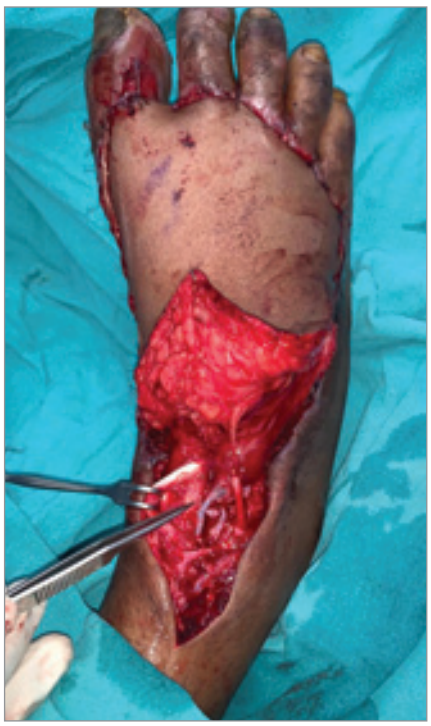

Fig. 2. Anterolateral thigh flap after the second vein anastomosis.

underwent reconstruction with a free flap between October 2022 to January 2024 were included in the study: those with a radial forearm free flap / fibular free flap / anterolateral free flap / medial sural artery free flap (Fig. 1). All patients were given standard preoperative workup.

Fig. 3. Anterolateral thigh flap after inset.

Patients with uncontrolled diabetes, hypertension, any chronic illness, cases where only one vein was available for anastomosis (due to anatomical variation or calibre mismatch) and patients not giving consent were excluded from the study.

Patients in the study were informed and explained about repeated flap sugar measurement by scratching the flap with a needle of the size 24/26 and peripheral blood sugar measurement from the fingertip simultaneously. Blood sugar measurement is done by using the standard glucometer Ozocheck. The depth of scratching was dermis deep.

Intraoperatively, pedicle artery and 1st vein anastomosis were done. Clamps were removed from both the artery and the vein. Thirty minutes were allowed to drain the blood completely for adequate washout of the ischemic metabolites from the flap. Simultaneous flap/peripheral sugar levels were measured, as described above. Again, after the second vein anastomosis (Fig. 2), the clamps were removed, and 30 min later, capillary flap and peripheral sugar levels were measured (Fig. 3) again after the flap inset (Fig. 4).

Recorded values were entered in a form and statistical analysis was done by the Mann Whitney test.

Fig. 4. Anterolateral thigh flap sugar monitored with a glucometer.

Tab. 1. Details of aetiology for free flap and procedure.

Subject No.	Etiology	Frequency (%) (total N =30)
1	head and neck malignancy	17 (56.7)
2	diabetic foot	1 (3.3)
3	post burns defect	3 (10)
4	giant cell tumour (right radius)	1 (3.3)
5	post traumatic soft tissue defect of the lower limb	6 (20)
6	post snake bite contracture over dorsum of left foot	1 (3.3)
7	fasciotomy wound for compartment syndrome (left dorsum of hand)	1 (3.3)

Subject No.	Flap done	Frequency (%) (total N =30)
1	free fibular flap	10 (33.3)
2	free anterolateral flap	11 (36.7)
3	free radial forearm flap	7 (23.3)
4	medial sural artery perforator flap	2 (6.7)

Tab. 2. Values of the glucose level measured.

Subject No.	Variable	Flap sugar (mean) mg/dL	Peripheral sugar (mean) mg/dL	Glucose index (flap/peripheral sugar ratio)
1	before division	119.07	127.23	0.96
2	after first vein anastomosis	116.60	131.73	0.90
3	after second vein anastomosis	131.50	134.07	0.99
4	post-surgery	117.69	129.17	0.91

Results

The mean age of patients enrolled in our study was 42 years, with the majority in the age group 41–50 years (26.7%). Most of them were males (76.7%). Details of the aetiology for which the free flap was done are listed in Tab. 1.

The measured blood glucose levels of the flap and periphery at various stages of surgery are given in Tab. 2. From the measured blood glucose levels, GI (flap/peripheral glucose levels) at various stages of the procedure was also calculated (Tab. 2).

The ratio of flap/peripheral capillary glucose levels was relatively stable across different stages of surgery (Tab. 2). This indicates that while glucose levels fluctuated, the relative glucose levels in the flap compared to peripheral tissues remained consistent throughout the surgical process.

To see the effect of a double vein anastomosis, the mean change of flap sugar levels and GI levels after doing the second vein anastomosis from the first vein anastomosis were also calculated (Tab. 3). There was a mean increase in the flap glucose level by 14.9 mg/dL after the second vein anastomosis which was found significant (P = 0.009). The mean GI also increased by 0.09 but this increase was not found significant (P = 0.05).

In our series, three flaps got congested. GI of this congested flap is tabulated separately for analysis (Tab. 4). However, timely intervention salvaged the flaps.

Discussion

Successful free tissue transfer is based on establishing continuous arterial inflow and venous outflow through the patent microvascular anastomosis, until neovascularization [6]. A common cause of flap failure is venous thrombosis but the reasons are multifactorial [3]. Performing a double vein anastomosis is a debatable concept. The perspective of performing a double vein anastomosis is

Tab. 3. Mean change after doing the second vein anastomosis from the first vein anastomosis.

Mean difference	Mean	SD	P-value
flap capillary glucose	+14.9	29.07	0.009
glucose index	+0.092	0.282	0.084

Tab. 4. Glucose index (flap/peripheral sugar levels) of congested flaps.

	Glucose index after first vein anastomosis	Glucose index after second vein anastomosis
Case 1	1.01	0.75
Case 2	0.83	0.82
Case 3	0.89	0.86

solely based on the fact that it will provide a "backup outflow in the event of a thrombosis of one vein.

The gold standard method to monitor the flap includes a conventional method of assessing the flap margin and inset, colour, turgor, refill, and pinprick showing bright red blood. Microdialysis monitoring is very effective but not cost-effective. Adjuncts to this include handheld Doppler, implantable Doppler, near-infrared spectroscopy, laser Doppler flowmetry, flow coupler, hyperspectral imaging, thermal imaging, and oxygen partial pressure measurement used for early detection of flap failure and hence increased flap salvage [7]. All this monitoring is done in the postoperative period.

Monitoring by measuring the flap sugar and comparing it to peripheral sugar is also used. Measuring flap sugar is a common method to monitor the flap. Many authors have tried to find out the cut-off value of flap sugar post-operatively at a point where the flap fails. A thorough search could not find any study to subjectivise the benefits of performing a double vein anastomosis. So, in this study, we measured and compared the flap and periphery sugar levels intraoperatively and after doing single- and double-vein anastomosis.

The mean increase in the flap sugar level after the second vein anastomosis from the first vein anastomosis is 14.9 mg/dL, which is statistically significant. This increase in the value is statistically significant. Stephan et al. studied the metabolism of a free flap by blood gas analysis of flap blood. In their study, they explained that 52 min of tissue ischemia leads to a decrease in pH ($p = -0.03$) with an increase in lactate, potassium, sodium and chloride levels due to anaerobic glycolysis [8]. When perfusion resumes, aerobic metabolism sets in, with a decrease in lactate level and an increase in glucose level. This proportionate increase in the glucose level is an indicator of flap perfusion. Thus, capillary glucose is a direct indicator of flap metabolism.

Similarly, Kishi et al. also stated that an increase in flap glucose level and a decrease in lactate level suggests that the flap's perfusion is increased [9]. Applying this concept to our series, there is an increase in flap sugar levels after the second vein anastomosis.

Hara et al. [10] have proposed that GI (flap/peripheral sugar levels) is a more reliable indicator than the flap glucose level alone for flap monitoring. The GI decreases progressively in time in failing flaps. Likewise, an increase in GI means that the perfusion of the flap is increasing. In our study, GI of the flap after the first and second vein anastomoses were 0.90 and 0.99, respectively. The GI increased after the second vein anastomosis indicating better perfusion of the flap although this increase in GI was not found statistically significant. Statistical significance could have been established with a higher sample size.

This theory is in contrast to a study by Hansano et al. They emphasised that the second vein anastomosis reduces the blood velocity of the draining veins. The explanation was that the mean blood venous velocity after the second vein anastomosis is significantly lower: 7.5 ± 4.3 cm/s, leading to venous stasis leading to venous thrombosis. Even at this velocity, the authors did not have any venous thrombosis or flap failures in their case series [11]. This can be understood in light of Virchow's hypothesis, which asserts that a low blood flow velocity alone is not the sole factor in thrombosis formation without the presence of hypercoagulability and endothelial damage. Therefore, reduced velocity following the second venous anastomosis may contribute to thrombus formation, but it is not the direct cause of thrombosis.

Malignancy is a hypercoagulability state. However, head and neck malignancy patients have always had better outcomes than those with a lower extremity free flap reconstruction [2]. This is due to the high vascular resistance of the venous system of the lower limb leading to a low velocity and the endothelial damage. The vessel concurred during the trauma increases the possibility of a thrombus [2]. So, a double vein anastomosis can be beneficial in free flaps of extremity cases.

Each vena commitantes drains a different area of the flap, thus performing a double venous anastomosis may also prevent a partial loss of the flap due to insufficient drainage because of the presence of a single vein. This is

supported by the study by Stranix et al. where they compared the outcomes of single vs double vein anastomosis by major and minor complications. A double vein anastomosis had lower partial flap failure with a statistical significance of P = 0.008 [12].

In our study, three flaps were congested on the first postoperative day. Tab. 4 shows GI after the first vein and then after the second vein anastomosis. Reexplanation was done for all. In case 1 with a free anterolateral thigh flap, there was a vessel compression and the flap survived after the release of superficial sutures. In case 2, intraoperatively venous thrombosis was detected and anastomosis was done. In case 3, both veins were thrombosed intraoperatively, and a redo anastomosis was done. In our series, GI increased after the second vein anastomosis. But in these three cases, the value of GI after the second vein anastomosis decreased, indicating compromised perfusion. This is an important finding from our study; however, more studies are needed to prove it. This will be helpful to anticipate flap congestion intraoperatively by monitoring GI.

The advantage of performing a single vein anastomosis is that it reduces the operative time during the primary surgery.

The advantage of performing a double vein anastomosis is that it becomes a backup if venous thrombosis is set in a vein. Studies have proven that partial flap necrosis and failure occur less commonly in a double vein anastomosis. Our study concludes that flap perfusion and metabolism are better with a double vein anastomosis. Considering the advantages it has to offer, it is desirable to perform a double vein anastomosis when feasible. Longer duration of the procedure may be reduced by using a venous coupler.

Conclusion

This study concludes that a double vein anastomosis improves flap metabolism. Further, a decrease in GI after the second vein anastomosis indicates a compromise in flap circulation.

Limitations

The limitation of our study is the lower sample size. Statistical significance could have been established in GI between a single vein and a double vein anastomosis if a higher number of patients were included. The patients included were heterogeneous.

Roles of authors

Dr. Abi Sindhuja – writing manuscript, flap sugar measurement, part of the operating team in all cases; Dr. Shamendra A. Sahu – operating surgeon, statistical analysis, editing of the manuscript; Dr. Jiten K. Mishra – operating surgeon, editing of the manuscript, Dr. Aparajita Saha – data compilation, writing the manuscript, assessment of the results; Dr. Abhijith Valsalan – flap monitoring, data collection; Dr. Jalaz J. Rahmi – flap monitoring, data collection.

Disclosure

The authors have no conflict of interest to disclose. The authors declare that this study has received no financial support. All procedures performed in this study involving human participants were in accordance with ethical standards of institutional and national research committee and with ethical standards of the institutional and national research committee and with Helsinki declaration and its later amendments or comparable ethical standards.

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Possibilities of intranasal reconstruction in complex nasal defects

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Summary

Background: Complex nasal defects most often arise due to oncological resection or severe trauma. Traditional methods of two-stage nose reconstruction using a forehead flap with a skin graft have often resulted in collapse and deformity of the nose with a very compromised outcome over time. These techniques were gradually replaced by new procedures consistently reconstructing the intranasal lining, most often with flaps from the nasal septum. These methods reconstruct the cartilaginous and bony support of the nose as well, while the skin cover of the nose is, nowadays, in large defects, reconstructed in three stages. **Evaluation of the topic:** The options for intranasal lining reconstruction are as follows: a composite graft, a turnover flap covered with a local flap, advancement of the residual lining (bipedicle vestibular mucosa flap), a folded forehead flap, a prelaminated forehead flap, the use of another local flap (a forehead, nasolabial, facial artery myomucosal flap), a hinged turnover flap, a septal mucoperichondrial hinged flap, a composite septal chondromucosal pivot flap, a turbinate flap and microvascular free flaps (a radial forearm flap, a helix free flap, a kite flap, a dorsalis pedis free flap, a temporoparietal free flap, a postauricular free flap). Thanks to the abundant vascular supply of the face, the risk of ischemia and infection is mitigated, allowing most complex nasal defects to be reconstructed by using local flaps to restore all layers of the nose. Local tissues retain ideal quality, coloration, and texture, are reliable, and usually result in esthetically acceptable morbidity of the donor area. If the inner lining defect is extensive, it must be reconstructed by free microvascular tissue transfer. If other than intranasal flaps are used in the reconstruction of the internal lining, it is preferable to postpone the reconstruction of the supporting framework until the second stage while thinning the flaps used; otherwise, there is a high risk of obturation of the nasal airways. **Conclusion:** The results of modern reconstruction dramatically improved after the introduction of three-stage nasal reconstruction and emphasizing the reconstruction of all layers of the nose. Therefore, a quality inner lining is the basis for the construction of the new nose.

Key words

reconstructive surgery – acquired nasal deformities – nasal surgery – intranasal lining

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Introduction

The original concepts of nasal reconstruction predominantly focused on the reconstruction of the external skin cover of the nose. The temporary postoperative stiffness and tissue swelling often ensured esthetically acceptable results early after surgery; these results, however, were unstable over time and irreversible deformations of the reconstruction occurred after further healing and scarring. Hence, new principles of quality and stable nasal reconstruction were accepted that can be summarized in the following points:

1) Reconstruction of all layers of the nose – nasal lining, supporting layer, and outer skin cover – needs to be performed [1–3].
2) due to the ideal color and texture quality, the forehead flap is the best donor flap to replace the skin cover of the nose [4]. The harvest site on the forehead is left for secondary healing [5,6].
3) Nasal reconstruction with a forehead flap is performed in three stages. First, the full-thickness forehead flap is moved into the position in the nose; 3–4 weeks later (surgical delay), the forehead flap is reelevated, thinned, and returned, and the pedicle is removed next 3–4 weeks later [7].
4) If more than 50% of the nasal subunit is missing, the entire regional esthetic subunit of the nose needs to be reconstructed.
5) Reconstruction of the supporting component (nasal skeleton) must be an integral part of the planned reconstruction in the first step before being covered with the soft tissue [3]. Both the central and lateral parts of the nasal skeleton need to be reconstructed [8].

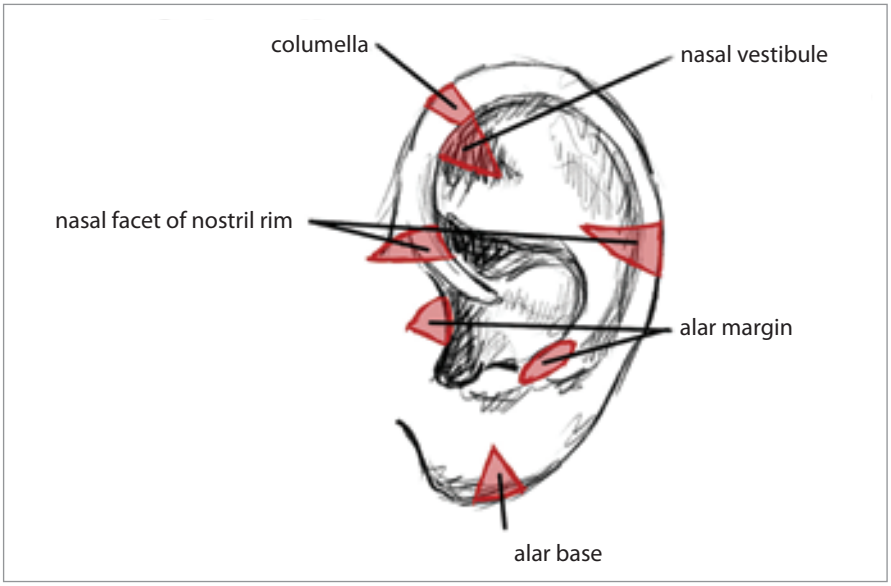

Fig. 1. Locations of harvesting composite chondrocutaneous grafts for individual parts of the nose. (Drawing by A. Berkeš according to [70]).

6) According to Thornton, an adequate well-vascularized intranasal lining is the most important element of nasal reconstruction as it provides overlay and nutrition to the supporting component [9]. Simply stated, a well-vascularized lining serves as a basis for the construction of a new nose.

Therefore, the well-vascularized inner mucosal lining of the nose is reconstructed first. Subsequently, the supporting layer of the nose is transferred and fixed on top of it. This layer consists of cartilage (transferred from the cavum conchae of the auricle, from the rib or nasal septum), and bone freely transferred from the skull (external cortices of the parietal region) or from the rib. For good healing of the supporting layer, its overlay with a well-vascularized outer layer of the skin and subcutaneous tissue is necessary [1]. Thus, the overall shape of the nose can be likened to a triangular pyramid made of cartilage and bone, which forms the center of the sandwich between the two layers of the soft tissues – the inner mucosal lining and external skin cover [10].

When transferring individual tissues for the purpose of nasal reconstruction, care must always be taken to ensure that they are adequately vascularized as only well-vascularized tissues are able to heal and fuse into new units. The necessary nourishment of the tissue can be ascertained either by a soft tissue bridge with a sufficient amount of capillaries (functional subdermal plexus) or by preserved vessels [11–13].

Assessment of the problem

The literature search of the MU Medical School Campus Library Discovery System using keywords „INTRANASAL LINING“ and „NASAL RECONSTRUCTION“ yielded 682 publications over the past 5 years. Subsequently, cross-referencing of the papers selected for thorough reading identified monographs on nasal reconstruction. From the resulting body of literature, we removed studies with apparent bias, studies that only described an overview of performed surgeries on an individual department, and those that did not specifically focus on the reconstruction of the intranasal lining. Finally, 70 papers were used as information sources for this review.

The reconstruction of well-vascularized inner lining seems to be the single most important point in modern nasal reconstruction as it serves as a basis for the entire supporting structure of the nose (which is then overlaid with a skin cover. Its importance is often underestimated, and its absence invariably results in the contraction and destruction of the reconstruction [14]. Below, we provide a list of reconstructive options:

1) composite skin graft;
2) advancement of residual lining;
3) prelamination of the forehead flap;
4) second flap (forehead, nasolabial, facial artery myomucosal flap, etc.);
5) hinged turnover flap;
6) folded forehead flap;
7) intranasal lining flap;
8) free flap.

Composite graft

Composite graft contains skin and cartilage, taken from various locations of the the auricle depending on the requirements of the target site (Fig. 1). This method is suitable for small defects of the soft triangle, nostril margins, or nostril base. The recipient wound bed must be well vascularized; if the transfer was preceded by extensive coagulation, it is better to postpone the procedure by 7–14 days. The full-thickness composite graft is fixed using simple skin stitches. Typically, the maximum width of the composite graft is 1.5 cm. The graft is initially white, grows blue within 24–72 hours and, after that, it starts to turn pink, reflecting an improvement in vascularisation [15].

Advancement of the residual nasal lining

In minor defects of the nostril margin, a bridge shift of the lining caudally can be performed along the margins of the nostrils. The position of the lining is secured by extraanatomically placed conchal cartilage grafts, covered externally with a local flap (Fig. 2).

Prelaminated forehead flap

In this technique, the reconstruction of the nose starts on the forehead. In the literature, this procedure is sometimes

incorrectly called prefabrication; the principle of prefabrication, however, lies in the manipulation of the vascular supply to create a new flap [16–18]. In principle, prelamination lies in the incorporation of new tissues or elements into the classic flap, thus changing its properties. If this is performed at the same time the flap is transferred, this procedure is called lamination [19].

During the preparatory surgery, a full--thickness skin graft is placed under the frontal muscle 1–1.5 cm from the „nostril" edge of the nostril and a bolus is inserted. Conchal cartilage grafts are inserted from the lateral approach as a reinforcement between the frontal muscle and the skin. After 6 weeks of healing, the entire construct is transferred into the nasal position (Fig. 3).

In the recipient site, the cranial lining is created by flipping the flap from the cheeks or nose dorsum; caudally, it is connected to the remnants of the nose wings and columella [2].

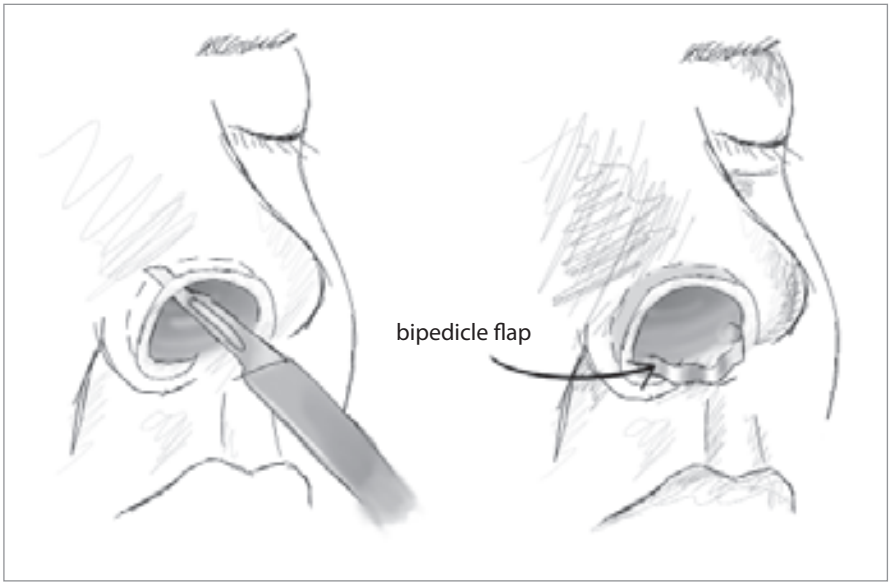

Fig. 2. Bridge vestibular flap. (Drawing by A. Berkeš according to [2]).

The limitations in positioning, shape, and size of the cartilage often result in an imperfect and unstable nasal skel-

Fig. 3. Prelaminated frontal flap and its transfer to the nose reconstruction. (Source: photo archive of the author).

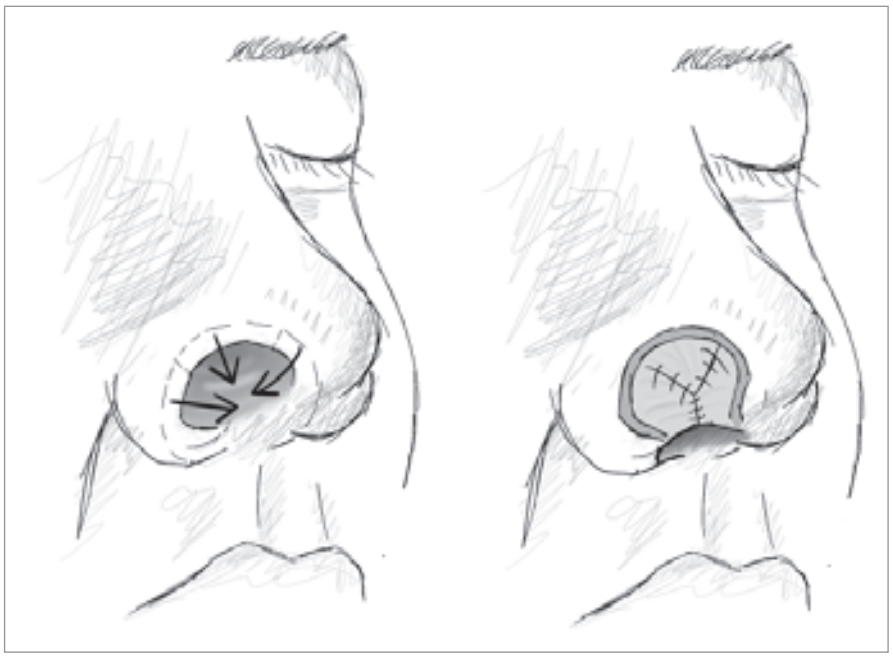

Fig. 4. Overlapping lining flap. (Drawing by A. Berkeš according to [2]).

eton. The indications for this method include:

- minor nose tip defects;
- elderly and frail patients (all steps of the surgery can be performed under local anesthesia);
- salvage surgeries (if other options are not available).

Turnover flap

After full healing, approx. 6–8 weeks after the surgery, continuity of the outer and inner lining is established. This allows turning the flap over along the defect margins. Flap nourishment is then provided through the capillaries in the scar (Fig. 4).

The maximum recommended width of these flaps is 1–1.5 cm. Care should be taken because the blood supply to the flaps unfortunately often fails and even a small loss of the blood supply can cause a major infection. Therefore, if the blood supply is problematic, the viability of the flaps can be improved by using a delay. The flap is elevated, turned over, and returned to its original position. The final turnover is performed approx. 1–2 weeks later [2].

Turnover flaps often suffer from greater scarification, contractibility, limited nutrition and mobility. Moreover, the aforementioned technique further prolongs the duration of the reconstruction. In general, the turnover flap is usually stiff, thick, and unyielding. The typical indications for this technique include:

- small defects;
- margins of the wings;
- salvage procedures – in cases of rhinoplasty failure, cocaine nose, reconstruction failure;
- pediatric nose reconstruction (reduction of the impairment of a growing nose; a composite flap should be considered as an alternative) [20].

Disadvantages of the turnover flap include:

- impossibility of use in fresh injuries – it is necessary to wait for 6–8 weeks;
- the result is thick, stiff, and non-pliable;
- if the flap covers a greater part of the nostril, a secondary contraction occurs [21].

In 2004, Lee et al. proposed a hinged turnover flap [22] facilitating a single-

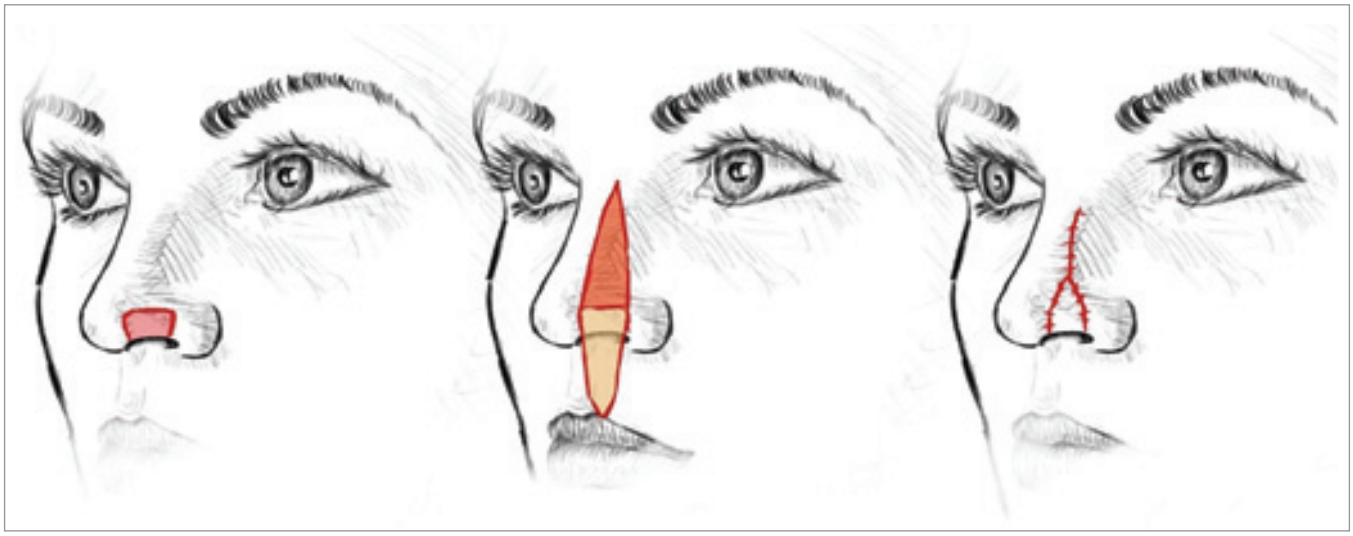

Fig. 5. Hinged turnover flap. (Drawing by A. Berkeš).

procedure resolution of minor defects of the wing. The principle of this modification is depicted in Fig. 5. In both situations, it is advisable to reconstruct the nasal wing skeleton with the conchal cartilage to prevent the retraction of the wing.

Use of a second flap for the inner lining

In this type of inner lining reconstruction, the defect is addressed by turning over an additional local flap with its own vascular supply. The nasolabial flap, the secondary paramedian forehead flap, and the facial artery myomucosal (FAMM) flap are the most commonly used flaps for this procedure.

Nasolabial flap

Millard used and popularized the randomly pedicled facial flap. When reconstructing the nasal lining of half of the nose, he usually flipped a flap of skin from the upper nose and used the nasolabial flaps from the cheek for the wings [23]. Nasolabial flaps were also used for the reconstruction of the nostrils and columella. However, the negatives of the nasolabial flap include:

- thickness and stiffness of the flap, it cannot be primarily thinned due to a high risk of compromising the vascular supply;
- it is impossible to apply primary cartilage grafts as this would lead to significant airway obturation with highly limited options of thinning the flap in the future;
- the need for later thinning of the flap to improve the nostril patency and modify its external contour.

Nowadays, this flap is rarely used as it has been largely replaced by the inner lining flaps.

Use of a second paramedian forehead flap

If this technique is considered, it is necessary to take into account the increased morbidity of the forehead and exhaustion of the material for the forehead flap for a potential additional reconstruction.

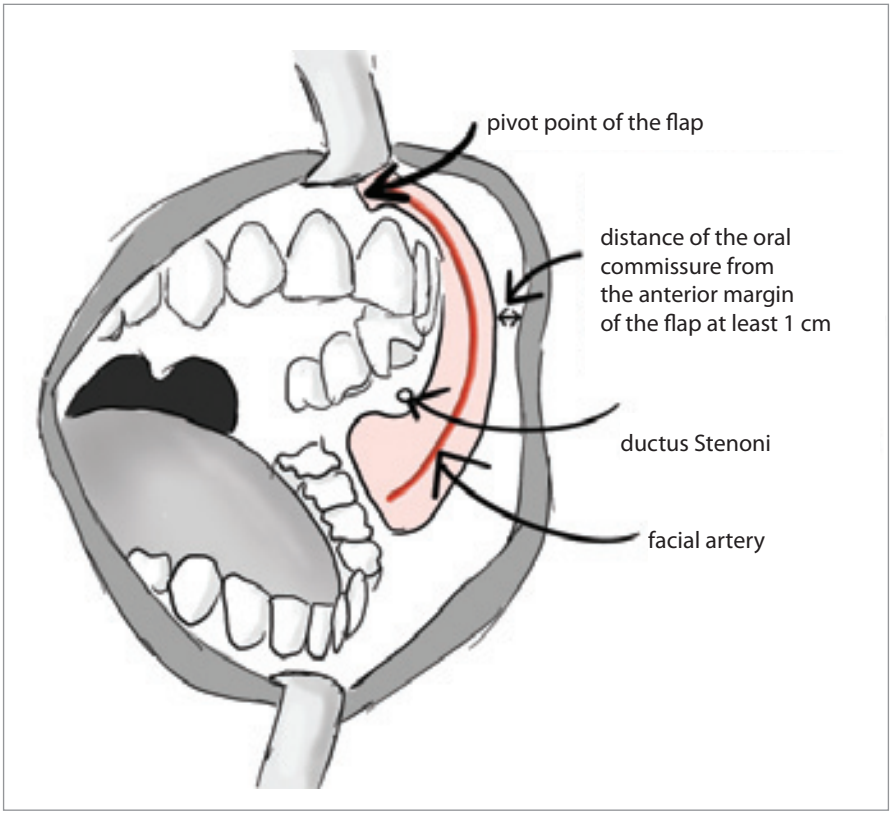

Fig. 6. Diagram of the oral cavity with drawing of the facial artery musculomucosal flap. (Drawing by A. Berkeš).

FAMM flap

The FAMM flap was first described by Pribaz et al. in 1992 [24]. Over the next years, several modifications have been developed and indications refined to make this intraoral musculomucosal flap even more universal.

The FAMM flap should not be mistaken for the buccal musculomucosal flap described by Bozola et al. (an intraoral flap pedicled on the buccal artery, a branch of the internal maxillary artery), which is pedicled more posteriorly, has greater width, and its rotation is more limited compared with the FAMM flap [25].

The FAMM flap consists of intraoral mucosa, submucosa, a part of the buccinator, the deep portion of the orbicularis oris muscle, the facial artery, and the venous plexus. In nasal reconstruction, this flap can be cranially pedicled and used with dimensions of 8–9 cm × 1.5–2 cm. The pivot point is located at the base of the adjacent nasal wing.

Positives of the FAMM flap include good vascularity, the absence of a facial scar after harvesting, and the possibility of bilateral elevation [2]. During preparation, care must be taken to preserve the terminal buccal branches of the facial nerve, the distance of the leading edge of the flap from the commissural line should be kept at 1 cm, and the parotid gland duct should not be included in the flap [26–28]. A sketch of this technique is shown in Fig. 6.

Lining flaps

The relevant ventral part of the nasal mucosa is perfused by:

- branches of the facial and angular arteries;
- the septal branch of the superior labial artery – running under the edge of the

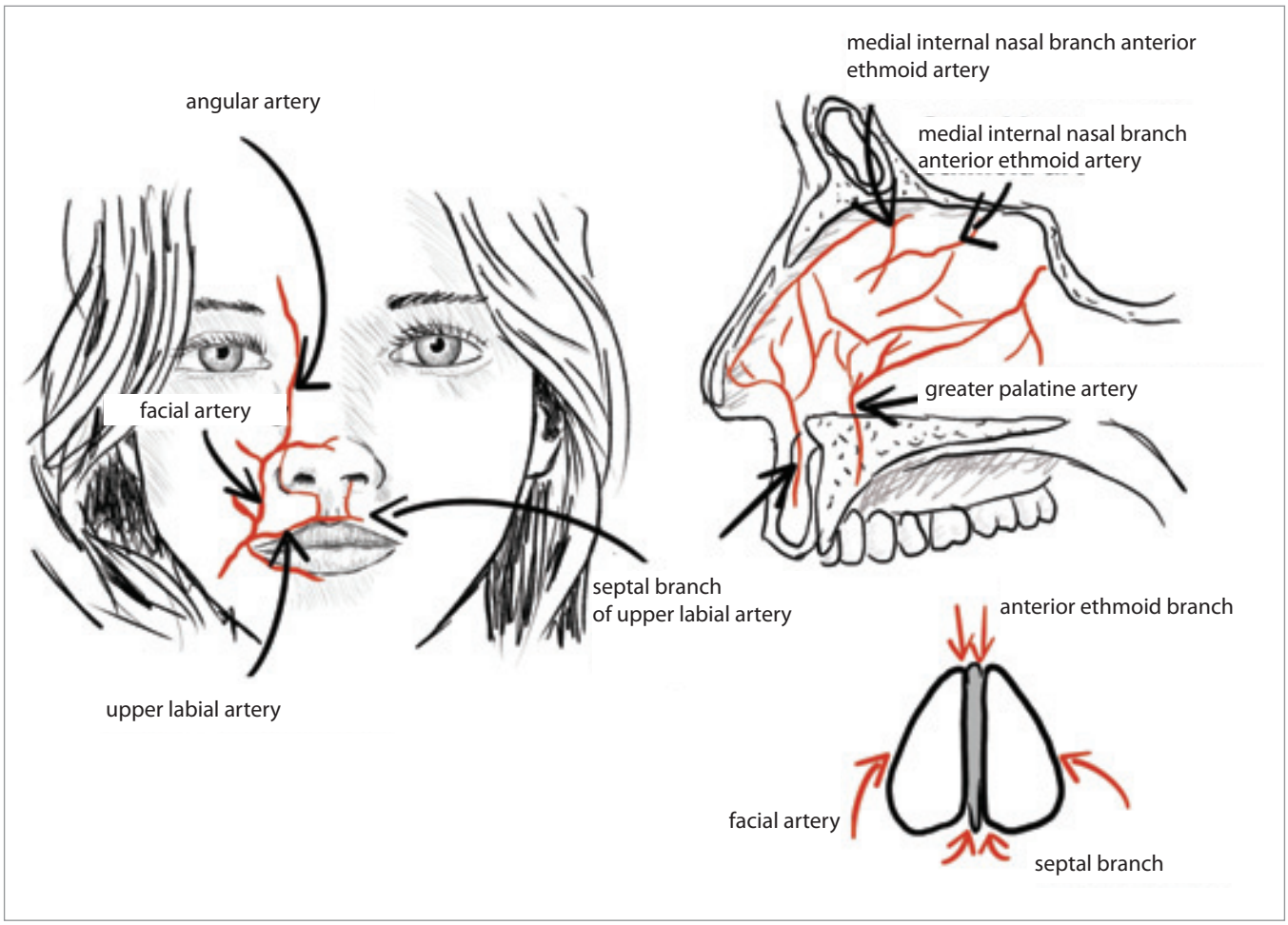

Fig. 7. Vascular supply to the septal mucosa. (Drawing by A. Berkeš according to [2]).

philtrum, lateral to the anterior nasal spine behind the base of the columella (approx. 1.0–1.2 cm behind the anterior nasal spine); this branch can supply the entire ipsilateral septum (Fig. 7);
- medial and lateral branches of the anterior ethmoidal artery [29].

Septal lining flaps were first described and used in various modifications by Burget and Menick [21,30–32]. They can be, however, unavailable after a previous surgery or trauma of the upper lip.

Bipedicle vestibular skin flap

It is indicated for marginal wing defects where the remaining vestibular lining of the nose can be moved caudally. The donor area may be covered with an ipsilateral septal flap, a skin graft, or a contralateral septal flap [31,32]. In all cases, however, the cartilaginous L-shaped septal rim must be preserved to maintain central support of the nasal skeleton (Fig. 2).

Ipsilateral septal mucoperichondrial flap

The ipsilateral septal flap is standardly used to reconstruct the nasal wing margin. It is pedicled on the septal branch of the facial artery, on which the flap is elevated from the entire equilateral surface of the septum and bent ventrocaudally (similarly as a quilt thrown over a window frame) to form the lining of the lower 1/3 of the caudal nose [31].

Contralateral septal mucoperichondrial flap

The contralateral septal flap is vascularly supplied from the cranial branch of the posterior septal artery and from both ethmoidal arteries. It is pedicled along the dorsum of the nose and turned over to the contralateral side through a cartilaginous window in the center of the septal cartilage (a "frame" arising after harvesting the central septal cartilaginous graft) [33,34]. This flap will form the central part of the inner lining of the lateral wall of the nose (it cannot reach the alar base or wing margin) (Fig. 8).

Composite septal pivot flap

A composite septal pivot flap (Fig. 9) is nourished by the septal branches of the superior labial artery. Thanks to this, the entire nasal septum can be rotated, allowing the reconstruction of the entire middle nasal support. Mucosal flaps, however, are not long enough to reach the base of the wings, necessitating

a combination of this technique with residues of the wings, nasolabial flaps, or turbinate flaps.

General properties of lining flaps

In general, lining flaps are thin, pliable, and well-vascularized. They enable the application of primary grafts, which brought significant progress in nose reconstruction. These flaps do not obstruct the airway; on the downside, their size is limited and their success in smokers is uncertain. They must always be reinforced by cartilage grafts. Lining flaps can be optimally used for isolated defects of the middle vault or unilateral complex defects (Tab. 1).

Unilateral nasal loss is resolvable with a contralateral septal flap. A transverse incision is made on the ipsilateral septal mucosa, the septum is exposed, and the central portion of the septal cartilage is removed while preserving an at least 7–8 mm wide cartilaginous rim. Subsequently, a dorsally pedicled contralateral septal flap is elevated and used to reconstruct the lining defect. After that, the harvested septal cartilage is implanted and the ipsilateral septal mucosa is sutured (or allowed to heal spontaneously). A forehead flap or another local flap is then used to reconstruct the skin cover [2].

If the alar defect is less than 1 cm in width, a bipedicled (bridge) vestibular flap may be used. It should be at least 8 mm wide. The bipedicled vestibular flap is then moved to the alar margin and the secondary defect of up to 3 × 3 cm in size is then covered with a dorsally pedicled ipsilateral septal flap or with a skin graft (Fig. 2).

In the case of a complete unilateral nasal defect, the ipsilateral septal flap can be used in the position of the lining at the alar margin (pedicled in the vicinity of the anterior nasal spina) and a dorsally pedicled contralateral septal flap can then be used to fill the defect above the previous flap. The ipsilateral flap may, however, partially obstruct the airway and needs to be subsequently transected [21].

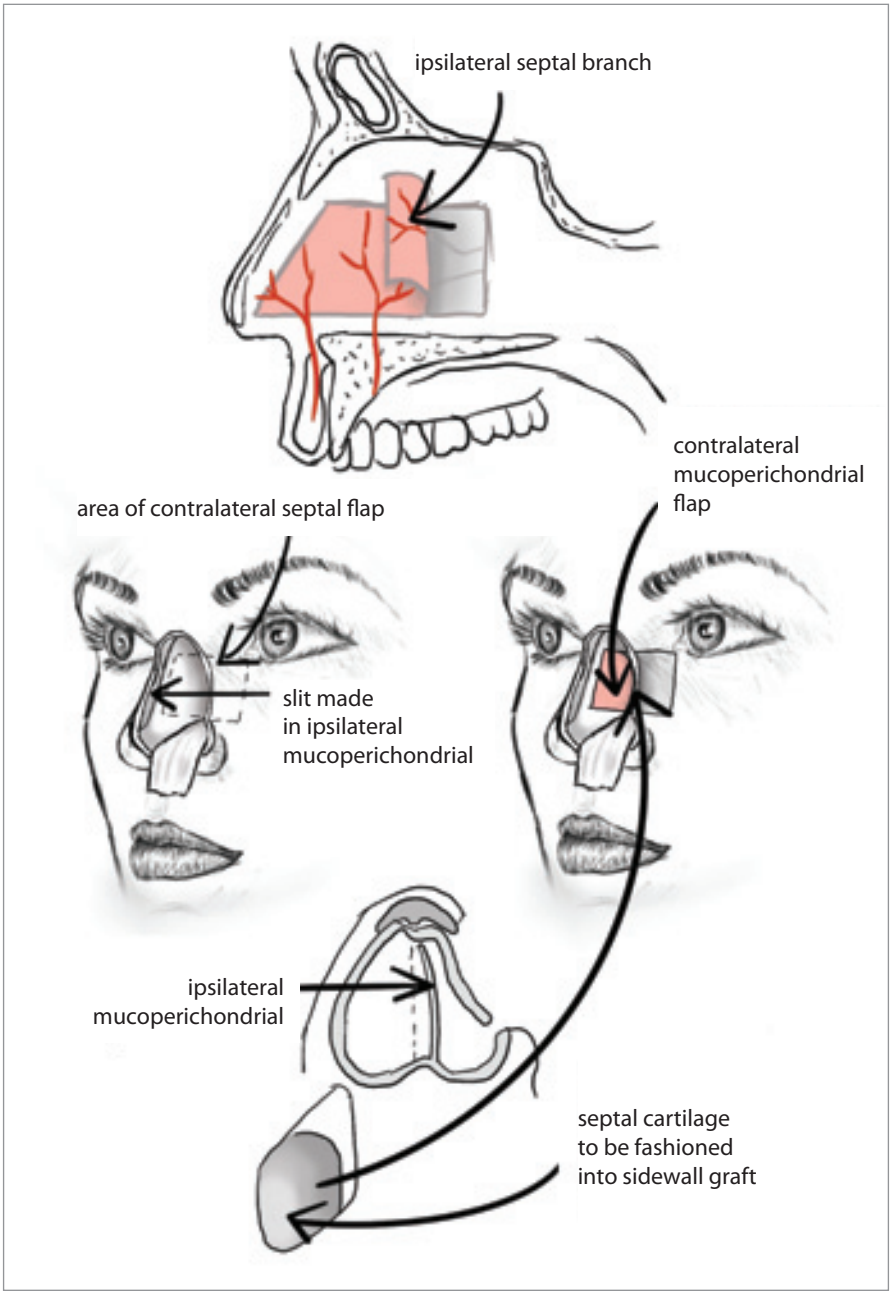

Fig. 8. Ipsilateral and contralateral septal flap in mid-nasal reconstruction. (Drawing by A. Berkeš according to [2]).

In the central nasal region, mucosal mobilization with a direct suture is often possible. It can be aided by the lowering of the dorsum of the nose, which is then re-established using a cartilaginous graft. Defects in the lower part of the nose can be classified into subtotal (soft nose missing) and total (loss of the entire nose including the septum and nasal bones). The septal pivotal composite flap is the ideal solution in all these cases; however, this solution may be unavailable in some cases. Where nasal bones are preserved, a cantilever graft can be applied. If the central part of the lining as well as the supporting structures were missing, Millard used preliminary surgery applying the following techniques:

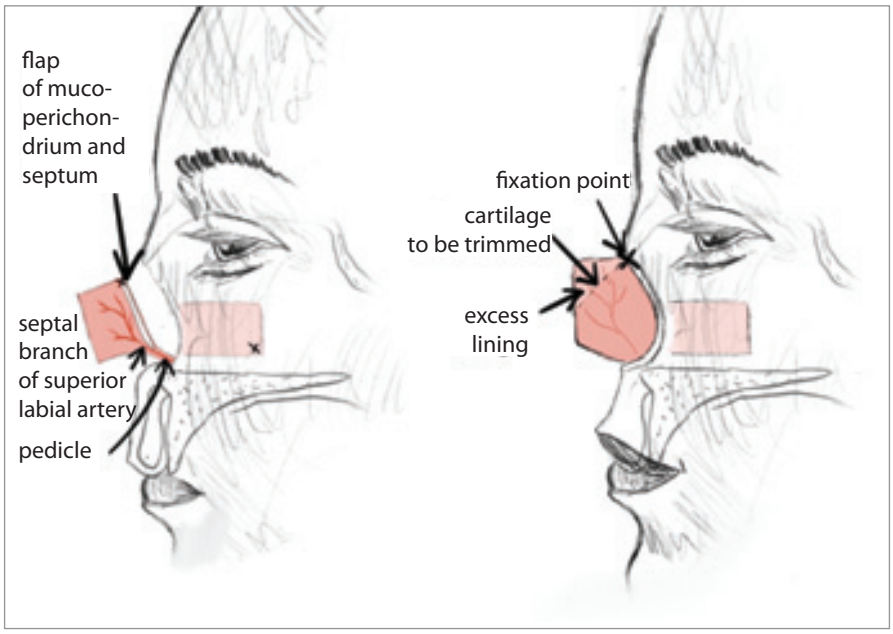

Fig. 9. Composite septal flap. (Drawing by A. Berkeš according to [2]).

1) turnover flap combined with bone grafts and forehead flap;
2) cranially pedicled composite L-graft from the septum;
3) local flaps (nasolabial, cheek) and a forehead flap with a cantilever graft [33].

Nowadays, however, all three of these techniques are considered unreliable. At present, the composite septal pivot flap is typically used (Fig. 9) with a graft from a rib anchored into the nasal bones (forming the base of the nose) or a costochondral L-graft [35]. When rotating the pivot flap, it is necessary to preserve approx. 2 cm of the tissue at the point of entry of the labial artery branches. After rotation, the septal cartilage is fixed to the upper lateral cartilages, and the entire reconstruction is then covered with the forehead flap. If the entire nose is missing, it is preferable to delay the surgery by 6–8 weeks (so that turnover flaps can be used if necessary) [36].

Turbinate flap

Flaps from the lateral wall of the nose can also be elevated to a limited degree. The turbinate flap comes from the mucosa of the inferior nasal concha. It can be pedicled ventrally on the anterior lateral branch of the anterior ethmoidal artery and the lateral nasal artery, or dorsally on the descending branch of the posterior lateral nasal artery [37]. This flap was originally proposed for the closure of septal perforations [38,39], of palatal fistulas in cleft defects [40], and for defects of the cranial floor [41]. In 1999, Mukarami et al. described nine cases in whom he used this flap as inner lining in the reconstruction of complex nasal ala and lateral wall defects (Fig. 10). In his small cadaveric study, he also defined the usable flap dimensions – usually 5 cm^2 with a length of 2.8 cm (1.7–4.0 cm) and a width of 1.7 cm (1.5–2.0 cm) [42]. The middle nasal concha can be used in a similar way, but the flap derived from it has a limited reach and size. The turbinate flap can be practically used in the reconstruction of the inner lining of the base of the ala [43].

Folded forehead flap

The folded paramedian forehead flap is used for the reconstruction of both inner lining and outer skin cover. It is a traditional reconstruction method; however, when used, the amount of available soft tissue is excessive, which necessitates a three-stage surgery [7]. In the first stage, the flap is extended by the inner lining at its end and a full-thickness forehead flap is elevated. Templates (made of e. g. tinfoil, packaging of the suture material, or canvas) can be easily used for planning the flap shape. To support the bending of the flap, a strip of at least 7 mm in width needs to be inserted between the inner and outer parts of the flap (Fig. 11).

The second stage comes a month later when the flap is transected at the site of

Tab. 1. Indication criteria for lining flaps.

Defect	Flap type
isolated medial vault defect	contralateral septal mucosal flap
unilateral lower 1/3 nasal defect	bipedicular vestibular flap + ipsilateral septal flap
unilateral defects up to ½ nose	bipedicular vestibular + contralateral septal flap
unilateral defects complete	ipsilateral + contralateral septal flap
central defect of the dorsum and tip	septal composite flap
central defect with wing defects	septal composite flap + nasolabial flap (or flap of wing remnants, turbinate flap)

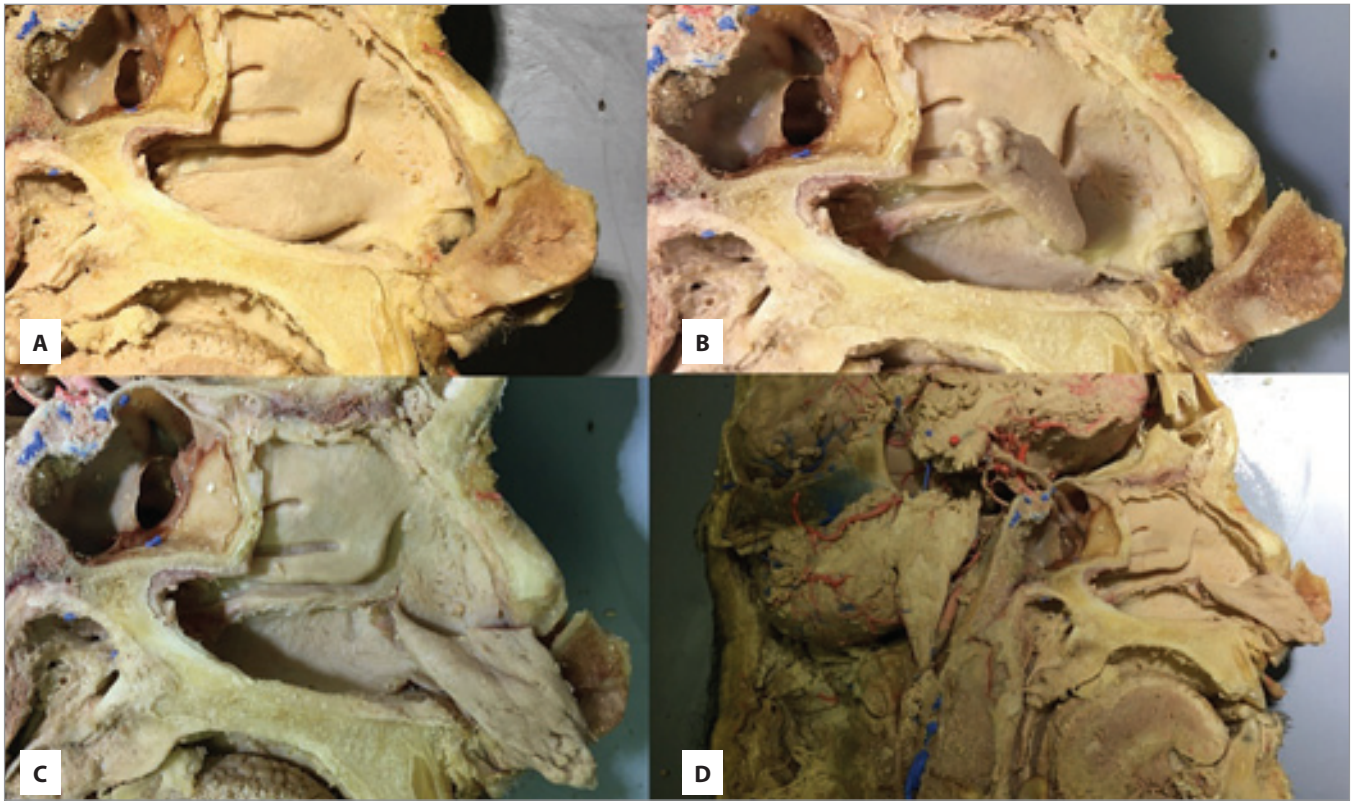

Fig. 10. Scheme of the elevation of the turbine flap. (Source: author's photo archive).

the future margin, layers are thinned to 2–3 mm (dermis and subcutaneous fat), and a cartilaginous conchal graft is inserted extraanatomically into the margins of the reconstructed nasal wing (a delayed primary graft). In the third stage, in another month, the pedicle is removed.

When using the folded forehead flap, it is necessary to adhere to the following rules:

- cartilaginous grafts are to be inserted only in the second stage;
- the frontalis muscle needs to be transferred as a part of the forehead flap, which preserves the softness and pliability of the flap, and prevents its contraction;
- it is suitable for defects of up to 3 cm in the full thickness of the ala;
- reconstruction of the nostril floor perpendicularly to the alar lining is also possible;
- thanks to the excellent forehead blood supply, this method is also suitable for using in smokers;

Fig. 11. First stage of nasal reconstruction with a duplicated forehead flap. (Source: author's photo archive).

- the individual surgical procedures are relatively short, making this technique suitable also for frail patients [21].

Microvascular free flaps

A microvascular free flap is indicated if the defect size is greater than a size that can be covered by local flaps. It serves to provide a sufficient amount of well-nourished tissue for primary healing. Most of the time, it is used in complex extensive injuries involving damage to tissues adjacent to the nose. Preparatory surgery is often necessary when using this flap.

Menick defined the principles of large defects reconstruction as follows [2,6,20,21]:

1) Establish the platform first with the primary reconstruction of the lips and cheeks.
2) The septum is usually not reconstructed, leaving an acceptable fistula.
3) The columella either hides part of the support system (strut graft) or is composed of soft tissue only.

4) Compared to the original lining area, the flap size is smaller (only approx. 7 × 8 cm). The columella must be long enough to maintain nasal tip projection and thin enough to maintain airway patency. The nasal floor can be likened to a platform on which the nose is placed caudally. It is often preserved or reconstructed in a preliminary surgery. It can also be reconstructed together with the nose, either applying a separate local flap or an extended free flap for the lining. The nasal floor defect following an excision or trauma must be reconstructed. Otherwise, scar retraction is likely to pull the upper lip and corners of the mouth up.
5) Nose reconstruction is performed in several stages. When free flaps are used, they are employed to reconstruct the intranasal lining, thus converting the defect to a skeletal and skin cover defect only.
6) The functions of the distantly transferred tissues:
   - filling in the dead space;
   - protecting vital structures;
   - creation of a barrier between the central nervous system and gastrointestinal tract;
   - formation of a stable platform.

The color and texture of the skin is, however, a downside of the use of free flaps, they resemble ugly pale patches. Flaps from the head and neck – the auricular helical flap, the retroauricular flap, and the submental flap (containing facial hair in males) are exceptions from this rule.

Free flaps ensure the presence of a well-vascularized tissue in the defect and can replace adjacent tissues. In large defects of the midface, the scapular and parascapular flaps are often used, along with the latissimus dorsi muscle and rectus abdominis muscle. All these flaps are of sufficient size to fill in the maxillary sinus. The reconstruction of the nose is then performed later, after a stable platform is established.

Radial forearm free flap

For reconstruction of central defects, the fasciocutaneous or osteocutaneous variant of the radial forearm flap is the most commonly used [44]. The principles of its use also apply to other flaps.

If the nostrils are preserved, it is advisable to turn the flap with the skin inwards and cover its surface with a skin graft. If the septum is preserved, the same procedure is followed.

If the nostrils are missing, the flap is bent around the future nostrils (in the ulnar or in the thinnest part) and immediately supported with a cantilever graft. In the next step, the outer skin is removed, the nose skeleton is added and the skin is replaced with a three-stage forehead flap.

If a part of the septum is primarily missing, it can be addressed using a composite septal pivot flap. Several modifications of this method have been described in the literature.

Burget and Walton [45] used multiple skin islands on the radial artery. They created three separate skin flaps – one for the columella, another one for the nasal entrance, and the last one for the lining (on the radial artery like beads on a string). The whole structure was covered with the skin graft (Fig. 12). Later, the flap was thinned, the nasal skeleton was applied, and a distally thinned three-stage forehead flap was applied. In all, at least six surgeries were needed for this technique. This technique allows a full reconstruction of the entire internal nasal surface. However, their approach came with downsides such as increased technical difficulty, a shortened pedicle length, the increased risk of pedicle injury due to multiple surgeries, and the fact that thinning the flap increases the risk of necrosis, potentially compromising the overall outcome of the reconstruction.

Menick and Salibian published their version of the use of the radial forearm flap in combination with a 3-phase forehead flap in 47 patients [46,47]. During the first surgery, an 8–10 × 6–8 cm flap is elevated with a 12–15 cm pedicle, which is then microanastomosed with the facial vessels on the neck (Fig. 13) or with the temporal superficial vessels. They fold the thin ulnar region of the lobe inward to form primitive nostrils. The septum is not primarily reconstructed. The thin ulnar region of the flap is folded inward to form primitive nostrils. In cases with a subtotal or total loss, an osteocartilaginous graft from the rib is implanted into the position of the cantilever graft, saving the remaining cartilage for the subsequent surgery. The second surgery takes place usually two months later. The position of the nostrils is measured and the outer skin covering the flap with a few millimeters of subcutaneous tissue is excised. Thus, the excess flap is excised and the neurovascular bundle is spared. The nose skeleton reconstruction is completed, fixing it to the previously applied grafts. Everything is covered with a three-stage forehead flap. A month later, a third surgery is performed, during which skin with 2–3 mm of subcutaneous tissue is elevated and, if needed, the cartilaginous supporting structures of the new nose are corrected. Another month later, during a fourth surgery, the pedicle is removed and if needed, nostrils are thinned. The final, fifth, surgery is performed four months later. In that surgery the scar on the forehead is corrected, the shape of the nose fine-tuned and, if required, the tip of the nose may be adjusted by implanting cartilaginous grafts. The entire reconstruction, therefore, takes eight months.

Advantages of the radial forearm flap include:
- thin, pliable skin;
- excellent blood supply;
- long pedicled;
- the flap is suitable for combined lining and columella defects.

Most authors use this flap for the reconstruction of the nasal lining [48–50]. However, other uses of this flap and its

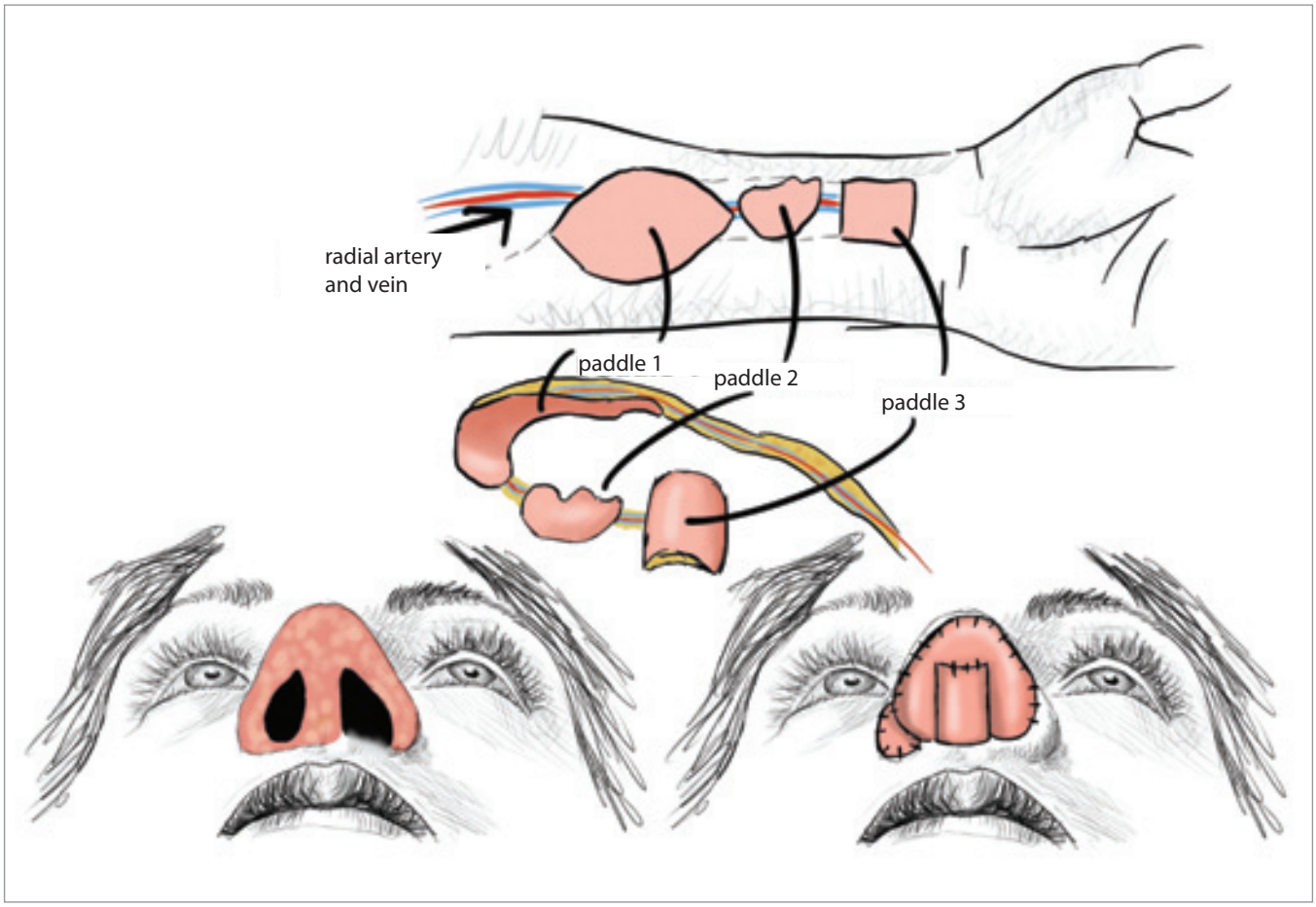

Fig. 12. Burget-Walton technique of Chinese flap nose reconstruction. (Drawing by A. Berkeš according to [2]).

modifications during nose reconstruction have been reported [51,52].

Prelaminated radial forearm flap

Prelamination was introduced by Pribaz and Fine in 1994, and since then, the radial forearm flap has been the most commonly prelaminated flap in facial reconstruction [18,49,53,54]. For example, Costa used a prelaminated osteocutaneous variant of this flap, modeling a nose with a central bony L-segment and nostrils created by folding the flap using reinforced nasal dilators. After 3 weeks, he transferred the prepared nose to the facial area [54].

Winslow et al. [55] reported an interesting modification, using the radial forearm fascial flap (radial forearm flap without skin, only vascularized fascia) to reconstruct the inner lining. On top of this, several remnants of nasal mucosa from the conchae were applied, the nasal frame was created from the calvarial bone, and the structure was covered with a three-stage forehead flap.

In 2019, Ahcan presented a case of a 52-year-old woman who underwent a two-stage reconstruction of the entire nose due to a complex nasal defect arising after the resection of invasive squamous cell carcinoma [56]. In the first stage, the osteocutaneous radial forearm flap innervated by the lateral antebrachial cutaneous nerve was elevated in the forearm using a 3D template. The bony L-graft was fixed using a plate. A skin island was used to reconstruct the inner lining, the future shape of which was ensured using a titanium mesh. The "supine" new nose was externally covered with the antebrachial fascia and covered with a skin graft. In the second stage, five weeks later, the well-vascularized "neo-nose" was transferred to the face and covered with a pre-expanded forehead flap.

Free flap of the first dorsal metacarpal artery (free kite flap)

Beahm et al. used this flap for columella reconstruction after the failure of a part of the radial forearm flap [57]. The donor site can be sutured or transplanted with a skin graft, depending on the extent of the flap. The thinness and the possibility to elevate two skin islands on a single vessel (Fig. 14) are the main advantages of this flap; the negatives are represented by the very short pedicle of the first metacarpal artery and the fact that the artery is very thin (diameter of 0.5–1 mm). To acquire a larger vessel diameter, the radial artery needs to be prepared up to the anatomical snuffbox.

Fig. 13. First stage of nasal reconstruction with Chinese flaps suitable for combined defects of the lining and columella. (Source: author's photo archive).

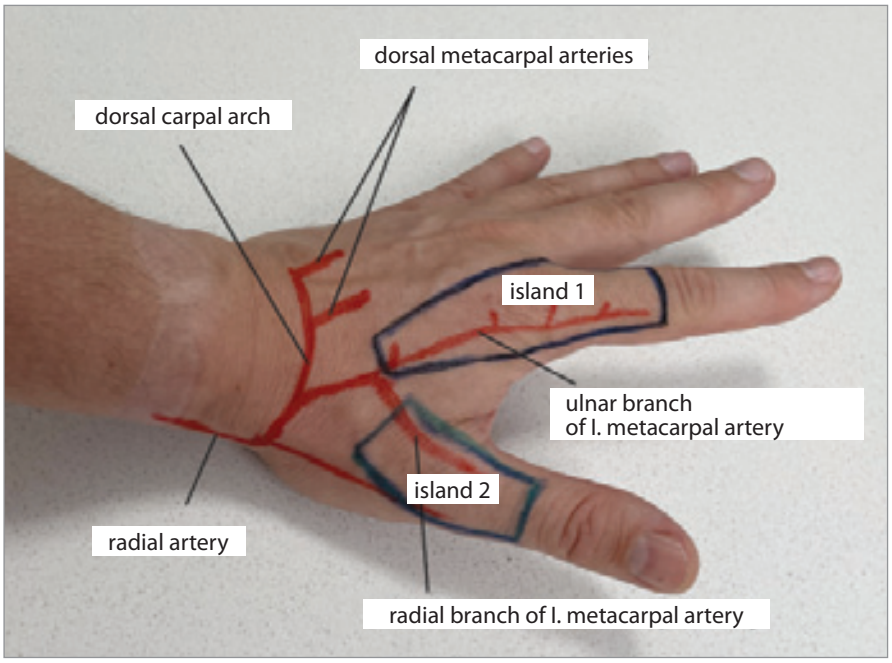

Fig. 14. Free flap of the first dorsal metacarpal artery. (Source: author's photo archive).

Dorsalis pedis free flap

The sufficiently thin skin cover is a crucial advantage of this flap [58–62]. Similar to the radial forearm flap on the forearm, the dorsalis pedis free flap can also be harvested as an osteocutaneous flap (with a part of the second metatarsal). However, there are also disadvantages when using this flap – in particular, the morbidity of the donor site with the need to cover the defect with a skin graft, which often causes problems when walking in shoes. Moreover, the collateral vascular supply to the distal limb is compromised, which can pose a problem in elderly patients.

Temporoparietal free flap

The temporoparietal free flap is flexible, thin, and well-vascularized. It reportedly perfuses the underlying calvarial grafts. Acikel et al. used this flap to cover the nose in combination with a skin graft from the supraclavicular region [63]. Although the authors achieved an acceptable nasal shape, the discoloration of the skin graft reduced the aesthetic result, compared with the outcomes of reconstruction when using the forehead flap. Still, the temporoparietal free flap is considered one of the alternatives to the radial forearm flap for reconstruction of the nasal mucosa.

Serratus anterior muscle free flap

Thomas and Harris reported a complex nasal reconstruction using a serratus anterior muscle free flap with a vascularized free rib [64]. The rib graft was anchored to the frontal bone using miniplates. The nostrils were shaped from the serratus muscle and lined with tubes enveloped with skin grafts. The graft, however, subsequently significantly contracted during healing (despite stenting) excessively narrowing the airway lumen down.

Postauricular free flap

The postauricular free flap represents a microvascular modification of the Washio technique. It was described and used by Swartz and it probably has a better vascular supply than if used in a pedicled variant [65]. The main disadvantage of this technique is the skin of the flap, which is smooth and thin, not resembling the thick sebaceous skin of the male nose.

Helix free flap

The auricular tissue was also reported to be transferred to the superficial temporal artery (Fig. 15). The full-thickness helix root is transferred to the nose as a composite free flap [66]. This method is particularly suitable for nasal wing reconstruction. Its advantages lie in the resistance to actinosis and the large diameter of the superficial temporal arteries. The main limitation, however, lies in the

maximum area of 3 × 3 cm that can be removed without disturbing the shape of the ear.

This method is particularly suitable for the reconstruction of alae. The actinic-resistant skin and large diameter of the superficial temporal vessels count among its advantages. The principal limitation lies in the maximum harvest area of 3 × 3 cm (harvesting a larger flap would compromise the shape of the ear). Zhang et al. used this technique in 63 pacients with various defects of the nose and reported very good results [67].

Free deltopectoral flap

Zhou and Cao presented a series of eight cases of nasal reconstruction using a free flap based on a cutaneous acromiothoracic arteriovenous system [68]. A skin flap of up to 8 × 9 cm can be obtained in this way. As for disadvantages, the small (1–2 mm) and short vascular pedicle of the flap, which often requires the use of vein grafts, is the main downside of this technique.

In general, we can say that there is currently a consensus that free flaps are primarily used to reconstruct the inner surfaces of the nose, and the outer nasal cover is reconstructed with a three-phase paramedian forehead flap [58].

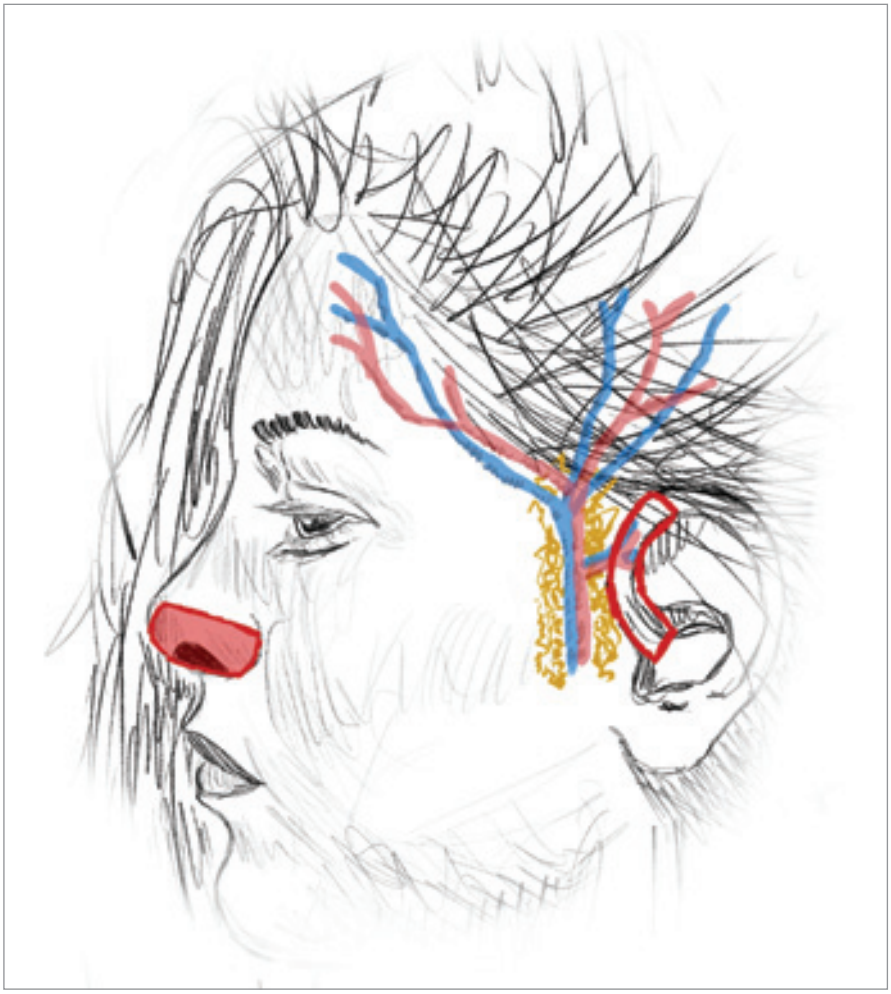

Fig. 15. Helix free flap to replace the missing nasal ala. (Drawing by A. Berkeš).

Discussion

For the reconstruction of the inner lining, the most readily available, well-nourished soft tissue should be generally used. The requirements include good vascularity, pliability, and, if possible, a sufficiently thin tissue that does not obstruct the airway. The simpler the principle and the shorter the facial scars, the better. When reconstructing large defects, free tissue transfer using a microvascular technique is often the only options [12,13].

In 1974, the eminent American plastic surgeon Millard proposed a three-stage concept of nasal reconstruction with a forehead flap [69]. In this concept, an additional step was added between the flap transfer and pedicle detachment (3 weeks after the transfer), in which the thick skin in the dorsum of the nose was thinned (by removing the frontalis muscle) and the flap was sutured back. Burget and Menick later modified this approach by omitting the initial thinning of the forehead flap before the transfer to the nasal region. This modification aimed to prevent any damage to the vascularization of the peripheral parts of the flap. In their modification, the thinning is performed only 3–4 weeks after the transfer during a necessary second surgery [7].

Of the various modifications of the forehead flaps, paramedian forehead flaps are the most commonly used. The current concept of reconstructing the skin cover of the nose with a forehead flap is illustrated in Fig. 16.

In complex nasal reconstructions, the entire external nose may be temporarily created from a free flap, which is inferior in appearance; such skin is then usually replaced with the skin of the forehead flap in the next surgical stage.

When reconstructing large defects, free tissue transfer using a microvascular technique is often the only option [12,13].

Conclusions

Even today, nasal reconstruction represents a great challenge for the reconstructive surgeon. The rich vascular supply of the face reduces the risk of ischemia, necrosis, and infection, allowing most large nasal defects to be re-

Fig. 16. Principle of three-phase nasal reconstruction with restoration of all layers of the nose and overlapping with the paramedian forehead flap thinned in the second period and with the vascular pedicle removed in the third period, before reconstruction on the left, final result on the right. (Source: author's photo archive).

constructed using local flaps. Local flaps retain ideal quality, coloration, and texture, are reliable, and usually result in esthetically acceptable morbidity of the donor area. If, however, the defect exceeds the possibilities of using local flaps, distant flaps need to be transferred, most often by free microvascular transport. The stability of the reconstructed result is directly proportional to the successful reconstruction of all layers of the nose. Reconstruction of a high-quality inner lining is an essential step in modern nasal reconstruction, allowing the exposure of additional nasal layers in complex nasal defects. Very good functional and esthetically acceptable results of nasal reconstruction can be achieved using the current concept.

Disclosure

The authors have no conflicts of interest to disclose. All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the Helsinki declaration and its later amendments or comparable ethical standards.

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Roles of the authors

Martin Kubát and Jan Menoušek conducted the literature search, designed the flowchart and analyzed the collected data. Andrej Berkeš drew the pictures. Zdeněk Dvořák and Jan Menoušek wrote the manuscript with the input from all authors. Richad Pink and Tomáš Kubek conceived the study and revised it critically for important intellectual content. All the authors approved the version to be published.

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Comparison of lymphovenous anastomosis and vascularized lymph node transfer in lymphedema treatment – a literature review

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Summary

Background: Lymphovenous anastomosis (LVA) and vascularized lymph node transfer (VLNT) are both accepted microsurgical treatment options for lymphedema. This article summarises and analyses recent data on outcomes associated with LVA and VLNT for lymphedema treatment at varying degrees of severity. **Methods:** Literature research was conducted in the PubMed and Embase Ovid database to extract articles published through March 2024. The included studies report data on objective and subjective improvement in lymphedema after physiological surgical procedures as LVA and VLNT. Extracted data comprised number of patients, affected limbs, staging of the disease, duration of the follow up period, objective and subjective improvement and percentage of discontinuation of compression garments. **Results:** A total of 23 articles were included in this article, representing 1,944 patients suffering from either primary or secondary lymphedema. The lymphedema stages were classified by classification of International Society of Lymphedema (ISL stage) or Campisi stage and range from stage I to III, as well as prophylactic indication for surgery. The follow-up duration ranged from 3 months to 8 years. Objective improvement was achieved in 82.76–100% and measured in circumferential reduction rate and reduction of cellulitis episodes. In 80–100% of the patient's subjective improvement was seen, which was measured in quality of life and personal feedback. The percentage of patients able to discontinue the use of compression garments ranges from 0 to 100%, while others were able to reduce the total time of wearing. **Conclusion:** LVA and VLNT are both safe and effective techniques for the surgical treatment of lymphedema in several stages. LVA should be preferred if the lymph vessels preserved its patency, otherwise VLNT might be the therapy of choice. Combinations of various procedures with an appropriate postoperative treatment plan might lead to improved patient outcomes.

Key words

lymphedema – lymphovenous anastomosis – LVA – lymphovenous bypass – vascularized lymph node transfer – VLNT – results

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Introduction

Lymphedema is a chronic pathology, which is manifested as an accumulation of protein-rich and lipid-rich fluid in the interstitial space due to impaired drainage of lymphatic fluid and presents therefore as tissue swellings. Those findings can be localized, especially in the extremities, or generalized as in patients with Turner syndrome. Depending on the cause, we differentiate primary and secondary lymphedema. Primary lymphedema can occur as a result of a congenital anomaly, which presents as poorly developed lymphatic vessels with incompetent lymphatic valves or obliteration. Secondary lymphedema is more common and occurs secondary due to neoplasms, radiation therapy, surgeries, trauma, body mass index (BMI) > 50 and infections (e. g. lymphatic filariasis) [1–4].

Because of its progressive characteristic of this pathology, it is categorized into stages I–III, according to the Classification of International Society of Lymphology (ISL). Stage 0 presents subclinical lymphedema, stage I describes reversible pitting edema without palpable fibrosis. Stage IIa is characterized with non-reducible pitting edema and stage IIb with non-pitting edema, secondary to pronounced fibrosis. Stage III is the last stage and described as lymphostatic elephantiasis with progressive fibrosis, acanthosis, hyperkeratosis and

papillomatosis [2,5]. Another used classification is Campisi staging from stage I to stage V. Campisi stage Ia represents the subclinical stage of lymphedema, whereas in Ib an edema is visible with a partial improvement while elevating the extremity. Stage II describes the persisting edema after elevation of the limb. Campisi stage III characterises a persistent edema with lymphangitis. The advanced stages IV and V show fibrotic lymphedema with column-like extremity with the presence of warts and elephantiasis with deformity of the affected extremity, respectively [6].

Chronic fluid stasis in the interstitial space might trigger inflammation, adipose hypertrophy, deposition of fat and fibrotic changes. The subcutaneous tissue can therefore indurate and present as a swollen, hard tissue [2,4,7]. Those consequences might lead to complications, such as cellulitis, infection, lymphorrhoea, lymphostatic blisters and social as well as psychological repercussions [2,8].

The specific approach to lymphedema therapy differs according to the underlying causes. In general, the earlier the stage of lymphedema, the better the prognosis. The incipient lymphedema is traditionally treated with non-surgical decongestive therapy as compression garments, manual lymphatic drainage, skin care and physiotherapy [2,9]. Chang et al. stated, that there is no evidence to support the use of pharmacotherapy for treatment of prevention of lymphedema [10].

Surgical approaches in therapy can be differentiated into reductive approaches, such as liposuction, partial excision or Charles procedure in which the hypertrophied adipose tissue is removed, and physiological approaches, like lymphovenous anastomosis (LVA) and vascularized lymph node transfer (VLNT). The latter approaches aim to improve lymphatic flow by promoting its clearance. In the following article, the focus will be put on these two physiological approaches [1,10,11].

LVA is a minimally invasive supermicrosurgical intervention, in which multiple anastomoses between subdermal collecting lymphatics and small veins are created in the affected area. Several anastomosis techniques have been presented, such as end-to-end, end-to-side, side-to-end fashion, using usually 11-0 or 12-0 nylon micro sutures. The crucial requirement for this surgery is the functionality of some lymphatic vessels [2,7]. This method was first described by O'Brien et al. in 1977, improved and manifested throughout the years [12].

The literature also mentions the immediate lymphatic reconstruction (ILR) as a prophylactic procedure during oncological surgeries, which implicates LVA at the same time as lymph node dissection. According to the results of Lustig et al., there was a reduction of cancer related lymphedema of the upper extremity after axillary lymph node dissection (ALND) from 20–30% to 9.1% of patients after ILR [13–16].

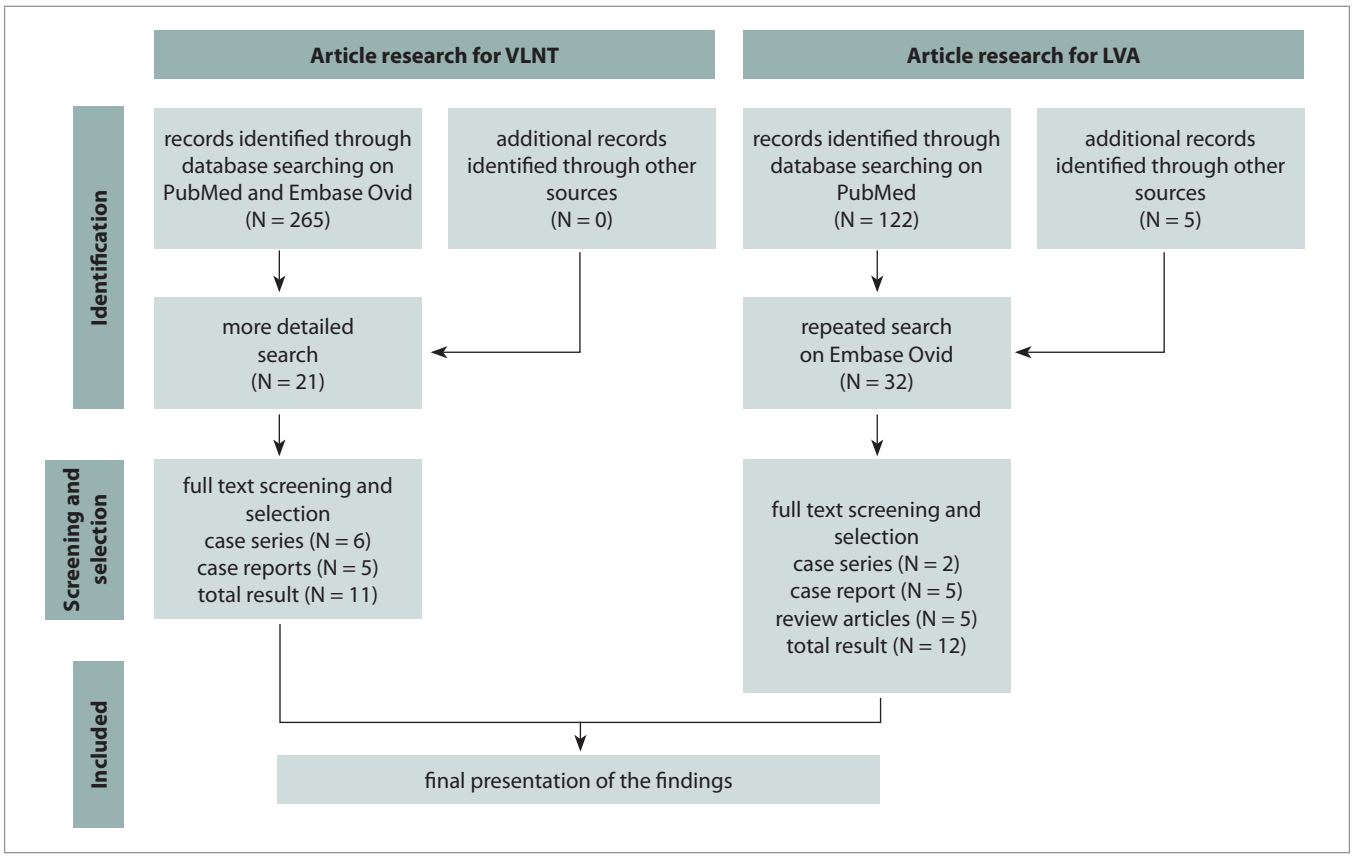
VLNT is another microsurgical intervention that follows the physiological approach to treat lymphedema. Lymph node (LN) containing tissue with vascular supply of an unaffected area is transferred and anastomosed with the vessels of the affected limb in the form of a free flap [17]. The common lymph node donor sites are groin, submental, thoracic and supraclavicular region as well as omental LN [2]. The ongoing hypothesis behind this procedure is that the transferred lymph node will behave as a new pump, which will help the dysfunctional lymphatic system on site and direct the accumulated lymphatic fluid through the newly anastomosed venous route. Additionally, it is thought to induce lymphangiogenesis, which will strengthen the lymphatic network at the affected site [18–25].

The selection of the donor LN site is crucial for this procedure. The removed LN should not be a sentinel LN draining the donor site, otherwise the risk of developing an iatrogenic secondary lymphedema increases. Therefore, preoperative mapping of the lymphatic system is of high importance [2,10].

Another advantage of LVA and VLNT is that it has the potential to reduce or eliminate the need for long-term compression garments, which has an immense positive impact on the patient's everyday life [2].

To ensure promising outcomes of the procedure, examination of the lymphatic system and lymphatic mapping is necessary. Indocyanine green-lymphography (ICG-L), lymphoscintigraphy, non-contrast magnetic resonance lymphography (MRL) and ultrasonography (US) can be used. ICG-L is a preferred technique for lymphatic mapping, examination of the functionality and diagnosis of dermal backflow due to absent patency of the lymphatics. Indocyanine green is injected subcutaneously at the affected area. At the plateau phase 12–18 h after the injection, a circumferential fluorescent image of the lymphatic drainage system is obtained using an infrared camera [2,10,26,27]. Lymphoscintigraphy with technetium-99m is another examination method to evaluate the lymphatic functionality and to assess the degree of lymphatic impairment [10,18,28–30]. Non-contrast MRL is used only for lymphatic mapping as it will not provide any information about the functionality. Furthermore, the stage of lymphedema can be observed in the aspect of location of the edema, morphology of the lymphatic vessels and LN and the presence or absence of fat deposition [10,28,31]. Ultrasonography is another cost-effective imaging method to evaluate the location and extent of the edema, as well as the location and quality of the lymphatic vessels and veins [10,28,32,33].

Postoperative management of patients is reduced to wearing compression garments or elastic bandages to increase the lymphovenous flow through the anastomosis. The use of compression garments is indicated for 24 h for



Scheme 1. Study flowchart.
LVA – lymphovenous anastomosis, VTLNT – vascularized thoracic lymph node transfer

2 weeks with a timely reduction after this period. The discontinuation of compression garments is considered by their practitioner, if some criteria are met: absence of tension sensation, absence of cellulitis episodes, progressive volume reduction, improvement of lymphatic drainage displayed on ICG-L [4,28,34].

Quantification of the results after the procedure include circumference measurements, MRI to display water displacement, tissue tonometry to determine the degree of fibrosis, perometry to measure overall limb volume and bioimpedance spectroscopy to evaluate the amount of extracellular fluid [2,28]. The Quality of life measure for limb lymphoedema (LYMQOL) questionnaire by the lymphedema service in Derby, UK, is another tool used for follow-up examinations. The patient questionnaire examines the function, body image/ appearance, symptoms and mood of the patient [2,35].

Evaluation of the topic

Methods for literature review and search criteria

The database PubMed and Embase Ovid were used for the literature search for the following case reviews. Articles published up until March 2024 were considered. The search strategy for the case studies about VLNT used, was the following by including the Boolean operators "AND" and "OR": ((VLNT[Title/Abstract]) OR (vasculari*ed lymph node transfer [Title/Abstract])) AND (results [Title/Abstract]). A total result of 265 articles was found, but then repeated for a narrower search. (((VLNT[Title/Abstract]) OR (vasculari*ed lymph node transfer [Title/Abstract])) AND (results [Title/Abstract])) AND (case report). The second search found 21 results. Due to exclusion, it got narrowed down to 11 articles, whereas six articles were identified as case series [17,18,36–39] and five articles as case reports [40–44].

The search strategy for the case studies about LVA used, was the following: (((((((LVA[Title/Abstract]) OR (lymphovenous anastomosis[Title/Abstract])) OR (lymphovenous bypass [Title/Abstract])) OR (lymphaticovenous anastomosis[Title/Abstract])) OR (lymphatic surgery[Title/Abstract])) AND (results[Title/Abstract])) AND (lymphedema[Title/Abstract])) on PubMed. A total result of 122 articles was found (Scheme 1.). A second search was repeated on Embase Ovid with the search strategy: ((LV.ab. and lymph*edema.kw.) or lymph*venous anastomosis.ab. or lymph*venous bypass.ab.) and case report*.af. and rezults.af. The second search found 32 results. Due to exclusion, it got narrowed down to a total of seven articles [45–51]. Also during the previous literature search, found review articles were put under consideration [6,7,26,52,53].

Comparison of the results of LVA and VLNT treatment

Crowley et al. evaluated the management of lymphedema and breast reconstruction with single-stage omental VLNT and autologous breast reconstruction. The case series involved 7 patients with altogether 8 affected limbs, suffering from breast cancer-related lymphedema after axillary lymph node dissection. The VLNT procedure was performed with simultaneous autologous breast reconstruction, using either omental fat- augmented free flap (O-FAFF) or deep inferior epigastric artery perforator (DIEP) or muscle sparing tram DIEP/MS-TRAM flaps. All the flaps survived and all the patients showed reduction of their extremity circumference of the affected limb and improvement of symptoms [36].

Demiri et al. presented a case series of 34 patients with breast cancer-related lymphedema who underwent a delayed breast reconstruction and lymphedema treatment using a predesigned chimeric DIEP flap with vascularized inguinal lymph nodes (DIEP-VILN flap). The patients were classified from stage I to stage III of the ISL classification and the volume excess reduced from preoperative 33% to postoperative 17.5%. Post-operative ICG-L showed improved lymphatic circulation in 76.5% of the patients. The patient satisfaction was documented by a self-evaluation questionnaire and showed that 33 out of the 34 patients were very satisfied or satisfied [17].

Ciudad et al. contributed with a case series of 78 patients suffering from breast cancer-related lymphedema on 78 upper limbs varying from stage II to stage III. A total of 18 patients were treated with LVA with a mean number of 3 anastomosis and 22 patients were treated with VLNT, of which 10 patients where simultaneous treated with DIEP flap for delayed breast reconstruction. Additionally, all the 38 stage III patients underwent combined suction-assisted lipectomy (SAL) and LVA (N = 36) or combined SAL and VLNT (N = 2). The stage II patients treated by LVA, VLNT and combined VLNT-DIEP flap showed a circumferential reduction rate of 56.5%, 54.4% and 56.5%, respectively. The stage III patients treated by combined SAL-LVA and combined SAL-VLNT showed a reduction rate of 85% and 75%, respectively. Two complications occurred in all the patients: one failed VLNT and a minor complication in a patient treated with DIEP-VLNT. The occurrence of cellulitis episodes per year decreased from 3 and 4 preoperatively in stage II and III patients to 0.5 and 0.4, respectively. According to Ciudad et al. the skin tonicity reduction rate was comparable of patients with LVA, VLNT, VLNT-DIEP and combined SAL-LAV after 12 months. Discontinuation of the utilisation of compression garments was possible in 38 patients after 9 months [37].

In another article, Ciudad et al. discussed a case study of a 33-year-old male patient with a 17-year history of secondary lower limb lymphedema after a trauma. In this case report, the lymphedema treatment was described with an ileocecal vascularized lymph node IC-VLN flap, which included three large lymph nodes. In a 15-month follow-up, the circumference reduction rate was measured at four locations of the lower extremity. There was a reduction of 36.5% above the knee, 32% below the knee, 21.4% above the ankle and 15.2% at the foot level. The increased lymphatic drainage was measured by lymphoscintigraphy [43].

A following case study of Ciudad et al. described a 62-year-old female patient with secondary lower limb lymphedema after inguinal LND with adjuvant radiotherapy with recurrent episodes of cellulitis. The treatment was performed by appendicular VLNT. In a 6-month follow-up, no more episodes of cellulitis were observed, and the circumference reduction rate was reported on four positions of the lower limb. A reduction of 17.4% above the knee, 15.1% below the knee, 12.0% above the ankle and 9% at the foot was measured [44].

Gazyakan et al. presented a case study of a 22-year-old female patient with secondary stage II lower limb lymphedema after severe trauma. Previous reconstruction surgeries of the lower limb were supplied by pre-expanded island parascapular flap. The lymphedema was treated with a thoracodorsal artery perforator LN flap (TAP-VLNT) and conservative compression therapy. The results were measured at four levels in the circumferential reduction rate after 3 months. It was reduced by 1.3% above the knee, by 7.4% below the knee, by 11.1% above the ankle and by 9.3% at the foot level [40].

Sinelnikov et al. introduced a case study of a 55-year-old female patient suffering from breast cancer-related lymphedema of the upper extremity who underwent delayed breast reconstruction with revascularized greater omentum flap with lymphatic component. The surgical results were noted in circumference rate changes at four locations and calculated to circumference reduction rate. There was a reduction by 100% at the level of the wrist, by 77% at the middle third of the forearm, by 72% at the middle third of the humerus and by 83.3% at the upper third of the humerus [41].

Mazerolle et al. described a case study of a 45-year-old male patient with secondary lower limb lymphedema after inguinal melanoma with inguinal and pelvic lymph node dissection (LND). The patient was treated with VLNT with submental free flap and showed a reduction of the volume by 30% in the follow-up [42].

Venkatramani et al. presented two cases of male patients with lower limb lymphedema. The first case discussed a 13-year-old male patient with primary lymphedema starting at the age of 2 years. At 13 years, he developed

stage III lymphedema with hyperkeratosis and pigmentation, history of recurrent lymphangitis and recurrent hydrocele at the affected side. The treatment of choice was VLNT based on latissimus dorsi pedicle with axillary LN. The ipsilateral axilla was anastomosed with the anterior tibial vessels, whereas the contralateral axilla was anastomosed with the posterior tibial vessels. The postoperative reduction rate in circumference was 9% with increased health state feedback of 95% from preoperative 70%. The second case described a 41-year-old male patient with stage III secondary lymphedema due to filariasis presenting with recurrent lymphangitis, hyperkeratosis, and pigmentation. (The previous surgeries included left above-knee amputation because of the filariasis with recurrent lymphedema.) The same surgery was performed as in the previous patient and a circumference reduction of 6% was achieved. The health state feedback increased from preoperative 50% to postoperative 75% [38].

Akita et al. contributed with a case series of 46 patients with 56 affected lower limbs with a comparison of VLNT and LVA in the treatment of advanced stage lymphedema. A total of 33 patients with 43 affected limbs underwent multiple LVA and 13 patients with 13 affected limbs underwent vascularized supraclavicular lymph node transfer (VSLNT). The results for the lymphatic function were measured with ICG-L or lymphoscintigraphy and the lower extremity lymphedema (LEL) index, which takes changes in the limb circumference at different locations and BMI into the calculation. The mean LEL index improved in patients with VLNT and LVA by 26.5 and 21.2, and the lymphatic function improved in patients with VLNT and LVA by 10 and 7, respectively. During this case series, there were less complications in the LVA group compared to the VSLNT group. In the follow-up, none of the patients was completely free from compression garments [39].

In their case series, Lin et al. discussed 13 patients with breast cancer-related lymphedema treated with vascularized groin LNT with anastomoses of the superficial circumflex iliac vessels to the superficial radial artery and cephalic vein of the recipient site. The results were measured in CRR, incidence of cellulitis and postoperative lymphoscintigraphy. The mean reduction rate was 50.55% and the cellulitis decrease was seen in 11 patients. The lymphoscintigraphy showed improved lymph drainage in all the patients [18].

Yoshida et al. presented a case study comparing the effect of LVA and the characteristics of the lymphatics in patients with secondary lower limb lymphedema due to obesity with a control group. The case study was divided into two groups: 22 patients with 44 affected limbs and BMI > 35 kg/m^2 and the control group of 91 patients with 141 affected limbs and BMI < 35 kg/m^2. Yoshida et al. reported a difference in the depth and diameter of the lymphatics of both groups. In average, the depth of lymphatics at the thigh area in the obese group was 4.5 mm (range 3–10 mm) with a diameter of 0.77 mm and 2.5 mm (range 2–5mm) in the lower leg area with a diameter of 0.82 mm, whereas in the non-obese group, the depth in the thigh area was 3.9 mm (range 2–10 mm) with a diameter of 0.54 mm and 2.1 mm (range 1–6 mm) with a diameter of 0.56 mm in the lower leg area. The LEL index improvement was 8.9 and 9.1 in the obese and non-obese groups, respectively. The patients had to continue their compression therapy after the procedure [26].

Qiu et al. contributed with a case series of outcomes for 100 cases of lymphedema in a 24-month follow-up. A total of 85 patients suffered from lymphedema at the upper extremities and 15 patients at the lower extremities. The lymphedema classification ranged from stage I to stage III, whereas the mean was stage IIa. The patients were all treated with LVA, by which 2.7 anastomoses per patient were created, in average. The mean difference UEL index was 0.5 and the LEL index was 2.3. A mean decrease of 6% in the circumference was observed in 52% of the patients. The cellulitis episodes per year decreased in 98% of the patients from 1.1 to 0.5 episodes. A total of 43% of the patients were able to completely discontinue the compression garment and 18% were able to discontinue wearing of the compression garment partially. The quality of life increased in 80% of the patients [52].

Gupta et al. published a systematic review summarising the outcome of LVA for upper limb lymphedema until June 2020. A total of 16 studies with a total of 349 patients with 244 affected upper limbs were included. The patients were treated with LVA with an average of 3 anastomoses ranging from 1.5 to 5.4. The objective measures included limb measurements, volume measurements and excessive volume. In 81.75% of a total of 10 studies including 250 patients, an objective improvement was seen. Subjective improvement was noted in 81.36% of 11 studies with 310 patients. Episodes of cellulitis per year were also observed and decreased following LVA in 3 studies, including 63 patients from 20 to 6% of occurrence and the average number of 1.06 to 0.04. Three included studies claimed that their patients were free of compression garment 1 month post-operatively, which accounts for 35% of the patients included in this review [6].

Verhey et al. released a systematic review concluding the outcome of LVA for lower limb lymphedema. A total of 74 studies of 6,260 patients with 2,554 affected lower limbs were included. The exact data of 20 studies including 1,030 patients and 1,175 affected limbs were given in this review and added to the table below (Tab. 1). All the patients were treated with LVA and followed-up for 13.9 months in average (range 6– 37.5 months). The average

Tab. 1. Characteristics of the previously explained studies.

Authors	Number of patients	Type of lymphedema (PL or SL and UE or LE)	Lymphedema stage prior surgery (ISL or Campisi)	Intervention	Follow-up	Objective improvement in % patients	Subjective improvement in % patients	Discontinuation of compression garments in % patients
Crowley et al. [36]	7	SL & UE		O-FAFF or DIEP/MS-TRAM flap		100		
Demiri et al. [17]	34	SL & UE	ISL I –III	chimeric DIEP-VILN flap		volume excess reduction from 33% (pre-OP) to 17.5% (post-OP)	33 out of 34 97%	
Ciudad et al. [37]	18	SL & UE	ISL stage II	LVA	12 months	CRR: 56.5%	cellulitis episodes decreased from 7 (pre-OP) to 1.3 (post-OP)	48.71
	12	SL & UE	ISL stage II	VLNT	12 months	CRR: 54.4%		
	10	SL & UE	ISL stage II	combined DIEP flap and VLNT	12 months	CRR: 56.5%		
	36	SL & UE	ISL stage III	combined SAL and LVA	12 months	CRR: 85%		
	2	SL & UE	ISL stage III	combined SAL and VLNT	12 months	CRR: 75%		
Ciudad et al. [43]	1	SL & LE		IC-VLN flap		CRR: above knee 36.5% below knee 32% above ankle 21.4% foot level 15.2%		
Ciudad et al. [44]	1	SL & LE		appendicular VLNT	6 months	no more cellulitis CRR: above knee 17.4% below knee 15.1% above ankle 12% foot level 9%		
Gazyakan et al. [40]	1	SL & LE	ISL stage II	TAP-VLNT and conservative compression therapy	3 months	CRR: above knee 1.3% below knee 7.4% above ankle 11.1% foot level 9.3%	100	none
Sinelnikov et al. [41]	1	SL & UE		combined VLNT: delayed breast reconstruction with revascularized greater omentum flap with lymph. component		CRR: upper third humerus 83.3% middle third humerus 72% middle third forearm 77% wrist 100%	100	

CRR – circumference reduction rate, DIEP/MS-TRAM – deep inferior epigastric artery perforator or muscle sparing tram, DIEP-VILN flap – deep inferior epigastric artery perforator flap with vascularized inguinal lymph nodes, EQ-5D-5L – quality-of-life tool, IC-VLN flap – ileocecal vascularized lymph node, LE – lower extremity, LEL – lower extremity lymphedema, LN – lymph node, LND – lymph node dissection, LVA – lymphovenous anastomosis, O-FAFF – omental fat- augmented free flap, PL – primary lymphedema, post-OP – postoperative, pre-OP – preoperative, SAL – combined suction-assisted lipectomy, SL – secondary lymphedema, TAP-VLNT – thoracodorsal artery perforator LN flap, UE – upper extremity, UEL – upper extremity lymphedema, VLNT – vascularized lymph node transfer, VGLNT – vascularized groin lymph node transfer, VSLNT – vascularized supraclavicular lymph node transfer, VTLNT – vascularized thoracic lymph node transfer

Tab. 1 – continued. Characteristics of the previously explained studies.

Authors	Number of patients	Type of lymphedema (PL or SL and UE or LE)	Lymphedema stage prior surgery (ISL or Campisi)	Intervention	Follow-up	Objective improvement in % patients	Subjective improvement in % patients	Discontinuation of compression garments in % patients
Mazerolle et al. [42]	1	SL & LE		VLNT with submental free flap		100 30% volume reduction	100	
Venkatramani et al. [38]	2	1 PL & LE 1 SL & LE	ISL stage III	VLNT based latissimus dorsi pedicle with axillary LN		100 #1: CRR: 9% #2: CRR: 6%	100 #1: health state feedback 70% to 95% #2 feedback 50% to 75%	
Akita et al. [39]	13	13 LE		VSLNT		LEL improvement: 26.5 lymphatic function improvement: 10		none
	33	43 LE		LVA		LEL improvement: 21.2 lymphatic function improvement: 7		
Lin et al. [18]	13	SL & UE		VGLNT with anastomoses vasa iliaca circumf. sup. to arteria radialis sup. and vena cephalica		100 mean reduction rate: 50.55% reduction of cellulitis in 11 patients		
Yoshida et al. [26]	113	SL & LE		LVA		mean LEL improvement: obese: 8.9 non-obese: 9.1		none
Qiu et al. [52]	100	85 SL & UE 15 SL & LE	ISL stage I–III mean: stage IIb	LVA		mean UEL improvement: 0.5 mean LEL improvement: 2.3 mean decrease of 6% circumference cellulitis episode from 1.1 to 0.5 in 98% of patients	80	43

CRR – circumference reduction rate, DIEP/MS-TRAM – deep inferior epigastric artery perforator or muscle sparing tram, DIEP-VILN flap – deep inferior epigastric artery perforator flap with vascularized inguinal lymph nodes, EQ-5D-5L – quality-of-life tool, IC-VLN flap – ileocecal vascularized lymph node, LE – lower extremity, LEL – lower extremity lymphedema, LN – lymph node, LND – lymph node dissection, LVA – lymphovenous anastomosis, O-FAFF – omental fat- augmented free flap, PL – primary lymphedema, post-OP – postoperative, pre-OP – preoperative, SAL – combined suction-assisted lipectomy, SL – secondary lymphedema, TAP-VLNT – thoracodorsal artery perforator LN flap, UE – upper extremity, UEL – upper extremity lymphedema, VLNT – vascularized lymph node transfer, VGLNT – vascularized groin lymph node transfer, VSLNT – vascularized supraclavicular lymph node transfer, VTLNT – vascularized thoracic lymph node transfer

Tab. 1 – continued. Characteristics of the previously explained studies.

Authors	Number of patients	Type of lymphedema (PL or SL and UE or LE)	Lymphedema stage prior surgery (ISL or Campisi)	Intervention	Follow-up	Objective improvement in % patients	Subjective improvement in % patients	Discontinuation of compression garments in % patients
Gupta et al. [6]	349	PL and SL all UE		LVA	average: 21.8months; range: 6 months– –8 years	average: 88.1	average: 81.6	35% of patients were able to discontinue; 65% unknown
Verhey et al. [7]	1030	PL and SL all LE		LVA (with or without conservative treatment)	average: 13.9 months range: 6–37.5 months	average: 82.76	96.8	
Thomas et al. [53]	150	101 UE 49 LE	ISL stage 0: 2 ISL stage I: 27 ISL stage IIa: 49 ISL stage IIB: 73	LVA	24 months	CRR: UE: 0% difference LE: +1% perimeter difference: UE: +2% LE: +2% occurrence of cellulitis episodes: 4.22 (pre-OP) to 0.31 (post-OP)	EQ-5D-L index: 0.74 (pre-OP) to 0.80 (post-OP) health score: 74.07 (pre-OP) to 78.75 (post-OP)	No. of days/week: 6.23d to 4.99d number of h/day: 14.45h to 11.27h - UE: 13.97h/d to 10.61h/d - LE: 15.42h/d to 12.78h/d
Kim et al. [50]	1	chylothorax, lymphedema in face & extremities		LVA, bilateral lymph node vascular anastomosis		100	100	
Scaglioni et al. [48]	8	1 PL & LE, 6 SL & LE, 1 SL & UE	2× Campisi stage II 4× Campisi stage III 2× Campisi stage IV	deep lymphatic vessel LVA	9 months	100	100	100
Scaglioni et al. [47]	1	LE, prophylactic	prophylaxis	LVA	7 months	100	100	
Mihara et al. [51]	1	SL LE	ISL stage IIb	LVA with conservative treatment	6 months	100	100 no more cellulitis episodes	none
Giacalone and Yamamoto[45]	1	SL breast	ISL stage IIb	LVA	1 year	100	100 no more cellulitis episodes	100

CRR – circumference reduction rate, DIEP/MS-TRAM – deep inferior epigastric artery perforator or muscle sparing tram, DIEP-VILN flap – deep inferior epigastric artery perforator flap with vascularized inguinal lymph nodes, EQ-5D-5L – quality-of-life tool, IC-VLN flap – ileocecal vascularized lymph node, LE – lower extremity, LEL – lower extremity lymphedema, LN – lymph node, LND – lymph node dissection, LVA – lymphovenous anastomosis, O-FAFF – omental fat- augmented free flap, PL – primary lymphedema, post-OP – postoperative, pre-OP – preoperative, SAL – combined suction-assisted lipectomy, SL – secondary lymphedema, TAP-VLNT – thoracodorsal artery perforator LN flap, UE – upper extremity, UEL – upper extremity lymphedema, VLNT – vascularized lymph node transfer, VGLNT – vascularized groin lymph node transfer, VSLNT – vascularized supraclavicular lymph node transfer, VTLNT – vascularized thoracic lymph node transfer

duration of lymphedema prior to the treatment was 5.1 years. The objective measurements taken were circumferential limb measurements, magnetic resonance volumetry, body weight, body composition analysis, perimeter limb volumetry, bioelectrical impedance, CT measurement of subcutaneous fat thickness, lymphoscintigraphy, ICG-L and the LEL index. Objective improvements in lymphedema ranging from 23.3 to 100% were noted in 68 studies [7].

Thomas et al. contributed with a case series of 150 patients with unilateral upper (67%) or lower (33%) limb lymphedema with a follow-up of 24 months. The objective measurements included the quality-of-life tool (EQ5D5L), circumferential measurements, compression garment usage and occurrence of cellulitis. Subjective measurements included patient-reported outcomes. The patients were all treated with LVA. The circumferential measurements did not show statistically relevant reduction, but the lymphedema staging changed: from preoperative 49% in stage IIb, it reduced to 26%. Stage IIa was reduced from 33 to 27%, stage I increased from 17 to 19% and stage 0 increased from 1 to 28%. The utilisation of compression garments partially decreased in the number of hours per week from 101.17 to 78.9 and the number of days per week from 6.23 to 4.99. The occurrence of cellulitis changed from 4.22 episodes to 0.31 postoperatively as did the need for hospitalisation due to cellulitis and therefore the economic burden. The EQ5D5L index increased from 0.74 to 0.80 as well as the overall health score from 74.07 to 78.75 (out of 100). Subjectively patient reported outcome measures, as pain, heaviness, anxiety, etc., decreased as well, implicating significant improvement in the quality of life [53].

Kim et al. presented a case report of a 3-year-old male patient with iatrogenic chylothorax which appeared after an obstruction of the thoracic duct leading to chyle leakage into the thoracic cavity and lymphedema in the extremities and the face. Congenital chylothorax would be treated with a thoracic duct to a venule anastomosis [54,55]. However, the case of Kim et al. was the first documented case report of iatrogenic chylothorax in a child treated with LVA to superficial veins and bilateral lymph node vascular anastomosis draining the abdomen. The outcome was satisfying for the patient with remarkable reduced lymphedema and absent chylothorax [50].

Koshima et al. discussed the effect of pregnancy on lower limb lymphedema, previously treated with multiple LVA. The case series describes five patients with five affected limbs, suffering from primary and secondary lymphedema. Out of these patients, four of them showed complete or near-complete functional recovery with improvement of symptoms after pregnancy. One of the patients needed continued compression therapy. A physiological pregnancy is correlated with limb edema, but did not worsen pre-existing lymphedema in patients post-LVA [46].

Scaglioni et al. contributed with two case series. The first described eight patients with one upper limb and seven lower limbs affected. All the patients were previously unsuccessfully treated with superficial LVAs and therefore a combination with deep LVA was indicated. Two cases were classified with Campisi stage II, four with stage III, two with stage IV. Subjective and objective improvement of the lymphedema was seen in all the patients. They were all able to discontinue the use of their compression garments [48]. Their second case report presents a prophylactic LVA in a 67-year-old female patient with a resected leiomyosarcoma in the thigh. The tissue defect was filled with a superficial circumflex iliac artery perforator (SCIP) flap. To prevent a secondary lymphedema, a prophylactic LVA was indicated. At 7 months of the follow-up, the patient did not show any signs of lymphedema [47].

Mihara et al. described a case report of a 67-year-old female patient with severe bilateral lower limb lymphedema and recurrent cellulitis treated with multiple LVA with an average of 3.25 anastomosis who was indicated to continue the use of compression garments and physiotherapy after the surgery. A 6-month follow-up showed a reduced edema of both legs, without recurrence of lymphorrhea and cellulitis episodes [51].

Giacalone and Yamamoto presented a case report of a 55-year-old female patient with secondary breast-cancer related lymphedema of the affected breast with recurrent cellulitis episodes treated with LVA with three anastomoses. The 1-year follow-up showed the absence of edema and cellulitis episodes. The patient was not indicated for any following conservative treatment [45].

Discussion

In this paper, the up-to-date surgeries of choice for the treatment of lymphedema are discussed and their outcomes are compared – LVA and VLNT. For the correct indication, it is essential to properly select the most suitable procedure to achieve the best possible outcome for the patient.

Regarding VLNT, the focus is on selection of well vascularized tissue containing LN and reduction of the incidence of complications such as necrosis of the transfer tissue and iatrogenic lymphedema of the harvest site. Therefore, it is required to choose the correct donor site. Preoperatively, we must describe the quality of the lymphatic system and perform lymphatic mapping to localise sentinel LN and avoid its harvesting. The examination can be done with doppler sonography, scintigraphy, ICG-L and MRL [56,57]. Dayan et al. proposed the use of a gamma probe to directly localise sentinel LN during the procedure. The intraoperative use of ICG-L or fluorescein sodium is suggested by Kim et al. to identify the functioning lymphatics in VLNT and LVA [50].

The different types of flaps in VLNT used in the previously stated studies were mainly omental flaps, parascapular flaps, latissimus dorsi flap, supraclavicular artery island flaps and submental flaps. The omental flaps had several modifications, as in O-FAFF, DIEP/MS-TRAM, DIEP-VILN flap, containing appendicular LN, ileocecal LN and inguinal LN. The harvesting was done via open surgery or laparoscopic surgery. Following the results, the main advantage emerged to be a lack of secondary edema, while the main disadvantage of the abovementioned flaps was the necessity of an abdominal surgery [17,19,36,37,41,43,44]. Pre-expanded-parascapular flaps for TAP-VLNT, latissimus dorsi flaps with axillary LN and supraclavicular LNT are also used quite frequently [38–40, 58,59]. Mazerolle et al. stated that the submental free flap may be the most reliable, associated with the lowest flap morbidity [42].

A positive predictive factor of the outcomes of VLNT is the quantity of transferred LN. Gustafsson et al. investigated the number of transferred LN with the objective result. In their study, 35 patients with comparable grading of lymphedema of their lower limbs were divided into three different groups according to the amount of postoperatively determined LNs in the transferred flap. Group A contained 1–2 LN, group B 3–4 LN and group C 5–6 LN. Groups B and C showed significantly higher improvement than group A. Nevertheless, there was no significant difference between the outcome of group B and C. In conclusion, the flaps with three or more LN statistically showed a greater improvement compared to flaps with fewer LN. Therefore, the selection and previous examination of the harvest site is of great importance [60].

A negative predictive factor is the presence of concomitant vascular lesions in patients treated with VLNT. Sachanandi et al. contributed with a study of patients with lymphedema and concomitant vascular disease and proposed two recommendations for the treatment plan. If possible, preoperative angioplasty intervention should be performed at least 6 months prior to the planned VLNT to optimize the results of VLNT. In case of concurrent known venous disease during the treatment with VLNT, postoperative systemic heparin therapy is indicated with the aim for an aPTT value 1.5 times multiple of the reference range [61]. Long-term compression therapy might increase the propensity to develop venous thrombosis due to long standing venous hypertension or from changes in the blood flow [61]. This thesis was also confirmed by Rooks et al.'s experimental free flap that proved a correlation of venous hypertension with free flap failure [62]. Szuba et al. supported the recommendation for preoperative angio-intervention due to the synergy of venous malfunction and lymphatic dysfunction. They therefore suggest performing a CT-angiography (CT-A) to diagnose vascular lesions before the treatment of lymphedema. In case of the absence of improvement after VLNT, CT-A is also indicated [61,63].

An increased BMI is a negative predictive factor in the treatment with LVA as it shows the risk of exacerbating lymphedema and an increase in subcutaneous fibrotic processes. As reported by Yoshida et al., the lymphatics of obese patients are positioned deeper in the thigh than in non-obese patients and the surgery outcome is slightly better in non-obese patients. For this reason, patients should be advised to maintain a healthy BMI prior to the surgery [26,53].

Different anastomotic configurations are possible in LVA and promise different outcomes. The most described ones are end-to-side (ES), end-to-end (EE), side-to-side (SS) and side-to-end (SE), in which the first position represents the lymph vessel, and the latter represents the vein. For example, in the end-to-side arrangement, the end of the lymph vessel is anastomosed to the side of the recipient vein [7]. Due to the patients' unique anatomy and individual lymphovascular network, anastomotic configurations are limited by the available vessel and the surgeon is often forced to improvise during the ongoing surgery [7]. Yamamoto et al. and Narushima et al. both described an intravascular stenting-method to facilitate performing an anastomosis and decrease the risk of iatrogenic damage to the vessel lumen. Another proposed method is the "parachute-technique", which promotes a greater visibility of the lymph vessel [64,65].

Another variable in LVA is the number and placement of anastomoses. Hayashi et al. compared the result of a re-LVA in primary LE limb lymphedema in two groups – anastomosis of the medial and anterior side and anastomosis of the posterior side of the leg. The first surgery was medial and anterior side LVA in all 26 patients. The average number of total anastomoses during both surgeries was 5–12, including 2–5 LVA in the posterior side group and average of 4.6 in the anterior-medial side group. According to the LEL-index, the post-operative volume reductions after the re-LVA in the posterior side group and in the anterior-medial side group were 10.5 (± 4.5) and 5.5 (± 3.6), respectively. LVA on the posterior side resulted in further improvement of the lymphedema with fewer number of anastomoses [66]. Further studies may be necessary to confirm the better outcomes of multiple locations of anastomoses around the limb, also in the treatment of secondary lymphedema and UE lymphedema.

Primary prevention for secondary lymphedema, especially cancer-related lymphedema, is described as immediate lymphatic reconstruction (ILR). In ILR, LVA is performed at the same time as LND to ensure the lymphatic drainage and to avoid the development of lymphedema [13,67]. Johnson et al. reported a significant decrease in UE lymphedema incidence of over 20% in

patients who underwent ALND with ILR, compared to patients undergoing ALND without ILR [68]. A similar result of a 16% decrease in the incidence was described by Ozmen et al. [6,69].

Comparing the procedures of LVA and VLNT directly, advantages and disadvantages can be found in both surgeries. The major disadvantage of VLNT appeared to be comparably longer hospital stay with longer operation time, the risk of flap failure and the risk of donor site morbidity, as already previously discussed [39]. According to the study of Akita et al., the mean surgery duration for lower limb lymphedema of LVA was 213min (± 68 min) and 414min (± 65min) for VLNT. During the LVA procedure, there was the possibility of performing the procedure in local anaesthesia; however, general anaesthesia was the only type of anaesthesia used in VLNT. Lastly, the mean hospital stay for patients with LVA was 8.9 (± 2.9) days, while VLNT patients had to stay 15.2 (± 1.6) days [39].

Cheng et al. proposed that VLNT shows greater improvement of lymphedema then LVA in patients with advanced stage of lymphedema, as the lymph vessels become more sclerotic [70]. The findings of Akita et al. are consistent with this theory [39]. Verhey et al. added that LVA is more effective in low stage lymphedema with a short period of symptoms [7]. Sachanandi et al. furthermore implicated that LVA is indicated, when the patency of lymphatic vessels is apparent. VLNT is indicated, when there is dermal backflow, due to non-patency of the lymphatics, such as obstruction. This stresses the importance of preoperative thoroughly examination of the lymphatic status, as the same clinical stage can present with different quality of lymph vessel [6,19,61].

A protocol of combined surgical treatments is proposed by Di Taranto et al. In their prospective study, they introduced 37 patients with secondary LE lymphedema ranging from ISL stage II to stage III. The patients were divided into two groups. The first group was treated with VLNT followed by suction lipectomy (SUL) after 2 weeks, the second one was treated with VLNT and LVA followed by SUL. For all the patients, the VLNT of choice was the gastroepiploic VLNT with omental flap. The SUL was performed extensively with the sparing of the previous surgery sites. Both groups showed improvement in their follow-up, the second group scored a greater circumference reduction rate which was not statistical relevant. In both groups, the tonicity reduced, and the episodes of cellulitis decreased significantly. Di Taranto et al. emphasize that they cannot state, which procedure was more responsible for the positive outcomes, therefore more studies will be necessary. They hypothesize that the following treatment of SUL could help to reduce the lymphatic load on the limb [19].

The treatment plan should also include the postoperative therapy for the patient. In their study, Shimbo et al. stated that the effect of LVA patency decreased to 75% at 12 months and to 36% at 24 months. Consequently, they indicated the use of compression garments at the third day after LVA surgery. A total of 20.7% of their patients discontinued the compression therapy on their own judgement at 24 months postoperatively [71]. They also stressed the result of other studies, while they reported a discontinuation rate after LVA for UE lymphedema from 34 to 85% [52,72,73]. A similar result was also found in our case reviews (Tab. 1). Nevertheless, Shimbo et al. expressed concern that advising patients to discontinue compression garments usage may be inappropriate due to the risk of recurrence of lymphedema [71]. Mihara et al. consider the positive effect of combined treatment of limb lymphedema with LVA followed by conservative decongestive therapy, as manual massages. They emphasized starting manual lymph drainage massages 3 weeks post-surgery, to avoid sheer stress possibly injuring the surgical wound and the anastomoses. However, immediate combined therapy leads to improved patency of the anastomosis and promote efficient lymph circulation, as shown in their study. They introduced the utilisation of a cosmetic roller for immediate conservative decongestive therapy after LVA, which will introduce a vertical force on the body and produces only small shear stress [51]. It should be examined, if this method will also optimize the results of VLNT.

Conclusion

VLNT and LVA are the physiological procedures of choice for surgical lymphedema correction. The decision for either one or another procedure should be considered for each patient individually. The comorbidities must be taken into consideration, too. The most crucial element is the preoperative examination of the lymphatics. It should be done thoroughly and if patency of the lymph vessels is present and dermal backflow absent, LVA should be preferred. The possibility of a multi-modal approach should be explored as well. Combining various procedures with an appropriate post-operative care might be an effective treatment strategy.

Availability of data and materials

The data underlying this article will be shared on reasonable request to the corresponding author.

Competing interests

The authors declare that they have no competing interests.

Roles of the authors

Svenja Theiner – first author, author of study design, major contributor in writing the manuscript, organizing the study and data assessment; Mária Lacková – co-author of study design, contributor in writing and editing the manuscript, corresponding author; Raffaele Russo – contributor in writing and editing the manuscript, organizing the study; Zdeněk Dvořák – contributor in writing the manuscript, organizing the study and data assessment; Břetislav Lipový – contributor in writing and editing the manuscript; Martin Knoz – contributor in writing and editing the manuscript.

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Landmarks in facial reanimation – a bibliometric analysis of the 50 most cited papers in dynamic facial reconstruction

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Summary

Background: Advances in the field of facial reanimation surgery have resulted in an increase in the quantity of published research in the international literature. The aim of this work is to provide the reader a synthesized view of the most influential themes, articles and authors in this field. **Material and methods:** We searched the Clarivate Analytics Web of Science Citation Index to identify the 50 most cited papers in dynamic facial reanimation in the past 70 years. Data regarding article title, authors, year of publication, total citations and citation index was obtained. Results are presented using descriptive statistics. **Results:** The most cited articles were distributed in 16 journals. Plastic and Reconstructive Surgery had the highest number of highly cited works with 27 articles, followed by JPRAS (5 papers) and the Journal of Neurosurgery (4 papers). The United States contributed most (17 papers), followed by Canada and Japan (6 each). Dr. Julia K. Terzis was the most cited author (7 works). Case series and comparative studies were the most prevalent type of article published (96%) from 1953 to 2015. The most cited paper focused on free functional muscle transfer (FFMT). Most articles were level IV research, with a mean citation index of 5.27 ± 2.85. **Conclusion:** This collection offers a clear overview of the key milestones and advancements in the field. We expect it serves as a practical resource for clinicians and researchers striving to advance the science and practice of facial reanimation surgery.

Key words

facial paralysis – facial nerve – facial reanimation – free functional muscle transfer – nerve transfer – nerve graft – nerve repair – bibliometry

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Introduction

Facial palsy is a profoundly disabling condition that negatively affects multiple aspects of a patient's life, including interpersonal communication, ocular protection, nasal airflow, and self-image [1,2]. Historical records document clinical observations of facial palsy in ancient times, but it was not until Charles Bell's seminal description of the seventh cranial nerve that the underlying pathology of this condition began to be understood [3].

In the late 19th century, numerous surgeons developed static procedures to restore facial symmetry at rest; however, achieving effective facial reanimation remained largely elusive. At the beginning of the 20th century, procedures such as temporalis muscle transfer gained popularity. Yet, it was the advent of the surgical microscope in the latter half of the century that revolutionized the field. This breakthrough enabled surgeons to perform precise nerve repairs and free muscle transfers, marking a pivotal moment in the evolution of facial reanimation surgery. This progress sparked a surge of interest in the field and led to a proliferation of scholarly publications [4–6].

Citation analysis is an established bibliometric method that catalogs research papers based on the number of times they have been referenced. This type of study provides an index of the most influential themes, articles, and authors within a field [7]. Moreover, citation analyses are valuable for identifying "classic" or seminal publications within medical specialties [8].

While citation analyses have been conducted in various subfields of plastic surgery, such as craniofacial surgery and microsurgery, few efforts have been made to define the most influential literature in the field of facial reanimation [9–11]. Therefore, the objective of this work is to identify and analyze the

50 most-cited articles in facial reanimation surgery over the past 70 years.

Methods

A literature search was performed using Clarivate Analytics' Web of Science Citation Index (SCI) to identify the 50 most cited articles related to facial reanimation surgery published between 1950 and 2022 [15–64]. The database was accessed in October 2023. Search filter terms included: facial nerve, facial paralysis, facial palsy, facial nerve reconstruction, and facial reanimation.

The authors browsed through all the titles and abstracts to ensure that articles referring exclusively to facial reanimation procedures were included. Only original research articles were included; review articles or editorials were excluded.

Each article was examined for its number of citations, authors, study design (case series, cohort studies, randomized control trials, reviews), level of evidence as described by the Oxford Centre for Evidence-based Medicine, type of procedure (nerve repair, cross face nerve grafts, nerve transfers, functional muscle transfers), year of publication, citation index (number of times cited / years since publication), journal's impact factor and country of origin.

All data was entered into a Microsoft Excel spreadsheet. Descriptive statistics were employed for analysis. Continuous variables are expressed in central tendency measures, and categorical values are presented as percentages.

Results

The 50 most cited papers in facial reanimation surgery accumulated a total of 5,660 citations, with individual citations counts ranging from 65 to 516 (mean 113.2 ± 72.32). The average number of years since publication were 25.52 ± 13.69, and the mean citation index was 5.27 ± 2.85. The earliest publication dated back to 1953, while the most recent one was published in 2015 (Tab. 1).

The most cited paper was "Free gracilis muscle transplantation, with mi-

Tab. 1. Fifty most cited papers in facial reanimation surgery.

Ranking	Title	Author	Country	Affiliation	Relevance
1	Free gracilis muscle transplantation, with microneurovascular anastomoses for the treatment of facial paralysis. A preliminary report	K. Harii	Japan	Tokyo Metropolitan Police Hospital, Fujimi, Chiyoda-ku Tokyo, Japan	Proved that microvascular techniques could deliver reliable results and recreate a spontaneous and symmetrical smile
2	Hypoglossal-facial nerve interpositional-jump graft for facial reanimation without tongue atrophy	M. May	USA	University of Pittsburgh School of Medicine, PA, USA	Great reduction in morbidity and facial mass-movements with use of the hypoglossal nerve as donor
3	Smile reconstruction in adults with free muscle transfer innervated by the masseter motor nerve: effectiveness and cerebral adaptation	R. T. Manktelow	Canada	Toronto General Hospital, Hospital for Sick Children and Toronto Western Hospital, University Health Network, Canada	Popularized the nerve-to-masseter as a donor and showed cortical readaptation is possible when using an extrafacial donor nerve for smile restoration
4	Analysis of 100 cases of free-muscle transplantation for facial paralysis	J. K. Terzis	USA	Eastern Virginia Medical School, Norfolk, VA, USA	One of the first large series on free flap facial reanimation, showing positive outcomes and few complications
5	Hypoglossal–facial nerve anastomosis for reinnervation of the paralyzed face	J. Conley	USA	St. Vincent´s Hospital and Medical Center, Manhattan, NY, USA	Described one of the first reliable and reproducible strategies for facial reinnervation
6	One-stage transfer of the latissimus dorsi muscle for reanimation of a paralyzed face: a new alternative	K. Harii	Japan	University of Tokyo, Graduate School of Medicine, Toykyo, Japan	Provided a single-stage alternative to the gracilis muscle transfer
7	Cross-facial nerve grafts and microneurovascular free muscle transfer for long established facial palsy	B. M. O'Brien	Australia	St. Vincent's Hospital, Melbourne, Australia	Established the classical two-stage reconstruction for gracilis muscle transfer

Tab. 1 – continuing. Fifty most cited papers in facial reanimation surgery.

Ranking	Title	Author	Country	Affiliation	Relevance
8	A comparison of commissure excursion following gracilis muscle transplantation for facial paralysis using a cross-face nerve graft versus the motor nerve to the masseter nerve	Y.-C. Bae	Canada	Hospital for Sick Children, Toronto, Ontario, Canada	First comparison between two reinnervation strategies for FFMT, showing equivalent results between them
9	The "Babysitter" Procedure: minihypoglossal to facial nerve transfer and cross-facial nerve grafting	J. K. Terzis	USA	Eastern Virginia Medical School, Norfolk, VA, USA	Bridged immediate functional recovery with long-term dynamic facial reanimation, setting a benchmark for staged facial nerve repair
10	Facial animation in children with Moebius syndrome after segmental gracilis muscle transplant	R. M. Zuker	Canada	Hospital for Sick Children; and the University of Toronto, Canada	One of the first series presenting postop results of patients with Moebius syndrome who underwent gracilis transfer
11	Lengthening temporalis myoplasty and lip reanimation	D. Labbé	France	Caen University Hospital, France	Modified the classical temporalis transfer to improve smile excursion and reduce bulk
12	Pectoralis minor: a unique muscle for correction of facial palsy	J. K. Terzis	USA	Eastern Virginia Medical School, Norfolk, VA, USA	Presented an early alternative for FFMT
13	Results of management of facial palsy with microvascular free-muscle transfer	B. M. O'Brien	Australia	St. Vincent's Hospital, Melbourne, Australia	Established FFMT as a gold standard for facial reanimation in long-standing paralysis cases
14	The pectoralis minor vascularized muscle graft for the treatment of unilateral facial palsy	D. H. Harrison	UK	Mount Vernon Hospital, Northwick Park Hospital, Edgware General Hospital and Barnet General Hospital, UK	Introduced the pectoralis minor as a reliable option for facial reanimation
15	Masseteric-facial nerve coaptation – an alternative technique for facial nerve reinnervation	C. J. Coombs	Australia	Royal Children's Hospital, Flemington Road, Parkville, Melbourne, Victoria, Australia	Introduced the masseteric-facial nerve coaptation as an effective alternative for facial nerve reinnervation
16	Facial reanimation using the masseter-to-facial nerve transfer	M. J. A. Klebuc	USA	Institute for Reconstructive Surgery, The Methodist Hospital, Houston, TX, USA	Further refined the use of the masseter-to-facial nerve transfer as a successful method for facial reanimation
17	Surgical support in permanent facial paralysis	C. R. Mc Laughlin	UK	Queen Victoria Hospital, East Grinstead, UK	One of the first large series focused on the integral management of patients with facial palsy, with static and dynamic procedures
18	Hemihypoglossal-facial nerve anastomosis in treating unilateral facial palsy after acoustic neurinoma resection	H. Arai	Japan	Juntendo University, Tokyo, Japan	Introduced a technique to reduce morbidity after hypoglossal nerve transfer
19	A new technique for hypoglossal-facial nerve repair	M. D. Atlas	Australia	St. Vincent's Hospital, Sydney, Australia	Introduced the concept of suturing the facial nerve to the hypoglossal to reduce tongue morbidity
20	The motor nerve to the masseter muscle: an anatomic and histomorphometric study to facilitate its use in facial reanimation	G. H. Borschel	Canada	Hospital for Sick Children; and the University of Toronto, Canada	Described a detailed assessment on the gross and microscopic anatomy of the nerve-to-masseter and described a reliable method for locating the nerve

Tab. 1 – continuing. Fifty most cited papers in facial reanimation surgery.

Ranking	Title	Author	Country	Affiliation	Relevance
21	Hypoglossal-facial nerve side-to-end anastomosis for preservation of hypoglossal function: results of delayed treatment with a new technique	Y. Sawamura	Japan	University of Hokkaido, School of Medicine, Sapporo, Japan	Initial description of the hemy-hipoglossal nerve transfer
22	Reconstruction of the face through cross-face-nerve transplantation in facial paralysis	H. Anderl	Austria	University Hospital, Innsbruck, Austria	First report of a cross-face nerve graft
23	Cross-face nerve graft with free-muscle transfer for reanimation of the paralyzed face: a comparative study of the single-stage and two-stage procedures	P. A.Vinod Kumar	Egypt	Whiston Hospital, Prescot, Liverpool, UK	Challenged the classical notion that gracilis muscle transfer has to be done in two stages for unilateral facial palsy
24	A new technique to correct facial paralysis	G. Freilinger	Austria	Vienna University Medical School, Vienna, Austria	First report of a CFNG used to reinnervate a muscle flap for facial reanimation
25	Postoperative functional evaluation of different reanimation techniques for facial nerve repair	O. Guntinas-Lichius	Germany	University of Cologne, Koeln, Germany	Analyzes the functional outcome of the mimic musculature after different types of facial nerve reanimation in consideration of electrophysiological data
26	Cortical adaptation to restoration of smiling after free muscle transfer innervated by the nerve to the masseter	S. D. Lifchez	USA	Medical College of Wisconsin, USA	Landmark in demonstrating the central nervous system's role in adapting to peripheral nerve transfers for facial reanimation in children with Moebius syndrome
27	The degree of facial movement following microvascular muscle transfer in pediatric facial reanimation depends on donor motor nerve axonal density	A. K. Snyder-Warwick	Canada	Washington University, School of Medicine, St. Louis, MO, USA	Highlights the importance of nerve quality in achieving successful functional restoration
28	Objective outcomes analysis following microvascular gracilis transfer for facial reanimation a review of 10 years' experience	P. K. Bhama	USA	Harvard Medical School, Massachusetts Eye and Ear Infirmary, Boston, MA, USA	Presents an analysis on the long-term effectiveness of microvascular gracilis transfer, providing an insight on the possible areas of improvement
29	Microsurgical strategies in 74 patients for restoration of dynamic depressor muscle mechanism: a neglected target in facial reanimation	J. K. Terzis	USA	Eastern Virginia Medical School, Norfolk, VA, USA	Highlights the importance of addressing the lower lip in facial reanimation
30	Reanimation of the paralyzed face by indirect hypoglossal-facial nerve anastomosis	J. J. Manni	Holland	University of Maastricht, Maastricht, the Netherlands	Showcases an alternative method to restore facial movement in patients with facial paralysis and provides insights into effective surgical strategies for reinnervation
31	Masseter muscle rotation in the treatment of inferior facial paralysis. Anatomical and clinical observations	P. De Castro Correia	Brazil	Hospital dos Defeitos da Face; and the São Paulo University Medical School, Brazil	Addresses the use of the masseter muscle as a regional donor for facial reanimation

Tab. 1 – continuing. Fifty most cited papers in facial reanimation surgery.

Ranking	Title	Author	Country	Affiliation	Relevance
32	Free rectus femoris muscle transfer for one-stage reconstruction of established facial paralysis	I. Koshima	Japan	Kawasaki Medical School, Okayama, Japan	Presents a surgical approach that reduces the need for multiple procedures in patients with long-standing facial paralysis
33	Temporalis tendon transfer as part of a comprehensive approach to facial reanimation	P. J. Byrne	USA	The Johns Hopkins University School of Medicine, Baltimore, MD, USA	Highlights the potential benefits and limitations of temporalis tendon transfer alongside other established techniques for facial reanimation
34	Paralysis of the marginal mandibular branch of the facial nerve: treatment options	P. Tulley	UK	Raft Institute of Plastic Surgery, Mount Vernon Hospital, Northwood, UK; Bowen Hospital, Wellington, New Zealand	Discusses treatment options for paralysis of the marginal mandibular branch of the facial nerve, focusing on surgical approaches to restore both function and appearance
35	Surgical anatomy for direct hypoglossal-facial nerve side-to-end "anastomosis"	K. Asaoka	Japan	Hokkaido University Graduate School of Medicine, Sapporo, Japan	Explores the surgical anatomy for direct hypoglossal-facial nerve anastomosis, highlighting its viability and technique for effective facial nerve repair
36	Hypoglossal-facial nerve anastomosis for facial nerve palsy following surgery for cerebellopontine angle tumors	L. F. Pitty	Canada	Toronto Western Division, Toronto Hospital, University of Toronto, Canada	Examines hypoglossal-facial nerve anastomosis as an effective treatment for facial nerve palsy following cerebellopontine angle tumor surgery
37	Treatment of facial paralysis: dynamic reanimation of spontaneous facial expression-apropos of 655 patients	J. Gousheh	Iran	Shahid Beheshti University of Med Sciences, Tehran, Iran	Large series on facial reanimation comparing multiple techniques and showcasing their outcomes
38	A comparison of surgical techniques used in dynamic reanimation of the paralyzed face	T. H. Malik	UK	Manchester Royal Infirmary, Manchester, UK	Comparison of outcomes between direct nerve repair, grafting and hypoglossal nerve transfer
39	Double innervation in free-flap surgery for long-standing facial paralysis	F. Biglioli	Italy	San Paolo Hospital, Università degli Studi di Milano, Milan, Italy	The first report combining two neural sources for the reinnervation of a gracilis muscle flap
40	Dynamic reconstruction of eye closure by muscle transposition or functional muscle transplantation in facial palsy	M. Frey	Austria	Medical University of Vienna, Austria	Explores dynamic reconstruction techniques for eye closure in facial palsy, comparing muscle transposition and functional muscle transplantation, offering insights into effective solutions for improving eye function in affected patients
41	Facial reanimation with jump interpositional graft hypoglossal facial anastomosis and hypoglossal facial anastomosis: evolution in management of facial paralysis	P. E. Hammerschlag	USA	New York University Medical Center, NY, USA	Describes the evolution, advantages and disadvantages of different modalities of hypoglossal nerve transfer
42	Quality-of-life improvement after free gracilis muscle transfer for smile restoration in patients with facial paralysis	R. W. Lindsay	USA	Massachusetts Eye and Ear Infirmary and Harvard Medical School, Boston, MA, USA	Demonstrates the significant quality-of-life improvement in patients with facial paralysis following free gracilis muscle transfer for smile restoration

Tab. 1 – continuing. Fifty most cited papers in facial reanimation surgery.

Ranking	Title	Author	Country	Affiliation	Relevance
43	Nerve sources for facial reanimation with muscle transplant in patients with unilateral facial palsy – clinical analysis of 3 techniques	J. C. M. Faria	Brazil	Hospital das Clinicas, Sao Paulo, Brazil	Analyzes three nerve sources for facial reanimation using muscle transplant in patients with unilateral facial palsy
44	Efficacy of the "baby-sitter" procedure after prolonged denervation	B. Mersa	USA	Eastern Virginia Medical School, Microsurgical Research Center, Norfolk, VA, USA	Delivered evidence that demonstrated that the babysitter procedure is an effective reinnervation method in longstanding facial palsy
45	Transplantation of free autogenous muscle in the treatment of facial paralysis: a clinical study	L. Hakelius	Sweden	University Hospital, Uppsala, Sweden	Explores the use of free autogenous muscle transplantation in treating facial paralysis, providing clinical evidence on its effectiveness in restoring facial function and improving the outcomes
46	Facial reanimation with gracilis muscle transfer neurotized to cross-facial nerve graft versus masseteric nerve: a comparative study using the FACIAL CLIMA evaluating system	B. Hontanilla	Spain	Clinica Universidad de Navarra, Spain	Compared different donor nerves for FFMT and reports results using an objective scale
47	Dynamic restoration in Moebius and Moebius-like patients	J. K. Terzis	USA	Eastern Virginia Medical School, Norfolk, VA, USA	Evaluates dynamic restoration techniques for patients with Moebius syndrome and Moebius-like condition, offering valuable information on providing facial movement and expression in patients with congenital facial paralysis
48	Long-term outcomes of free-muscle transfer for smile restoration in adults	J. K. Terzis	USA	Eastern Virginia Medical School, Norfolk, VA, USA	Highlights that microsurgical flaps are useful and safe for facial reanimation in adults
49	Anastomosis of masseteric nerve to lower division of facial nerve for correction of lower facial paralysis. Preliminary report	M. Spira	USA	Baylor College of Medicine, USA	Presents preliminary report on the anastomosis of the masseteric nerve to the lower division of the facial nerve as a technique for correcting lower facial paralysis, providing early insights into its potential effectiveness in improving facial function
50	Free gracilis transfer for smile in children. The Massachusetts eye and ear infirmary experience in excursion and quality-of-life changes	T. A. Hadlock	USA	Massachusetts Eye and Ear Infirmary, Boston, MA, USA	Emphasizing improvements in facial movement and quality of life after FFMT

CFNG – cross facial nerve graft, FFMT – free functional muscle transfer

croneurovascular anastomoses for the treatment of facial paralysis. A preliminary report". With this article from 1976, Dr. Harii's group revolutionized the field of facial reanimation by showing that microvascular techniques could deliver reliable results and recreate a spontaneous and symmetrical smile, laying the foundation for multiple innovations and

Tab. 2. Top five most cited authors.

Ranking	Title	Number of entities	Affiliation
1	J. K. Terzis	7	International Institute of Reconstructive Microsurgery, Norfolk, VA, USA
2	R. M. Zuker	5	The Hospital for Sick Children and the University of Toronto, Ontario, Canada
3	R. T. Manktelow	3	Toronto General Hospital, Hospital for Sick Children and Toronto Western Hospital, University Health Network, Canada
4	T. A. Hadlock	3	Massachusetts Eye and Ear Infirmary, Boston, MA, USA
5	K. Harii	2	University of Tokyo, Graduate School of Medicine, Tokyo, Japan

refinements in years to come. This landmark study remains a cornerstone in reconstructive microsurgery and plastic surgery as a specialty.

The article with the highest citation index was "Smile reconstruction in adults with free muscle transfer innervated by the masseter motor nerve: Effectiveness and cerebral adaptation" by Manktelow et al. (SCI 12.3) [17]. The study highlighted that the masseteric nerve's anatomical location and axonal count make it a reliable and powerful donor for smile restoration. Furthermore, the article delves into the concept of cerebral adaptation, emphasizing the brain's ability to rewire motor pathways to integrate the masseter nerve into facial expressions (Tab. 2).

The articles were published across 16 different journals, with Plastic and Reconstructive Surgery leading with 27 articles (54%), followed by JPRAS/British Journal of Plastic Surgery with 5 papers (10%) and the Journal of Neurosurgery with 4 articles (8%). A total of 16 countries contributed to the top 50 articles, with the USA contributing the most (N = 17, 34%), followed by Canada and Japan with 6 papers each (12%).

There were 126 different authors involved in the 50 articles, with 19 authors contributing with more than a single article. Dr. Julia K. Terzis was the most cited author with 7 works included in the list, she was followed by Dr. Ronald M. Zuker with 5 citations and Dr. Ralph T. Manktelow with 5 entries as well.

The subjects of the articles were mostly focused on free functional muscle transfers (N = 22, 44%) and nerve transfers (N = 20, 40%). Regional muscle transfers (N = 6, 12%), cross-facial nerve grafts (N = 4, 8%), direct nerve repairs (N = 2, 4%) and nerve grafting 2% (N = 1, 2%) were the subjects of the remaining articles.

Regarding article type, the vast majority were case series 70% (N = 35), followed by comparative studies 26% (N = 13) and two case reports. The level of evidence of the articles predominantly included level IV research (N = 36, 72%), level III publications (N = 12, 24%), and two articles were of level V.

Discussion

The evolution of facial reanimation surgery over the past seven decades has witnessed remarkable advancements, particularly following the advent of the operating microscope and microsurgical instruments. These breakthroughs resulted in a surge in research interest, fueling the development of diverse surgical techniques and management protocols aimed at restoring facial function and aesthetics [12].

The fields of peripheral nerve and facial reanimation surgery have matured significantly, prompting the quest for identifying "citation classics" – highly cited papers that serve as pivotal reference points within our specialty. Notably, several of these works transcend disciplinary boundaries, emerging as top papers in microsurgery and facial plastic surgery, highlighting the interdisciplinary nature of facial reanimation surgery and its interconnectedness with cooperating medical specialties [11,13].

A previous publication by Boonipat et al. from 2021 analyzed the 50 most cited publications in facial reanimation surgery, offering valuable insights into the field's influential works. However this work did not present a full overview of the evaluated publications, leaving room for further comprehensive evaluation.

Our findings reveal a temporal trend wherein a majority (78%) of the identified classics were published during or after the 1990s. This stands in contrast to the broader field of microsurgery, where seminal publications often originate from the 1970s or 1980s, indicative of the accelerated pace of innovation and knowledge dissemination within facial reanimation surgery in recent decades [14].

Thematic analysis of the top cited articles unveils the dominance of free functional muscle transfers as the preferred technique in 44% of the studies, with the gracilis muscle emerging as the flap of choice for facial reanimation across multiple centers. Additionally, nerve transfers garnered significant attention, encompassing 40% of the analyzed papers, with donor nerves such as the masseter and hypoglossal nerves gaining prominence.

The geographic distribution of the articles shows that the United States con-

tributed with a third of the most cited articles, followed by Canada and Japan with 12% each. While this trend likely reflects the availability of financial resources and robust academic infrastructure in the United States, potential publication bias cannot be discounted, particularly given the predominance of high-impact journals based in the US and "national-citation" bias.

The Plastic and Reconstructive Surgery emerged as the predominant journal in the analysis, holding 54% of the articles and making it a significant platform for spreading impactful research in this field. The prominence of pioneering figures such as Drs. Terzis, Zuker, and Manktelow among the list of authors reaffirms their enduring contributions to facial reanimation surgery, while the inclusion of 123 additional authors underscores the collaborative and ever-evolving nature of our specialty.

This study's design presents certain limitations; first, the reliance on Web of Science as the primary database for citation analysis may lead to bias, and results might vary slightly with the use of alternative databases. On top of that, it must be considered that, while the study reflects the top cited articles in 2023, the dynamic nature of citations implies a constant reshuffling of rankings over time. Despite these limitations, this compilation provides a valuable reference for understanding the historical and scientific evolution of facial reanimation surgery, serving as a comprehensive "must-read" list for both newcomers and seasoned experts in the field.

Conclusion

The compilation of the 50 most cited articles in facial reanimation surgery provides a clear overview of the key milestones and advancements in this field. By identifying these influential works, the study highlights the foundational research that has shaped current practices and offers a framework to guide future investigations. This collection serves as a practical resource for clinicians and researchers striving to advance the science and practice of facial reanimation surgery.

Roles of authors

Jose E. Telich-Tarriba – original idea, project supervision, data analysis, text writing and editing; Alexa Rivera del Río-Hernández – project coordination, data examination, data analysis, text writing and editing; Ricardo Esquiliano-Raya – data retrieval, database construction, text writing; Ximena González-López – data retrieval, database construction, text writing; Cinthya Domínguez Suárez – data retrieval, database construction, text writing.

Conflicts of interest

The authors have no conflicts of interest to disclose. The authors declare that this study has received no financial support. All procedures performed in this study involving human participants were in accordance with ethical standards of the institutional and/or national research committee and with the Helsinki declaration and its later amendments or comparable ethical standards.

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Elevation of vitamin B12 levels attributed to biopolymer implants – a case report

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Summary

A 62-year-old female patient with no relevant medical history presented with elevated vitamin B12 levels, which were incidentally detected during a routine examination. Comprehensive evaluations excluded oncohematological disorders, liver diseases, pulmonary conditions, viral infections, autoimmune disorders, and cardiovascular causes, as well as paradoxical increases in vitamin B12 levels. It was hypothesized that the elevated vitamin B12 levels were related to a chronic inflammatory process, potentially exacerbated by the presence of biopolymers. Given the improvement in symptoms and the risks associated with implant removal, it was decided to proceed with semi-annual clinical monitoring, with surgical intervention considered only if clinical abnormalities or significant changes in imaging were observed.

Key words

silicon – prostheses and implants – vitamin B12 – polymethylsiloxane

Avila Rueda JA, Hurtado-Ortiz A, Licht-Ardila M et al. Elevation of vitamin B12 levels attributed to biopolymer implants – a case report. Acta Chir Plast 2025; 67(1): 64–67.

Introduction

Biopolymers are inert compounds frequently utilized to enhance the volume of specific body areas, such as the buttocks and breasts. Some of these biopolymers are synthetic, often derived from silicone [1]. However, their use can be associated with various complications, including granuloma formation and migration of the material to different parts of the body, which can potentially compromise vital organs [2]. Complications may manifest both locally and systemically [2,3]. Systemic manifestations may include polyarthralgia, myalgia, and cognitive and sleep disorders [3]. Additionally, serum vitamin B12 levels can be altered in association with chronic inflammatory processes, with documented levels exceeding 950 pg/mL [4].

Case presentation

A 62-year-old female patient with no relevant medical history has been reviewed intermittently in hematology since June 2021. The consultation was prompted by an incidental finding of elevated serum vitamin B12 levels during a routine examination performed in the context of musculoskeletal pain, which resolved spontaneously. Upon inquiry, the patient denied taking any supplements or medications containing vitamin B12 and has remained asymptomatic to date. However, the patient reported complaints of pain, edema, and erythema, which were most pronounced between 4 and 12 months following biopolymer infiltration. Currently, pain in the infiltration areas persists, though it is sporadic and occurs primarily when acupressure is applied to these regions. The following studies were conducted, as detailed in Tab. 1.

In July 2022, the patient underwent several examinations, including a mammogram, which showed no pathological findings (BIRADS 1): a contrast-enhanced CT scan of the neck, chest, and abdomen, which also revealed no pathological findings, a complete blood count with no abnormalities, and both a total colonoscopy and upper gastrointestinal endoscopy, which showed no morphological alterations. Additionally, her vitamin B12 levels were found to be 4,000 pg/mL. In December 2023, a bone marrow biopsy demonstrated normal cellularity for her age, with appropriate maturation of erythroid, granulocytic, and platelet lineages, and no evidence of dysplasia, blasts, or pathological plasma cells. The bone marrow karyotype was normal (46, XX), and the electrocardiogram showed a sinus rhythm with no alterations in the QRS complex.

Furthermore, repeated levels of carcinoembryonic antigen and alpha-fetoprotein remained within expected values. To date, oncohematological disorders, liver diseases, pulmonary conditions, viral infections, autoimmune disorders, and car-

Tab. 1. Laboratory results – June 2021, December 2021, and February 2024.

Parameter	RV	June 2021	December 2021	February 2024
carcinoembryonic antigen (ng/mL)	< 2.5	< 2.5	–	–
CA 19-9 (U/mL)	0–37	20	–	–
CA 125 (U/mL)	< 35	30	–	–
alpha-fetoprotein (ng/mL)	0–40	10	–	–
vitamin B12 (pg/mL)	200–350	3,8	4	4
folic acid (ng/mL)	3–17	13	–	12
homocysteine (mmol/L)	5–15	14	–	14
hemoglobin (g/dL)	12–16	14	–	–
white blood cells (cells/mm^3)	4,000– 10,000	6	–	–
eosinophils (cells/mm^3)	0–400	200	–	–
platelets (cells/mm^3)	150,000 –450,000	190	–	–
serum creatinine (mg/dL)	0.59–1.04	0.9	–	–
thyroid stimulating hormone (μU/mL)	0.5–4	–	1	–
complement C3 (mg/dL)	88–201	–	100	–
complement C4 (mg/dL)	15–45	–	24	–
anti–DNA antibodies	negative	–	negative	–
antinuclear antibodies	negative	–	negative	–
rheumatoid factor (IU/mL)	< 15	–	< 15	–
anti–phospholipid antibodies (IgG) (GPL U/mL)	< 11	–	< 10	–
anti-phospholipid antibodies (IgM) (GPL U/mL)	< 11	–	< 10	–
serum IgG (mg/dL)	650–1,600	–	200	–
serum IgM (mg/dL)	54–300	–	60	–
serum IgE (UI/mL)	3–423	–	20	–
serum immunofixation	negative	–	negative	–
aspartate aminotransferase (UI/L)	5–40	–	20	–
alanine aminotransferase (UI/L)	5–40	–	21	–
serum holotranscobalamin (pmol/L)	35–171	–	–	250
methylmalonic acid (μmol/L)	0.07–0.27	–	–	0.1
serologies (hepatitis B, C, HIV, CMV, EBV)	negative	–	–	negative
total cholesterol (mg/dL)	125–200	–	–	156
triglycerides (mg/dL)	up to 150	–	–	150

CA – carbohydrate antigen, CMV – citomegalovirus, EBV – Epstein-Barr virus, GPL – IgG phospholipide units, HIV– human immunodeficiency virus, RV – reference values

diovascular causes, as well as a potential paradoxical increase in vitamin B12 levels associated with a deficiency in its active form, have been excluded. It was hypothesized that the elevated vitamin B12 levels were related to an exacerbated chronic inflammatory process. Consequently, the patient was queried about any procedures involving the placement of prosthetic materials or the presence of retained foreign bodies. The patient reported receiving polymethylsiloxane implants in 2009 for cosmetic purposes in the buttocks and ankles. An MRI of the pelvic and gluteal regions and a soft tissue ultrasound of both ankles were performed, revealing the following findings. Biopsies were not performed due to the high risk of complications, including soft tissue infection and potential inflammatory response triggered by the disruption of encapsulated biopolymer content in the absence of clinical signs or symptoms warranting invasive intervention.

The MRI of the pelvis (Fig. 1a, b) showed multiple nodular lesions in the subcutaneous tissue of the gluteal region (diameters up to 10 mm), hyperintense lesions on short tau inversion recovery (STIR) sequences, and silicone, suppressed on silicone suppression sequences as well as diffuse alteration with hyperintense signals on the STIR sequence in the subcutaneous tissue and the superficial fibers of the gluteus maximus muscle. Diagnosis: changes of alogenosis with focal nodular involvement and diffuse infiltration of the subcutaneous tissue and superficial fibers of the gluteus maximus bilaterally and symmetrically.

The ankle ultrasound (Fig. 1c, d) showed the presence of mixed echogenic material with marked attenuation in deep planes as well as cystic images with thin walls (average diameter of 0.3 cm) in the subcutaneous tissue of the distal third of the leg, neck, and dorsum of the foot. Diagnosis: Presence of modulating material (pure silicone and silicone oil) widely distributed in the subcutaneous tissue of the distal third of the legs, neck, and dorsum of both feet.

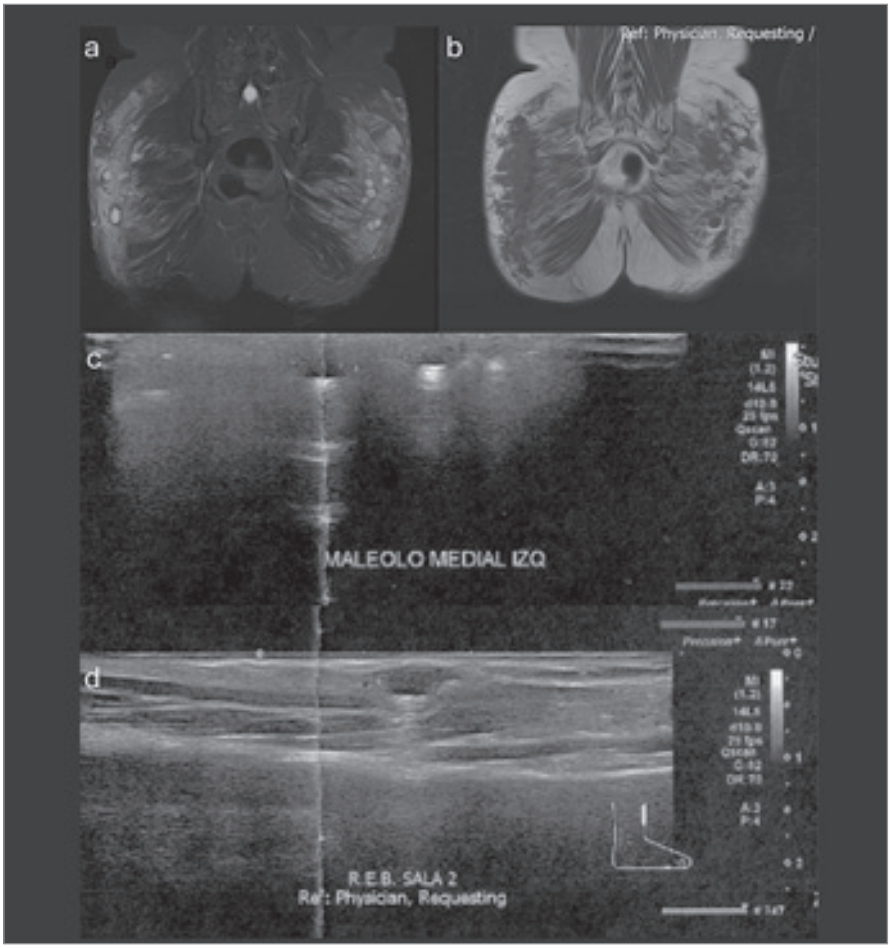

Fig. 1. MRI of the pelvis and ultrasound of the ankle.

Although initially and according to what was stated by the patient herself, she presented obvious clinical signs of inflammation (within the period between 4 and 12 months after the infiltration procedure with biopolymers, the same external signs of inflammation such as pain and erythema subsided over time spontaneously); however, according to the recent images taken in our department, image changes compatible with chronic inflammation still persist (in this case being mild edema of the surrounding fatty tissue, signs of pericapsular hyperintensity in the nodular lesions) beyond the fact that currently there is no pain, limitation or redness.

Given these findings, it was assumed that the elevation of vitamin B12 was related to a chronic inflammatory process exacerbated by polymethylsiloxane implants. Currently, since the patient is asymptomatic and, aside from her age, does not present high cardiovascular risk factors, the risk and benefit of attempting to remove the multiple foreign bodies lodged in the buttocks and ankles were evaluated. It was decided to maintain semi-annual clinical monitoring, including laboratory tests and imaging studies, with extraction surgery to be considered only if the patient presents clinical abnormalities or significant changes in imaging.

Discussion

The infiltration of substances into the buttocks for esthetic purposes is sometimes associated with complications, such as the migration of the material to different parts of the body and the development of inflammatory processes (sometimes leading to foreign body granulomas), potentially resulting in local or systemic damage [3]. In our case, a persistent elevation of vitamin B12 without a clear explanation was noteworthy, ruling out its origin from the considered hematological, hepatic, and autoimmune pathologies. Metabolic disorders and even "paradoxical elevation" of non-functional vitamin B12 were also ruled out. Given that medical literature reports have associated cases of hypervitaminosis B12 with local or systemic inflammatory processes, our medical team proposed a viable interpretation of increased vitamin B12 levels associated with the presence of biopolymers in the subcutaneous tissues. Biopolymers have been described as adjuvants in the development of a systemic inflammatory response mediated by B and T lymphocytes. The chronic inflammatory reaction induced by these foreign materials, characterized by granuloma formation and infiltration of in-

flammatory cells, could have triggered this situation, leading to elevated vitamin B12 levels [5].

Previous studies have described associations between chronic inflammation and alterations in the metabolism of various vitamins and minerals [6]. Similarly, chronic diseases and some types of cancer can affect vitamin B12 metabolism [7]. In this case, the presence of biopolymers and the chronic inflammatory response revealed in imaging studies showing the presence of foreign material and changes in subcutaneous tissue suggest a persistent associated inflammatory reaction, which could have altered the mechanisms of transport and metabolism of vitamin B12, leading to its chronic accumulation in the serum.

The decision to opt for semi-annual clinical monitoring instead of surgical intervention was based on the absence of symptoms and significant cardiovascular risk factors, as well as the absence of similar reports in the medical literature at the time of this case publication documenting experiences in management strategies for this situation. Besides, taking into account that the patient has not been presenting clinical signs, or limitation, pain or secretion, the risk/benefit of performing some type of invasive intervention was evaluated. Given the location (areas of biopolymer infiltration), a high risk of soft tissue infection, and spillage of already encapsulated content within the area with subsequent initiation of an inflammatory response of unknown intensity, it was decided not to perform invasive procedures on the patient who has not presented any clinical recurrence to date. This conservative strategy allows for the monitoring of potential complications without exposing the patient to the risks of extraction surgery, which will only be considered if clinical abnormalities or significant changes in imaging arise, taking into account that there has been no clinical recurrence to date.

Conclusions

Considering this case where biopolymer implants can be a potential source of unexplained systemic symptoms and laboratory anomalies, regular monitoring and a comprehensive approach are essential for managing patients with these implants and preventing complications. Future guidelines should emphasize surveillance and consideration of complications related to biopolymers in differential diagnoses.

This study followed the principles of the Declaration of Helsinki. The patient provided written informed consent for the publication of this case report and the use of her clinical data. The identity of the patient has been protected to ensure confidentiality and privacy. The research was conducted in accordance with ethical standards, ensuring that all patient interactions prioritized well-being, respect, and autonomy.

Roles of the authors

Jhon Alexander Avila Rueda – conceptualization of the case report, clinical data collection, and primary manuscript drafting; Edgar Fabián Manrique-Hernández – analysis and interpretation of laboratory results, as well as critical revisions of the manuscript; Alexandra Hurtado-Ortiz – coordination of patient management, imaging studies, and drafting of clinical discussion; Maricel Licht-Ardila – supervision of the ethical considerations and patient consent process, ensuring compliance with the Declaration of Helsinki; Gianmarco Camelo-Pardo – statistical analysis and review of differential diagnoses, essential input on diagnostic processes; Alejandra Mendoza-Monsalve – final manuscript revision for intellectual content and assistance with journal submission.

Disclosure

The authors have no conflicts of interest to disclose. The authors declare that this study has received no financial support. All procedures performed in this study involving human participants were in accordance with ethical standards of the institutional and/or national research committee and with the Helsinki declaration and its later amendments or comparable ethical standards.

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Treatment options for infratemporal fossa tumors – case reports

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Summary

Infratemporal fossa (ITF) tumors represent a group of tumors with complicated approach, due to specific anatomy of the space. The incidence is rare, but they always represent a challenge for choosing a treatment for each patient. We would like to present a few cases of ITF tumors treated in cooperation with our department to provide multiple views on this topic. In the presented cases, we used the open transmandibular approach, the endoscopic approach and the conservative approach in terms of patient observation.

Key words

infratemporal fossa tumor – endoscopic endonasal approach – zygomatico-transmandibular approach

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Introduction

Tumors of the infratemporal fossa (ITF) form a heterogenous group, mostly consisting of benign tumor. Due to its specific anatomy and complicated approach, there are several factors to consider in treatment. These types of tumors represent approximately 0.5% of all head and neck tumors [1]. ITF tumors treated with radical surgical resections carry a high risk of complications, high morbidity, and mortality rate [2]. However, advancement in endoscopic endonasal surgery (EES) allowed to use this treatment option for ITF tumors and its use for management of these patients increased through the years [3].

For understanding and deciding about treatment options, the knowledge of specific anatomy of ITF is crucial because of its proximity with cranial nerves and neurovascular structures [4].

ITF lies anteriorly to the posterior wall of maxilla, posteriorly to the tympanic plate, inferiorly to zygomatic arch and laterally to the ramus of mandible and pterygoid plates. It contains masticatory muscles (masseter, temporalis, and pterygoid muscles), temporomandibular joint, maxillary artery with veins and pterygoid venous plexus and nerves – including the lingual, mandibular, and otic ganglia) [5].

Although the incidence of these type of tumors is extremely rare, they always represent a challenge for surgeons from neurosurgical, maxillofacial and otorhinolaryngology departments. Therefore, patients with ITF tumors always demands interdisciplinary approach.

In literature review by Bin-Alamer et al. containing 27 articles related to 106 patients, they described schwannomas, meningiomas and synovial chondromatosis as the most common types of ITF tumors.

There are several types of possible surgical approaches to ITF tumors. We can divide ITF approaches into lateral (traszygomatic and lateral infratemporal), anterior (transmaxillary, transfacial, transpalatal, transoral) or inferior (transmandibular and transcervical) [6].

Endoscopic endonasal approach (EEA) provides an alternative access to lesions lying both in ITF and pterygopalatinal fossa, providing less invasive method with lower morbidity rate than transcranial approaches [7]. We can further divide EEA into those treated with transpalatine, transantral and endonasal inferior turbinectomy approaches [8].

Experience of our department

As there is no agreement in literature to the therapy of ITF tumors, we would like to present a few cases of ITF tumor patients treated in cooperation with our department and different approaches to them.

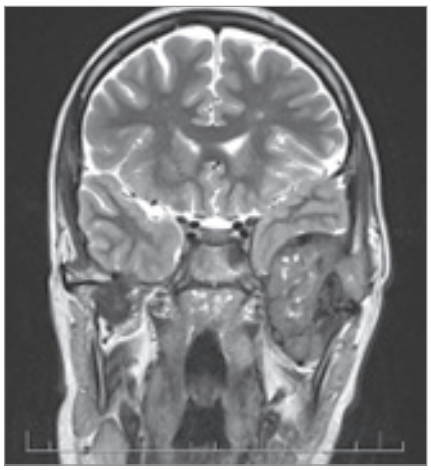

Fig. 1. Pre-operative MRI – first case.

Fig. 2. Pre-operative MRI – first case.

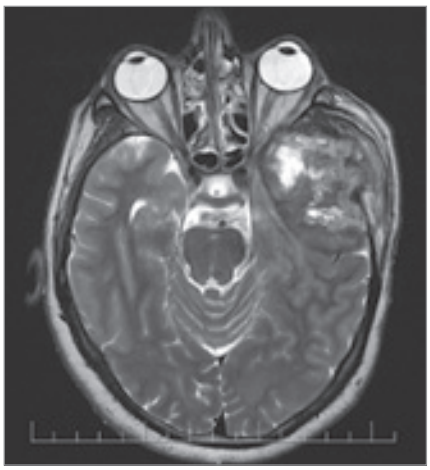

Fig. 3. Pre-operative MRI – first case.

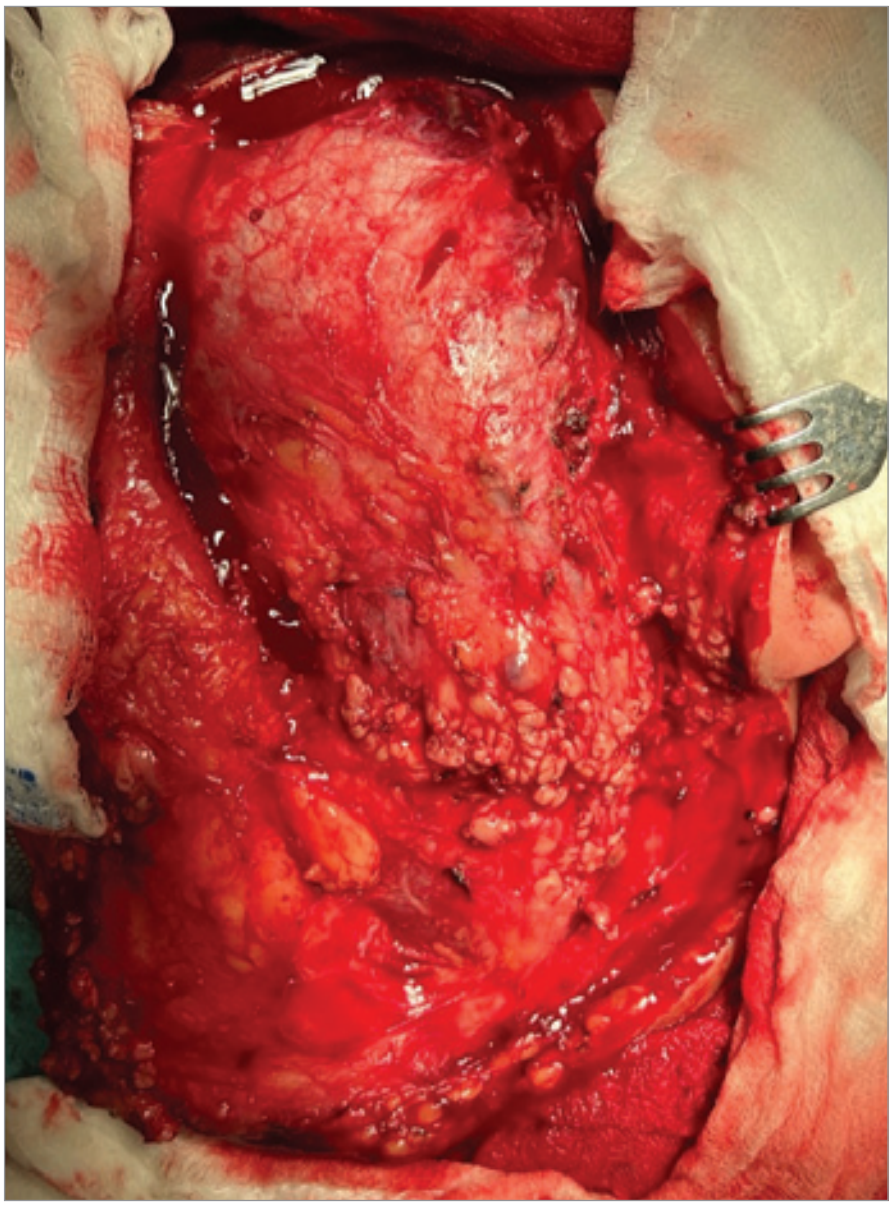

Fig. 4. Modified Blair approach to the tumor.

Trans-mandibular approach

A 31-year-old male patient was referred to our department from an otorhinolaryngologist for pain in the temporomandibular joint area. He was complaining of pain during chewing in front of the ear lobes bilaterally, but after taking non-steroid anti-inflammatory drugs, the condition was better. During the examination, both clinically and on the orthopantomographic scan there were no signs of any pathology in the temporomandibular joint area, but there was severely poor oral hygiene, periodontitis and multiple radices. He was advised to be treated by a dentist in the first place, to rule out dental origin of symptoms, and if the difficulties persisted, he was instructed to come for a check-up.

He came again after 14 months with a CT scan of the brain showing a tumorous process in the middle cranial fossa on the left side with extracranial expansion of 55 × 55 × 45 mm in size. A neurosurgical consultation and an MRI scan was done, showing a tumorous lesion extracranially, compressing the skull base with the destruction of temporal bone without intracranial invasion, with infiltration into the mastoid process and mandibular fossa on the left side (Fig. 1–3).

In that time there was an edema in preauricular area present, with facial asymmetry and limited mouth open-

Fig. 5. Infratemporal fossa after extirpation of the tumor and condyle resection – first case.

Fig. 6. Wound closure – first case.

ing. Because of the contradictory results of imaging examination, based on consultations with otorhinolaryngologists, neurosurgeons and maxillofacial surgeons, a CT navigated biopsy was indicated with the result of giant cell granuloma without metaplasia present in the biopsied material.

In the next step angiography with placement of a stent graft into the internal carotid artery on the left side and embolization of the tumor were done. The removal of the tumor was done by a neurosurgeon in cooperation with a team of maxillofacial surgeons from our department. A modified Blair approach from temporal to preauricular areas was done, following separation of the temporal muscle (Fig. 4). Resection of the mandibular ramus, condylar and muscular process of the mandible was done to get approach to the tumor. The tumorous mass was growing from the temporomandibular joint. Subtotal resection of the tumor was done, without the possibility of complete removal of the tumorous lesions due to its intracranial invasion (Fig. 5, 6).

The result of the histopathological exam was a giant cell lesion, similar to chondroblastoma, without H3F3A/B mutation. It was described as an aggressively growing giant cell tumor from the tendon sheath, probably growing from the temporomandibular joint into the surrounding skeleton.

In the early check-ups he was complaining of pain, pressure in the temporal area and paresis of the facial nerve on the left side. The check-ups were performed every 2 weeks right after the surgery. This period was extended to 1 month and later in time to 3 months. The first MRI scan was performed 1 week after the surgery, showing some residual collection and residual tumorous tissues. The residual tumorous mass was considered inoperable. In the next MRI examination, there was regression of residual collection with persisting residual tumor. It was performed 3 weeks after the surgery. Currently, the patient undergoes check-ups every 6 months in both neurosurgical and our departments and his symptoms are getting better due to chronic pain management and rehabilitations (Fig. 7, 8). In the check-ups the cone-beam CT (CBCT) scans are performed without signs of progression of the lesion into the skeletal bones and every 6 months there is an MRI examination scheduled to observe the residual tumor and its possible progression or regression.

Endoscopic approach

A 69-year-old male patient was referred to our department for a lesion found on a CT scan. The CT scan was done due to a collapse and the ITF tumor was an accidental finding on the scans. He did not have any previous signs or complaints connected to the tumor. He was treated for arterial hypertension without any other previously treated diseases.

On the CT scan, it was described as circumscribed contrast-induced hyperdense lesions located dorsally from the lateral maxillary sinus wall on the right side. A potential diagnosis based on these scans was an osteoblastoma or a chondrosarcoma.

On MRI, enhancing tumor of right ITF with a calcified border destroying lat-

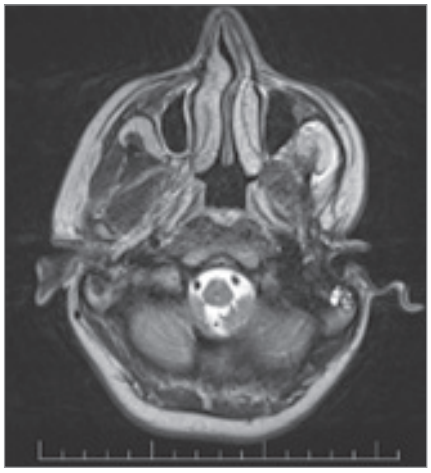

Fig. 7. Postoperative MRI – first case.

Fig. 8. Post-operative MRI – first case.

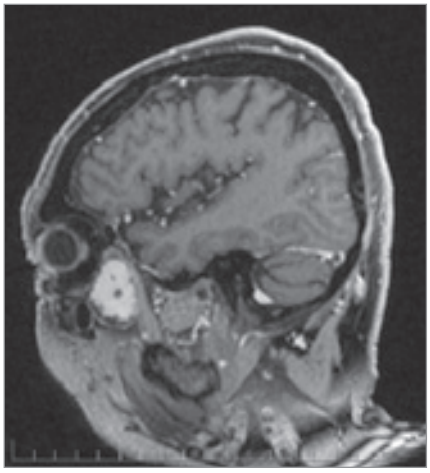

Fig. 9. Pre-operative MRI – second case.

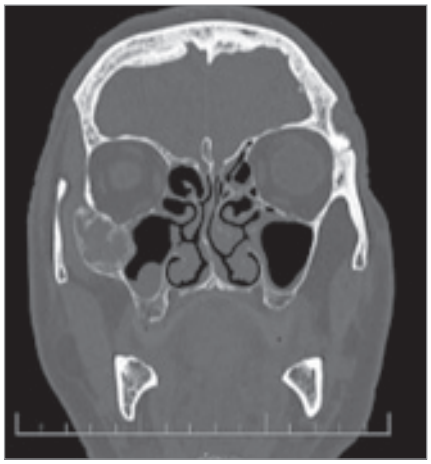

Fig. 10. Pre-operative MRI – second case.

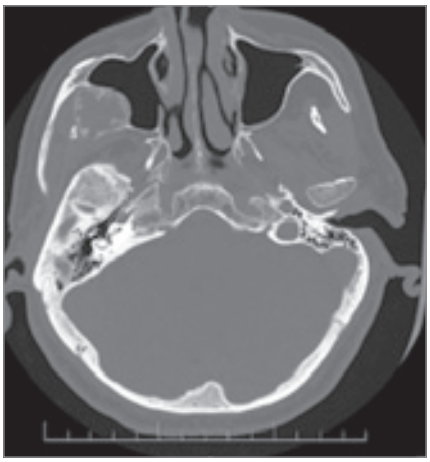

Fig. 11. Pre-operative MRI – second case.

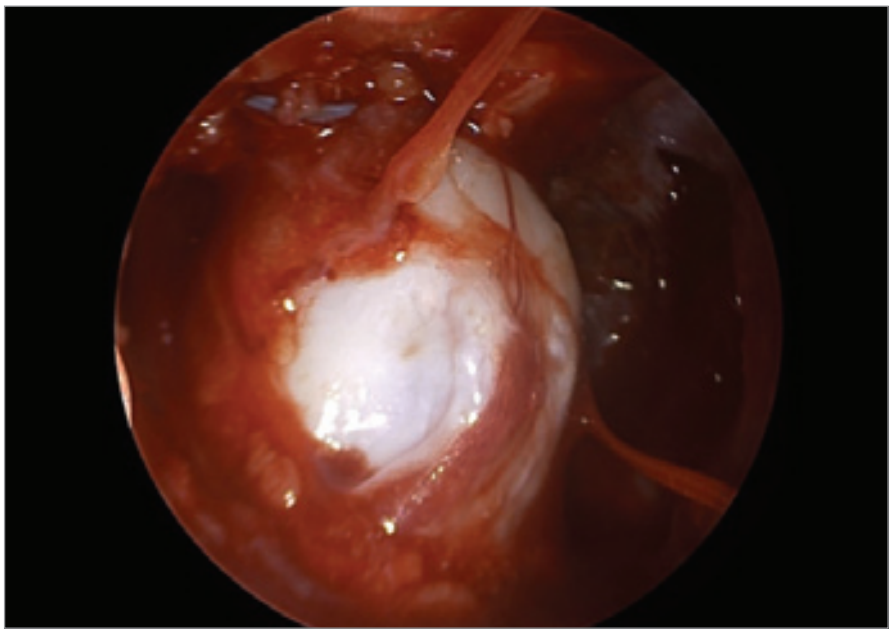

Fig. 12. Per operative visualization of the tumor through endoscope – second case.

eral wall of the maxillary sinus was described, with 23 × 36 × 31 cm in size. It was slightly protruding into the maxillary sinus (Fig. 9–11).

After the consultation with neurosurgical and otorhinolaryngology department, we decided for endoscopic endonasal approach after embolization of the branches of maxillary artery – blood supply of the tumor.

At the beginning of the surgery approach for functional endoscopic sinus, functional endoscopic sinus surgery (FESS) was done with supraturbinal antrostomy on the right side. Visualization of tumor verified by CT navigation was done, without other pathological finding in the maxillary sinus (Fig. 12). Part of the tumor obtained after removing the bone in the lateral wall of maxillary sinus was send to frozen section with the result of mesenchymal lesion with unclear dignity. Because the tumor was not possible to reach from the supraturbinal antrostomy, intraoral approach through the anterior wall of the maxilla was chosen. The tumor was then mobilized into the maxillary sinus and removed through the anterior wall of the maxillary sinus (Fig. 13). It was growing into the ITF with its size of 40 × 25 × 25 mm. The defect was reconstructed with an autologous fat pad graft from the left thigh, covered with oxidized regenerated cellulose and

the fascia lata. Through supraturbinal antrostomy an epistat (nasal catheter) was inserted into the maxillary sinus to hold the graft in place.

The definitive histopathological examination described the tumor as a benign fibro-osseal lesion growing from the cranio-facial skeleton. The patient was complaining of mild pain 1 month after the procedure without any alterations of sight.

Observation

A 71-year-old female patient was referred to our department by an otorhinolaryngologist with a lesion found on MRI. The patient was previously treated for migraines without any other complaints with possible connection to the tumor. An accidental finding was described on MRI – a tumor of 2 cm (in the largest diameter) in the skull base behind the left maxillary sinus. Due to its characteristics, it was suspected to be a congenital cholesteatoma or an epidermoid tumor (Fig. 14).

The patient was referred to our otorhinolaryngology and neurosurgical departments. Based on the MRI scan, it was an incidental lesion with benign characteristic and the localization was hardly achievable, therefore we decided consensually for observing the patient with follow-up MRI scan after 1 year.

Discussion

There is a certain discrepancy in literature between authors about exact borders of ITF [4], as well as its approaches. Before 1960s, ITF was considered surgically inaccessible [9].

Currently, because of the possibilities connected with innovations in microsurgery and endoprostheses, it should be a standard to do the reconstruction after resection of large benign tumors to improve patient's quality of life. However, in the first described case, we have not done the reconstruction yet because of incomplete removal of the lesion. The remaining lesion was described as inoperable by neurosurgeons, an otorhinolaryngologist and a maxillofacial surgeon due to its localization and proximity to brain structures without clear borders of the lesion.

Fig. 13. The tumor after extraction.

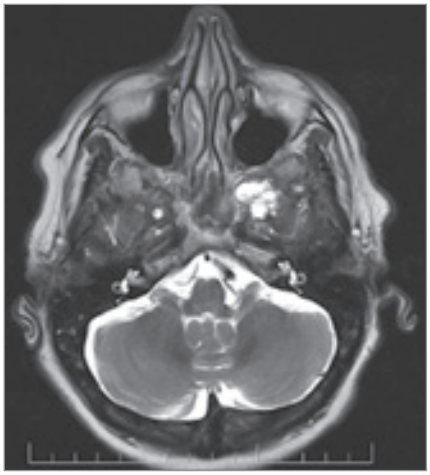

Fig. 14. MRI of the tumor – third case.

Another important thing to consider is performing condylectomy for ITF tumor removal. An alternative to this kind of resection can be the anterior displacement of the mandible in order to get an acceptable field of view. Some authors prefer resection because of the pain and temporomandibular joint disorders that can result from lateral movement of mandible [10]. On the other hand, there is a deviation of the mandible and pain resulting from the resection of the condyle [11]. We believe that after careful analysis of possible complications, appropriate approach should be chosen to get a sufficiently large surgical field for safe performance of the resection.

In the second case, we decided to use the transoral endoscopic approach with electromagnetic navigation to decrease possible complications from open surgery. There is a limitation in the exposure and instrumentation of the lateral part of ITF through endoscopic endonasal surgery [12]. At the beginning of the identification of the tumor through the endonasal approach, we did not have enough space to reach the ITF, so the access by modified Caldwell-Luc was done through the anterior maxillary wall. The possible limitations included mobilization of the tumor and incomplete resection of the lesion endoscopically. Due to the localization of the tumor, we were trying to avoid disruption of the orbital floor, which would be then reconstructed by a titanium plate. The most important limitation of endoscopic approaches to consider is a restricted possibility to repair severe vascular injuries, so in-depth anatomical knowledge is necessary to choose this type of approach. After the surgery, there was a dispensation of the patient – every 7 days in the first month after the surgery, then every 14 days for another month and currently the patient is attending regular check-ups every month. Three months after the surgery a CBCT scan was done – with presentation of clear paranasal sinuses and afterwards 4 months post-surgery MRI examination was performed without showing any residual tumor or relapse. The next MRI examination is planned in 1 year from the surgery.

The third case represents a non-surgical treatment of ITF tumor. The decision of observing the tumor was based on the age and overall health of the patient, regarding the placement and characteristics on MRI.

The pre-operative biopsy was only performed in the first case. The tumor was considered almost inoperable, so the outcome of the biopsy was cru-

cial for choosing the treatment option. Furthermore, the localization of tumor made it reachable for performing the biopsy. If the tumor is malignant, palliative treatment would be a better option for the patient, because of the size and placement of the tumor. In the second case, based on the localization and appearance on MRI (pre-operatively), it was assumed, that the tumor had benign characteristic. It was approachable and complete removal was presumed. In the third case, the localization of the tumor made it inapproachable for probatory biopsy. The possible risk factors and damage of associated structures resulting from biopsy of the tumor would not bring such benefit for the patient, as it was clearly evaluated in the MRI scans – the tumor has the characteristics of congenital cholesteatoma or epidermoid tumor. This type of lesions would not be considered as life threatening for the patient, so the decision was made to observe the patient during regular check-ups – the first one was performed 6 months from the diagnosis. Based on the interdisciplinary consultation, another MRI examination will be performed after 1 year (and every year) from the first examination. The benefit of the preoperative biopsy both for the patient and for the outcome of the possible surgical procedure should be considered, especially if the tumor is not easily approachable, and the result of preoperative biopsy would not change the decision process of the treatment.

Conclusion

The ITF tumors are rare but rather complicated lesions for surgical approach. Removal of this type of tumor is associated with a high morbidity and mortality rate due to its usual proximity to crucial neurovascular structures, and often due to their invasion of the intracranial space. They present a challenge in every patient, they usually grow asymptomatically and when the symptoms occur, the lesions tend to be large and sometimes they cannot be removed completely. As for the surgical (or even non-surgical) treatment, there is not one universal solution for every ITF tumor. We need to analyze every case individually and we can also combine approaches yet described in the literature. In presented cases, the trans-mandibular and endoscopic approaches were performed. Observation of the tumor was chosen in the third case of ITF tumor considering the possible risk factors resulting from surgery due to its localization. Anatomical knowledge is essential together with cooperation between other specialties – maxillofacial surgery, neurosurgery, otorhinolaryngology, vascular surgery and radiology – for the best outcome with minimal complication rate and successful rehabilitation of the patient.

Disclosure

The authors have no conflicts of interest to disclose. The authors declare that this study has received no financial support. All procedures performed in this study involving human participants were in accordance with ethical standards of the institutional and/or national research committee and with the Helsinki declaration and its later amendments or comparable ethical standards.

Roles of authors

Sarah Kalmanová – article writing, data processing, surgery; Vadimír Čalkovský, Pavel Hanzel, Branislav Kolarovszki, Romana Richterová – surgeries, part of diagnostic process, interdisciplinary consultations; Katarína Adamicová – histopathological examination; Mária Janíčková – performing surgery, supervision, text editing, corresponding author.

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