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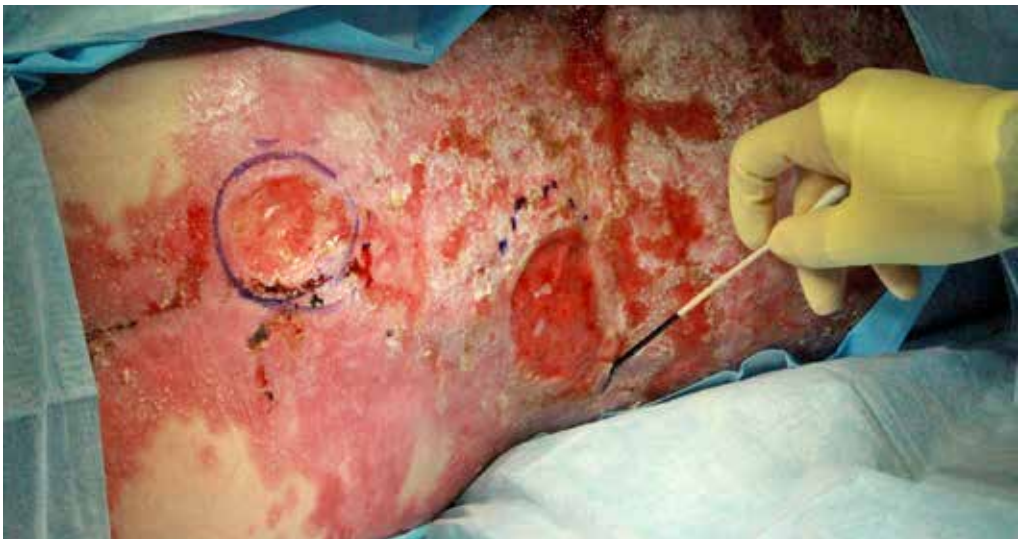

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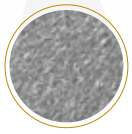

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1. Sforza M, Hammond DC, Botti G et al. Expert Consensus on the Use of a New Bioengineered, Cell-Friendly, Smooth Surface Breast Implant. Aesth Surg. J. 2019 May, 39(S3):S95-S102. doi: 10.1093/asj/sjz054 **2.** ISO-14607:2018 Non-active surgical implants - Mammary implants - Particular requirements. **3.** Atlan M. Lecture presented at: Audition publique ANSM.; March 26, 2019; Paris, France. **4.**Cappellano G, Ploner C, Lobenwein S et al. Immunophenotypic characterization of human T cells after in vitro exposure to different silicone breast implant surfaces. PLoS ONE 2018;13(2):e0192108. **5**. Chacón M, Chacón M, Fassero J. Six-Year Prospective Outcomes of Primary Breast Augmentation with Nano-Surface Implants. Aesthet Surg J. 2018; doi: 10.1093/asj/sjy196. **6.** James G, Boegli L, Hancock J et al. Bacterial Adhesion and Biofilm Formation on Textured Breast Implant Shell Materials. Aesth Plast Surg. 2019 Apr; 43:490–497. **7.** Jones P, Mempin M, Hu H, et al. The functional influence of breast implant outer shell morphology on bacterial attachment and growth. Plast Reconstr Surg. 2018;142(4):837-849. **8** Doloff J. Overcoming host rejection response to improve breast implant biocompatibility. Oral presentation at: 3rd World Symposium on Ergonomic Implants; Sep 2017; Lago di Garda, Italy. **9.** Sforza M, Zaccheddu R, Alleruzzo A et al. Preliminary 3-year evaluation of experience with SilkSurface and VelvetSurface Motiva silicone breast implants: a single-center experience with 5813 consecutive breast augmentation cases. Aesthet Surg J. 2018; 38(Suppl 2):S62-S73. **10.** Huemer GM, Wenny R, Aitzetmüller MM, Duscher D. Motiva Ergonomix Round SilkSurface Silicone Breast Implants: Outcome Analysis of 100 Primary Breast Augmentations over 3 Years and Technical Considerations. Plast Reconstr Surg. 2018; 141(6):831e-842e. **11.** Sim HB. Revisiting Prepectoral Breast Augmentation: Indications and Refinements, Aesthet Surg J. sjy294, https://doi.org/10.1093/asj/sjy294. **12.** Nelson MT, Brattain KA, Williams JM. Does Electronic Identification Enablement for Silicone Gel Implants Impact Patient Safety? J Surg Open Access. 2018;4(1). doi: 10.16966/2470-0991.162.

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*LEED = Leadership in Energy and Environmental Design, MDSAP = Medical Device Single Audit Program

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ACTA CHIRURGIAE PLASTICAE

INTERNATIONAL JOURNAL OF PLASTIC SURGERY, MAXILLOFACIAL SURGERY, HAND SURGERY AND BURNS

Volume 63, No. 4, 2021

Contens

Editorial

Dear colleagues,

You have just received another issue of *Acta Chirurgiae Plasticae*. This issue is another proof of the fact that we have managed to stabilize our journal and, despite many turbulent years, we have (thanks also to your compliance) come back to publishing four issues a year. I am delighted that this issue contains 7 original research papers, covering a wide spectrum of issues spanning the fields of maxillo-facial surgery, plastic surgery and burn medicine. I firmly believe that you will find a wide range of topics to choose from and that you will find this issue as interesting as the previous ones.

Although the times have has not been easy recently and we, as medical professionals, have been confronted with a brand new and unprecedented situation, we have stood up to it. We have had to provide the same quality of care as well as to continue our research and scientific projects as well as teaching of undergraduate and postgraduate students in non-standard conditions. A number of wards were suddenly transformed into units caring for COVID-19 patients. Burn units have been worldwide used very frequently for these purposes, caring both for patients requiring intensive care and patients in standard wards. This was mainly due to the optimal spatial, instrumental and material equipment of these units and, most importantly, the high-grade staffing.

Come the summer, the pandemic situation has gradually begun to look optimistic. Face-to-face congresses were planned and successfully organized, bringing better satisfaction compared to online conferences as they offer the spice of such events – backstage discussions. We all wanted to believe that their organisation would not be affected by various forms of restrictions again and that we would gradually reach a social, scientific and medical state of mind similar to that before the pandemic. However, the last few weeks have once again observed another rising wave of the pandemic that is beginning to affect us in a way we know from a few months ago. We can only conclude that every crisis is also an opportunity for a new beginning, be it a personal or team reboot. I wish you all the best in this wave and believe that you will stand it with honour again, just as you have done in the previous waves.

Thank you for your ongoing support.

Wishing you a peaceful time.

Assoc. Prof. Břetislav Lipový, MD, PhD, MBA

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Moriarty's sign – predictor of skin graft take

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Summary

Background: Resurfacing wound beds with split skin graft is the most common procedure in plastic surgery. Association of more pain in the donor site than in the recipient site has been used as a predictor of successful graft take by Stark in 1962 who termed it Moriarty's sign. **Purpose:** The aim of the study was: 1) to predict the successful take of skin graft by eliciting Moriarty's sign; 2) to decide the day of first graft inspection based on Moriarty's sign. **Methods:** The authors hereby present a prospective study in 100 patients who underwent wound resurfacing with split thickness skin graft at the Department of Plastic Surgery in a tertiary care center between January 2014 and June 2015. The area with more pain, absence of pain or equivocal response at the graft donor site was recorded on the visual analog scale for 10 days. **Results:** In this study, 80 patients had positive Moriarty's sign, 12 patients had equivocal responses and 8 patients showed a negative sign. Patients with positive Moriarty's sign underwent their first graft inspection on 10th postoperative day and showed 100% graft take. Twelve patients with equivocal response underwent first graft inspection on 5th day and had 70–80% graft take. In 8 patients, with negative Moriarty's sign first graft inspection done on 3rd day, the graft take was < 50%. **Conclusion:** The study demonstrates that Moriarty's sign is a reliable clinical predictor of split thickness skin graft take and may be useful as a guide to determine the day of first graft inspection. It is an effective method even for junior members of the surgical and nursing team to monitor parameters in relation to this sign. It can be practiced in a smaller group of hospitals, too. Hence, the authors recommend to integrate this clinical assessment in routine practice.

Key words

donor site – graft take – recipient site – split skin graft – time of graft inspection

Veena P. W., Shanthakumar S., Kumaraswamy M., Udayashankar O. Moriarty's sign – predictor of skin graft take, Acta Chir Plast. 2021, 63(4): 166–170.

Introduction

Resurfacing of wound beds with split skin graft is the commonest procedure undertaken in the field of plastic surgery. The success of skin graft depends on local vascularity and wound microbiology on one side and on hemostasis and adhesion of the skin graft to the wound bed on the other side.

The fact that a successful split skin graft procedure is associated with more pain at a donor site than at a recipient site has been tacitly recognized from the early days of skin transfer but Dr. Stark delineated in his text of 1962: "If there is no discharge from the graft or pain in the immediate area, the dressing on a graft is left undisturbed for at least a week (Moriarty's sign); if the reverse is true, the dressing should be removed earlier [1]".

Since no further literature has been published on this aspect, keeping the clinical application in mind in terms of patient management, we felt it would be useful to popularize this simple clinical assessment of graft take, which also enabled us to decide on the day of first graft inspection.

Split skin graft adheres to its new bed by fibrin within 24–48 hours which then starts breaking down [2]. This coincides with the outgrowth of capillary buds from the recipient area that unite with those on the deep surface of the graft by 3rd day, which appears clinically as increasing pinkness in the graft. [2].

This adhesion is maintained by proliferation of fibroblasts and deposition of collagen to replace fibrin; the strength of these attachment increases quickly providing an anchorage within 4 days which allows the graft to be handled safely if reasonable care is taken.

The variation in graft thickness relates to the thickness of their dermal component and this influences the vascularity. The dermis is less vascular in its deeper part. A number of cut capillary ends exposed when a thick skin graft cut is smaller than with a thin graft and with a full thickness skin graft, there are even fewer capillary ends. Hence, the thin grafts generally get to take easier than thick grafts [3].

Rapid revascularization of graft depends on the distance to be travelled by the capillary ends from wound bed to link-up with the graft. Hence, the graft has to be in the closest possible contact with the bed. The most common cause of separation is hematoma acting as a barrier to link-up the outgrowing capillaries [4]. The graft also has to lie immobile on the bed until it firmly attaches itself. Hence, an optimized bed capable of providing the necessary capillary outgrowth to vascularize the graft is necessary for complete graft take [5].

The authors have conducted a prospective study of 100 patients, based on Dr. Stark's observation which states the simplicity of the test to assess the pain in the donor area which can be correlated for graft take in the recipient area. Pain at the donor area is caused by exposed donor dermal cut nerve endings after skin graft harvesting. The recipient area is painless as the wound is covered. However, a negative Moriarty's sign is also a predictor of graft failure.

The study not only validates the Moriarty's sign but also solves the dilemma of the time of inspection of the grafted recipient site.

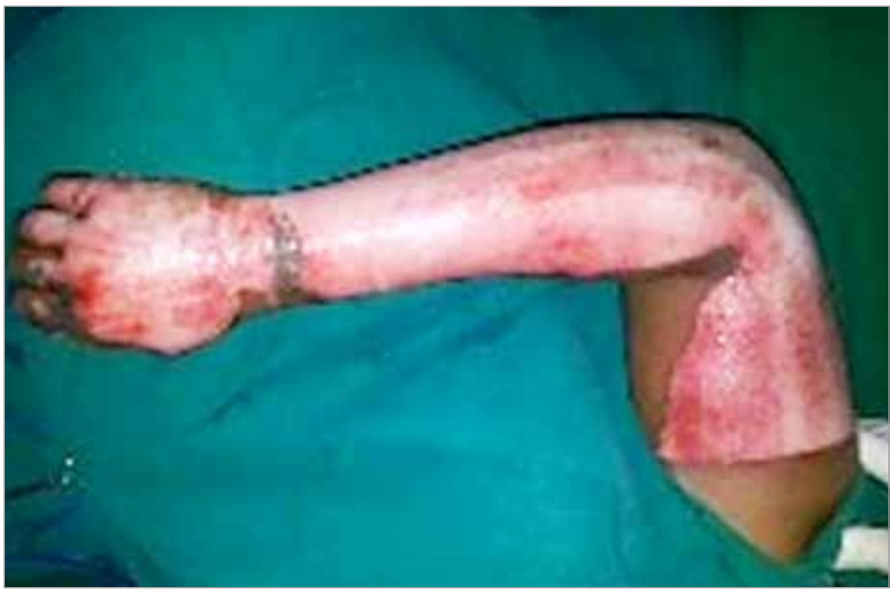

Fig. 1. Partial thickness burn wound – right upper limb.

Methods

The authors hereby present a single center based prospective study in 100 consecutive patients in a period of 18 months between January 2014 and June 2015 at the Department of Plastic Surgery in a tertiary care centre.

Patients with varied range of age, gender, diagnosis and anatomical site of lesion were included in the study. Traumatic, infective, diabetic or post burn wounds, post tumor excisional defects, congenital defects and flap donor areas were included. Children below 5 years and full thickness grafts were excluded from the study.

Tab. 1. Etiology, donor and recipient sites.

Etiology	Donor site	Recipient site
trauma 34%	thigh + leg (lower limb) 80	lower limb 67%
infective 28%	arm + forearm (upper limb) 3	upper limb 17%
diabetic wounds 18%	multiple sites (including trunk) 17	head and neck 7%
burns, post burn contractures 12%		trunk and abdomen 6%
post-tumor excisional defects 2%		multiple areas 3%
congenital 2%		
flap donor area 4%		

All wounds were resurfaced with a split thickness skin graft. The grafts were fenestrated (meshed) except those used for face and neck areas, where sheet grafts were used. Both donor and recipient sites were dressed conventionally using non-adhesive dressing i.e. Sofra-tulle and burn mesh, respectively, covered by well-padded Gamjee rolls and crepe bandages.

Daily enquiries were made by two surgeons who operated and the pain was assessed on a 5-point VAS scale. Detailed clinical assessment was carried out based on questions posed to the patients to elicit Moriarty's sign. The patients with more pain in the donor area compared to recipient area were considered as Moriarty's sign positive. Postoperatively, the recipient site was left undisturbed for 10 days (double the conventional time of 5 days) in patients with positive Moriarty's sign. In patients with negative Moriarty's sign, the graft was inspected on 3rd day. In patients with equivocal response grafts were inspected on 5th day. Discharge and smell were also taken into consideration for early change of dressing.

Descriptive statistics of Moriarty's sign was summarized in terms of percentage. The patients were categorized as positive and negative based on Moriarty's sign. The validity of predicting the graft uptake based on Moriarty's sign was assessed by sensitivity, specificity, positive predictive value and negative predictive value.

Results

All 100 patients in the study group were questioned as to whether pain was more in the donor or recipient areas and was recorded on VAS scale. Among the cases, the average age was 42.3 ± 18.7 years; 63% were males and 37% females. The most common co-morbidities in the selected cases were diabetes (59.8%),

Tab. 2. Day of first graft inspection based on Moriarty's sign.

Moriarty's sign	Day of first graft inspection
positive	10
negative	3
equivocal	5

hypertension (44.5%) and peripheral vascular disease (17.8%).

Most of the patients (67%) had wound resurfaced with split thickness skin graft (SSG) in the lower limb; next most common site was the upper limb (17%). Head and neck included 7%, trunk and abdomen 6% and 3% of patients had multiple sites.

In the study, large number of wounds were of traumatic etiology followed by infective or diabetic, burns, post tumor excisional wounds or congenital and flap donor areas (Fig. 1, Tab. 1).

The authors harvested split skin graft commonly from the thigh, with other areas being upper limbs and the trunk.

The grafts were fixed to wound bed with sutures or skin staples. Autologous platelet rich plasma was also applied on the wound bed as an adhesive in many patients [6].

Pain at both donor and recipient sites were compared for 10 days post-operatively. Graft take was assessed qualitatively by clinical observation. In 80%, the patients with positive Moriarty's sign had their first graft inspection on 10th day with 100% graft take (Tab. 2). In patients with negative Moriarty's sign, first dressing was changed as early as 3rd day with graft uptake less than 50%, and 12% of patients in whom the response was equivocal had first dressing changed on 5th day with 75–80% graft take. Discharge and smell were also taken in to consideration for early dressing change in both donor and recipient areas.

Moriarty's sign positive patients underwent graft inspection on 10th day as the dressings were dry and there was no smell (Fig. 2, 3).

Fig. 2. Day 10: first graft dressing – dressings dry (Moriarity's sign positive).

Fig. 3. Day 10: first graft dressing –100 % graft take (Moriarity's sign positive).

In patients with strongly negative Moriarty's sign, graft inspection was done as early as on the 3rd day, as by that time the graft would have adhered to the wound bed [2]. Here the loss was due to hematoma, infection and shearing (neck and trunk region due to unwarranted movement by the patients). Patients with equivocal response underwent graft inspection conventionally on 5th day and the graft loss was due to seroma and mild infection (Tab. 3).

It is noted that all patients with positive Moriarty's sign had a positive

Tab. 3. Assessment of skin graft take based on Moriarty's sign.

Moriarty's sign	Number of patients	% of skin graft take
positive	80	100
negative	8	< 50
equivocal	12	75–80

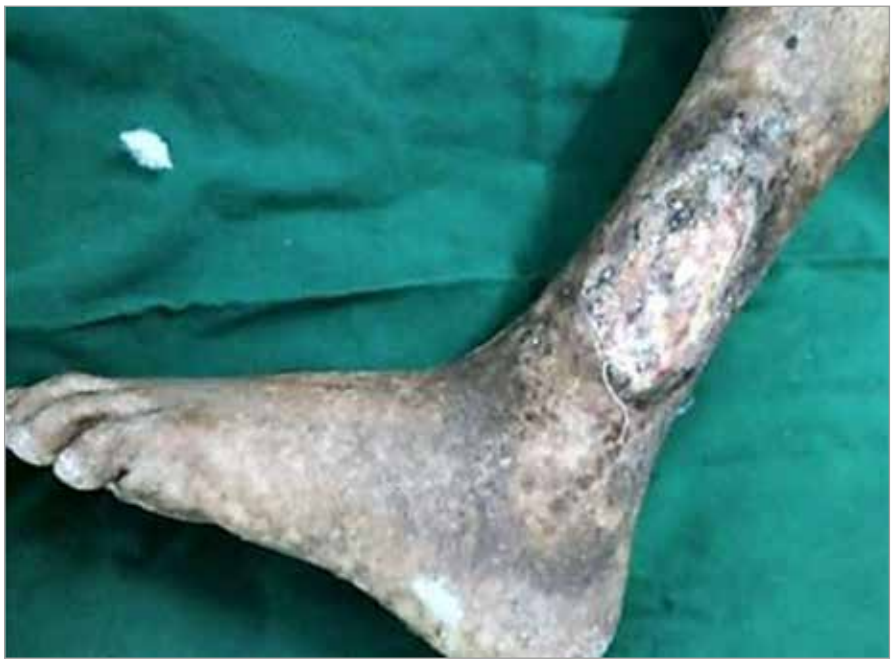

Fig. 4. Equivocal response – partial graft loss.

graft uptake indicating high sensitivity and specificity for clinical outcome evaluation.

Discussion

This study confirms the usefulness of Moriarty's sign as simple bedside clinical test which gives reliable information about the graft take. The population includes different age groups, ranging from 9–74 years. In our series, post-traumatic skin loss, acute burns, post burn contracture release and flap donor sites were the indications for SSG. The most common donor sites were thighs, arms and trunk. The grafts were fixed to wound bed with sutures or skin staples. Autologous platelet rich plasma was also applied on the wound bed in many patients as an alternative to adhere the graft [6]. The test was applied in our sample study to all sizes of split thickness skin grafts except full thickness skin grafts.

The test was applied from the 1st post-operative day. The dressings are conventionally changed for the first time by 5 days after skin grafting [7]. In our study, first graft inspection was done on 10th post-operative day, in all patients with positive Moriarty's sign. In patients with equivocal and negative response, early dressings were undertaken (Fig. 4).

It was observed that the graft take was 100% in patients with strongly positive Moriarty's sign.

Frequent causes of graft loss are [8] seroma, hematoma which separates grafts from the bed, shearing movements which prevent adhesion between the graft and its bed and infection [9–11].

In our study, in patients with equivocal response (12%), the graft loss was due to seroma formation and mild infection. In patients with negative Moriarty's sign (8%), the graft loss was due to hematoma, infection and shearing (neck and trunk region due to unwarranted movement by the patients).

The cutting of SSG leaves variable portion of pilosebaceous apparatus and sweat glands in the donor area. The epithelium regenerates and spreads from multiple foci until the area is resurfaced with skin. The remnants of pilosebaceous apparatus are much more active as foci of epithelial regeneration than sweat gland remnants, which react sluggishly.

The donor site of a thin graft with its full complement of cut pilosebaceous follicle heals in approx. 7–9 days, while the donor site of a thick graft depending virtually entirely on sweat gland remnants heals more slowly, with healing time of 14 days or more [7].

Traditionally, the donor areas were dressed with Sofra-tulle over which absorbent gauze was laid and held in position with crepe bandages [12,13]. The dressing of donor area in our patients was left in situ until it got separated spontaneously; an approach which is practical if it remained dry.

This study demonstrates that Moriarty's sign is not only an excellent predictor of graft take but can also be used as a determinant for the time of graft inspection. There were relatively few patients in the failure category (8%).

Conclusion

This study demonstrates that Moriarty's sign is a reliable clinical predictor of split thickness skin graft take and may be useful as a guide to determine the day of the first graft inspection. It is an effective method for even the junior members of the surgical and nursing team to monitor the parameters in relation to this sign. It can be practiced in smaller group of hospitals, too. Its clinical application helps to reduce the discomfort and cost of frequent changes of dressing, time and man power, especially in busy clinical units.

Hence, the authors recommend to integrate this clinical assessment in routine practice.

Role of authors: All authors have been actively involved in the planning, preparation, analysis and interpretation of the findings, enactment and processing of the article with the same contribution.

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 research committee and with the Helsinki declaration and its later amendments or comparable ethical standards. An informed written consent was obtained from all patients.

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Fractional CO_2 laser therapy of hypertrophic scars – evaluation of efficacy and treatment protocol optimization

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Summary

Introduction: Hypertrophic scars are an unwanted and mutilating consequence of deep burns, and are further exacerbated by extensive burn injuries. Fractional CO_2 laser therapy is one of the methods for complex treatment of hypertrophic scars, it has been used since 2007 [1]. Although its effectiveness has been objectively proven in clinical practice, the optimal settings parameters have not been determined. To evaluate the effect of laser therapy, previously designed evaluation tools are used, which evaluate the quality of scars well, but fail to capture specific changes for the performed laser therapy. **Material and methods:** Fractional CO_2 laser therapy of hypertrophic scars is performed at the Department of Plastic and Esthetic Surgery, University Hospital Olomouc, since 2017 and the systematic study took place in 2019–2020. In common, 25 hypertrophic scars were treated in 13 patients; each scar was treated by fractional CO_2 laser therapy more than once. **Results:** Statistical analysis detected statistically significant improvement of the texture of the scars and the improvement of overall functional and esthetic result. We found significant reduction of the height under 2 mm (62,5% of scars) in scars with the height > 2 mm before the initiation of laser therapy. Correlation analysis detected a statistically significant positive correlation between the energy of laser beam and the reduction volume of the scar protruding above the niveau of healthy surrounding tissue. Fractional CO_2 laser therapy showed statistically significant efficacy in the reduction of the risks associated with full-format CO_2 laser-therapy. Fractional treatment was very well tolerated by the patients. Topical 5% lidocaine gel was effective in 24 out of 25 patients. Further healing was without complications in all patients. **Conclusion:** Fractional CO_2 laser therapy has achieved statistically significant improvement of the texture and reduction of hypertrophic scars and overall improvement of functional and esthetic result in our study.

Key words

hypertrophic scars – fractional CO_2 laser – setting parameters – therapy efficacy

Klosová H., Xinopulos P., Zálešák B., Lamgová K. Fractional CO_2 laser therapy of hypertrophic scars – evaluation of efficacy and treatment protocol optimization. Acta Chir Plast. 2021, 63(4): 171–180.

Introduction

Hypertrophic scars are defined as scars above the level of healthy surrounding tissue. They are an undesirable consequence of injury or surgery with prolonged healing. They can be linear, extensive or widespreading, causing various mental and physical difficulties to patients.

Extensive hypertrophic scars most often occur in the areas after dermoepidermal autotransplatation due to a burn injury. The prevalence of scar hypertrophy reported in the literature ranges from 30 to 70%. In fact, the prevalence is purely documented and remains unknown [2,3]. Significant interindividual variability in the onset of scar hypertrophy is based on many factors [4].

The predisposing factors are: childhood and younger age, prolonged healing, infection, widespread deep destruction of the dermis during burns or extensive decollement, dermoepidermal autotransplantation and meshed grafts, genetic factors, increased hormonal activity during adolescence, somatization of fears and untreated mental tension in injuries, especially in hypersensitive and anxious individuals [5,6]. The scars after autotransplantation of meshed grafts present a specific problem. The regular geometric appearance is striking and esthetically disturbing.

Successful treatment must be complex with active patient's cooperation. An integral part of modern treatment of hypertrophic scars is laser therapy. Its effectiveness has been proven in numerous clinical studies [7–9].

In principle, the treatment of hypertrophic scars is divided into the treatment of immature scars and the treatment of mature scars. Pulsed-Dye Lasers (PDLs), CO_2 laser, Erb: YAG laser and Q-switched Nd: YAG lasers are most frequenly used in the treatment. Vascular laser treatment causes selective photothermolysis

of small vessels, so it is especially suitable for the treatment of immature scars [10].

Ablation fractional CO_2 and Erb-YAG lasers are suitable for the treatment of mature scars, which significantly reduce the height and hypertonus of both mature and immature scars by evaporating scar tissue [10]. Fractional lasers act non-selectively in the epidermis and dermis and lead to the formation of microscopic cylindrical zones of thermal destruction (microscopic thermal damage zones, MTZs) [11–13]. Lateral thermal destruction zones are immediately adjacent to the cylindrical zones of thermal destruction as thermal damage to the immediate vicinity of the borehole. Among the vaporized canals is preserved tiny net of healthy, laser-untouched tissue, from which regeneration and epithelialization occurs. Subsequent retraction of the zone of thermal damage is responsible for volumetric reduction of the scar. Repeated fractional laser therapy reduce gradually the thickness of the scar [14]. Ideally, the relief is smoothed into healthy surrounding.

The scars after 12–18 months are generally considered to be matured [15–18]. They are usually stable and are not a subject to further changes. Stability is a basic requirement for quantifying the effect of laser therapy both clinically and with objective methods to eliminate the changes caused by spontaneous regression. Generally, hypertrophic scars have a tendency to spontaneous regression which vary individualy between few and several months. Thus, in unstable scars, the effectiveness of laser therapy is always combined with the changes that accompany spontaneous scar regression over time. These changes show significant individual variability and therefore the effectiveness of laser therapy in immature scars cannot be precisely estimated [19].

To evaluate the effectiveness of laser therapy in everyday medical practice, clinical evaluation and specifically designed evaluation tools and scoring scales, such as Vancouver Scar Scale (VSS), Patient and Observer Scar Assessment Scale (POSAS), Visual Analog Scale (VAS), and Manchester Scar Scale (MSS) are most frequently used with VSS being the most commonly used and generally accepted rating scale for scar hypertrophy [20]. Although clinical evaluation of scars using the above scales is always subjective [21], it is a practical and affordable tool with satisfactory informative value. The limiting factor is that none of the above scales was designed directly to evaluate the response of scars to laser therapy, so it fails to capture the spectrum of changes in its complexity.

For this reason, it is necessary to create new evaluation protocols that can more accurately capture the changes in scars and evaluate the effects of laser therapy. The creation of such an evaluation tool was a secondary goal of our study focused on the optimization of the treatment protocol of fractional CO_2 laser therapy (fr-CO_2-LT).

The primary goal of the project was to optimize fr-CO_2-LT parameters that will lead to the smoothing of prominent areas of the scar to the level of healthy surrounding skin and a significant reduction of scar hypertonus with a minimum number of laser therapy sessions possible.

Methods

Patients with hypertrophic scars who required more than one fr-CO_2-LT session to achieve significant improvement were included in the study. These scars, with their texture, appearance, height, color, pigmentation and pliability, differed significantly from the surrounding healthy tissue. Stiff, contracting scars and scars limiting the range of motion in the joints were evaluated as functionally deficient. Contracting scars accounted for 44% of the intervention group, and mobility-limiting scars accounted for 28% of the group (Tab. 1).

Tab. 1. Demographic characteristics.

	No.	%
patients	13	100
scars	25	100
scars – gender: male/female	6/7	46/54
scars – age: children/adults	16/5	64/38
scars – maturation: mature (≥ 18 months after healing) immature (<18 months after healing)	16 9	64 36
contracting scars	11	44
contracting scars with limitation of motion	7	28

There were 25 hypertrophic scars in 13 patients (6 men and 7 women). Eight children were indicated for fr-CO_2-LT (Tab. 1). The vast majority of scars occurred after healing of deep burn; one of the patients developed scar hypertrophy after the excision of a giant nevocellular naevus followed by cutaneous dermoepidermal autotransplantation.

The treatment of fr-CO_2-LT scars was performed in all patients under topical anesthesia by applying lidocaine 5% gel (Lidocaine 5% gel, magistraliter according to the Czech Pharmacopoeia, Olomouc University Hospital) under an occlusion of 1–1.5 hours prior to the procedure. In patients (23%) who experienced pain of VAS 3–4 intensity, the analgesia was supplemented by local cooling with gel pads (Mediflex Duo, Medicalflox, Czech Republic). In one case, treatment under general anaesthesia was required. The interval between the first and second fr-CO_2-LT (L1–L2) was in agreement with a median of 11 weeks.

Tab. 2. Vancouver Scar Scale.

Vascularity	normal – 0, pink – 1, red – 2, purple – 3
Pigmentation	normal – 0, hypopigmentation – 1, mixed pigmentation – 2, hyperpigmentation – 3
Pliability	normal – 0, supple – 1, firm – 2, banding – 3, contracture – 4, contracture with permanent deformity – 5
Height	normal – 0, < 2mm – 1, 2–5 mm – 2, > 5mm – 3
Total score	0–14

Fractional CO_2 laser therapy was performed with a Microsys 40W high power CO_2 laser (Daeshin Enterprise (D.S.E), 0476 ISO 13485) using a pulse fractional mode with a fraction scanner. This mode generates short, high-energy pulses suitable for tissue vaporization.

The CO_2 laser operates at the wavelength λ = 10 600 nm. It is a vaporization laser, its target chromophore is water and the radiation is non-selectively absorbed by tissue fluid [22]. Reduction in the mass of the scar tissue is achieved by vaporization.

The following parameters can be optionally set for fractional CO_2 laser therapy with the Microsys 40W device:

- fluence: laser output energy per dot of the scanned area, 5–300 mJ / 1 point;
- repeat time: the length of delay (repeat interval) between laser pulses, 0.5–2.5 s or SINGLE = OFF;
- density level: the density of points in the scanned area per cm2, 1–23;
- depth level: laser depth, level 1–5;
- scan area: scan size, from 2 × 2 mm to max 20 × 20 mm, max 4,489 fraction points (dots)
- scan shape: square, hexagon, triangle, circle;
- shape rendering: line – ARRAY, diagonal – GRID, random – RANDOM.

The treatment strategy and parameters of fractional CO_2 laser therapy – fluence, density level, depth – were set according to the current clinical findings and the intended power of treatment in order to reduce scar height, release hypertonic, contracting scars and improve the homogeneity of relief and texture of scars. Medical photography was obtained for all patients before and after laser therapy, and the parameters of laser therapy were recorded in a special protocol. The areas before and after the treatment were disinfected with Octenisept (Schülke & Mayr, GmbH, Germany); after the treatment, they were covered with Flamigel (Dahlhausen, Czech Republic), greasy tulle (Lomatuell, Lohmann & Rauscher, GmbH, Germany), and mule; thereafter, they were gently fixed with Fixa crep bandage (Batist Medical as, CR).

The scars were clinically evaluated shortly before fr-CO_2-LT (rating 1, H1) and, in average, 11 weeks following the first fr-CO_2-LT (rating 2, H2), using two assessment tools – Vancouver Scar Scale (VSS) and HTT protocol.

In accordance with the VSS, four scar qualities were monitored clinically, by inspection and palpation: vascularity, pigmentation, pliability, and height. The resulting VSS is the sum of individual scores; its value ranges from 0 to a maximum of 14 points. The zero value corresponds to healthy skin (Tab. 2).

Scar vascularity and pigmentation were assessed visually on a four-point scoring scale (Tab. 2). The vascularity and pigmentation were considered normal if the entire area of the scar with its color or pigmentation corresponded to healthy surrounding tissue. If any part of the scar had other than normal vascularity or pigmentation, an appropriate rating was recorded in the protocol. Flexibility was assessed by palpation, on a six-point scale as normal (0), scar elastic, flexible with minimal resistance (1), scar flexible, flexible under pressure (2), scar firm, inflexible, resistant to hand pressure, immobile (3), scar cords and patchy scars that whiten when the scar is extended (4), scarring contracture or permanent shortening of the scar causing deformity (5). The height of the scar was assessed by inspection and qualified clinical estimate on a four-point scale (Tab. 2). It is typical that the height of the scar is heterogeneous in the majority of extensive hypertrophic scars. The areas within, above or below the level alternate. The most prominent area of the scar was always decisive for the classification of a scar in the relevant VSS subcategory. Qualified height estimation of the most prominent part was made and recorded in the VSS protocol.

VSS is a generally accepted and most frequently used scar rating scale in studies [19]. Clinical practice of laser therapy shows that VSS is not a sufficiently sensitive and esthetically sensitive tool for the purposes of evaluating the effects of laser therapy, because some of the changing qualities of the scars occurring after laser therapy are not part of the evaluation protocol. Therefore, VSS is a less specific tool for the evaluation of the effectiveness of laser therapy. In order to describe a spectrum of changes in scars after laser therapy, the researchers designed their own evaluation protocol, the so-called HTT protocol. The name of the protocol was derived from the names of evaluated parameters (Tab. 3).

The following parameters were evaluated for each of the treated scars:

- homogeneity of the color (H-C) of the scar in comparison with the surrounding normal skin;
- homogeneity of intralesional relief (H-IL) within the scar area;

- homogeneity of extralesional relief (H-EL) in comparison with healthy surrounding skin;
- scar tonus – scar tension in comparison with healthy surrounding skin;
- raster texture – raster visibility across the mesh;
- texture – the presence pf textural irregularities.

The overall functional and esthetic result is the sum of the scores of the individual evaluated parameters.

After-mesh raster and relief inequalities were rated on a dichotomous scale. Other monitored qualities include ordinal quantities; they were evaluated using scoring scales. The homogeneity of the color with surrounding normal skin was evaluated on a three-point scale and the tone of the scar in comparison with healthy surrounding skin was evaluated on a five-point scale (Tab. 3).

Intralesional homogeneity of relief (H-IL) and homogeneity of relief with surrounding healthy skin (H-EL) were evaluated using VAS in the range 0–10 (Tab. 3). Intralesional homogeneity assessed the extent to which the surface of the scar is uniform in its various parts. According to the VAS, the homogeneity of the relief to the surroundings assessed the extent to which the appearance of the scar surface was in accordance with surrounding healthy skin.

The characteristics of the scars were recorded in the H1 and H2 clinical trials by a physician performing laser therapy in both the VSS and HTT protocols. Visually evaluable scar qualities (color, pigmentation, intralesional homogeneity of relief, homogeneity of relief to surroundings, raster after mesh and area of scar hypertrophy within the area of intervened scar) were evaluated by visual analysis of medical photography by an independent evaluator, experienced plastic surgeon not performing fr-CO_2--LT intervening scars. The numerical data recorded in the H1 and H2 clinical trials were subjected to statistical analysis using IBM SPSS Statistics for Windows statistical software, Version 23.0. Armonk, NY: IBM Corp. Quantitative data were presented using median, minimum and maximum values, means, and standard deviations (SD). Qualitative data were evaluated using absolute and relative frequencies. It was verified by Shapiro-Wilk normality tests that quantitative quantities do not have a normal distribution. The McNemar test was used to determine the differences between the dependent selections in qualitative dichotomous quantities, and the non-parametric serial Wilcoxon test was used

Tab. 3. HTT-protocol – qualitative evaluation of scars.

Evaluated scar parameters	Evaluation
homogeneity of color in comparison with the surrounding normal skin	1 – complete, 2 – partial, 3 – none
homogeneity of intralesional relief	VAS 0–10: 0 = fully homogeneous, uniform; 10 = completely inhomogeneous
homogeneity of extralesional relief	VAS 0 –10: 0 = fully homogeneous, uniform; 10 = completely inhomogeneous
scar tonus	1 – normotonus, 2 – hypotonus, 3 – hypertonus, the scar does not contract the surroundings, 4 – hypertonus, the scar contracts the surroundings, 5 – scar contracture limiting mobility
raster texture – after mesh grid	1 visible, 0 – no visible grid
texture – relief inequalities	1– present, 0 – absent
functional and esthetic result (total score)	1 – excellent (0–8 points), 2 – very good (9–14 points), 3 – good (15–19 points), 4 – less satisfactory (20–24 points), 5 – unsatisfactory (25–30 points)

HTT – homogeneity, texture, tonus, VAS – Visual Analog Scale

Tab. 4. Functional and aesthetic result - changes between H1 and H2.

Clinical evaluation		H1 number	H1 %	H2 number	H2 %	P-value
functional and esthetic result according to HTT protocol	excellent	0	0	0	0	< 0.001[a]
	very good	3	12	7	28	
	good	8	32	12	48	
	less satisfactory	7	28	3	12	
	unsatisfactory	7	28	3	12	
height of scars according to VSS	up to 2 mm	16	64	22	88	0.035[a]
	2–5 mm	8	32	3	12	
	over 5 mm	1	4	0	0	

[a]Wilcoxon test

The homogeneity of the color of the scars with the surroundings, the visibility of the grid after the mesh and the presence of relief unevenness did not show statistically significant changes between H1 and H2.

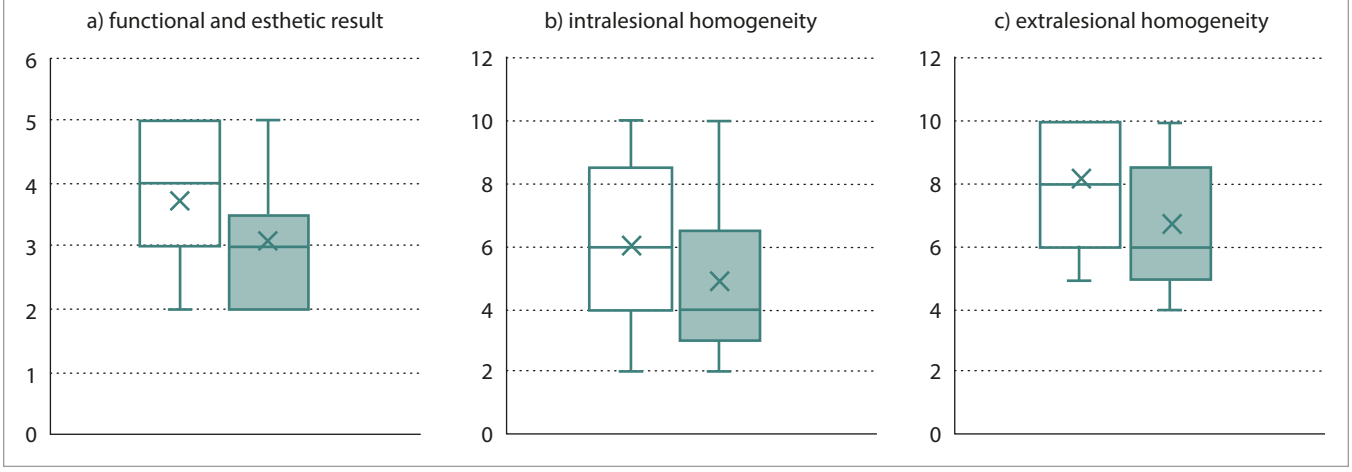
HTT – homogeneity, texture, tonus, VSS – Vancouver Scar Scale

Tab. 5. Evaluation according to HTT-protocol – statistically significant changes.

Monitored scar qualities	H1					H2					P-value
	Med	Min	Max	Mean	SD	Med	Min	Max	Mean	SD	
H-IL	6.0	2.0	10.0	6.0	2.5	4.0	2.0	10.0	4.9	2.6	0.001[a]
H-EL	8	5	10	8.2	2.0	6	4	10	6.8	2.0	0.0004[a]
contraction	0	0	8	2.0	2.4	0	0	6	1.4	1.9	0.007[a]
hypertonus	4	0	9	4.72	2.19	3	0	8	3.32	2.29	0.0001[b]
above niveau	60.0	10.0	100.0	61.6	29.4	50.0	5.0	100.0	52.2	30.8	0.001[a]

[a]Wilcoxon test, [b]Friedman test

H-EL – extralesional homogeneity (VAS 0–10), H-IL – intralesional homogeneity (VAS 0–10), Contraction (VAS 0–10), HTT – homogeneity, texture, tonus, Med – median, SD – standard deviation, VAS – visual analogue scale



Graph 1. Scars – changes H1 and H2.

for ordinal quantities. The correlation of quantitative and ordinal quantities was verified using Spearman's correlation coefficient. The differences between the two independent selections were verified using the Mann-Whitney U-test. All tests were performed at the level of statistical significance $\alpha = 0.05$. The results with P-values < 0.05 were considered statistically significant.

Results

Source data from VSS and HTT protocols were subjected to statistical analysis. There was a statistically significant improvement in the height of scars, a decrease in their hypertonus and an improvement in the overall functional and esthetic outcome between H1 and H2, $P < 0.05$ (Tab. 4, 5).

The reduction in scar height achieved after the first laser therapy in 24% of treated scars was statistically significant (Tab. 4). The median hypertonus

Fig. 1. Hypertrophy scar of the thumb after spontaneous healing of deep dermal burns before (A) and after (B, C) one session of fractional CO_2 laser treatment.

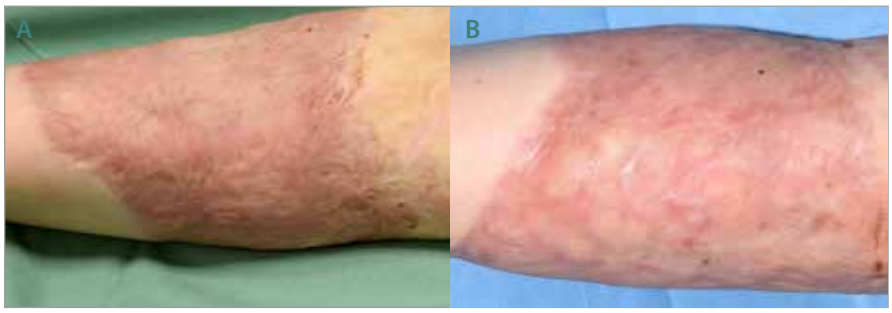


Fig. 2. Hypertrophy scars of the forearm after dermoepidermal autotransplantation before (A) and after (B) one session of fractional CO_2 laser treatment.

Tab. 6. Descriptive statistics of the parameters of the first laser therapy (L1).

L1 laser therapy parameters	Modus	Median	Minimum	Maximum	Average	SD
E [mJ]	200	160	50	250	148	57.61
density	21	21	15	21	20	1.67
depth	2	2	2	3	2	0.37

SD – standard deviation

Tab. 7. Changes in scar qualities according to VSS and HTT protocols – correlation analysis with laser therapy parameters.

H1 and H2 – rated scar quality	Energy – E [mJ] Spearmann test		Density of points Spearmann test	
	Test criterion	P-value	Test criterion	P-value
homogeneity of color to the surroundings	0.107	0.612	–0.083	0.693
functional and aesthetic result	0.170	0.417	0.343	0.094
homogeneity – IL	0.339	0.097	0.169	0.418
homogeneity – EL	0.336	0.101	0.356	0.081
range of motion	–0.332	0.105	–0.157	0.454
hypertonus (VAS 0–10)	–0.271	0.190	0.049	0.815
contraction (VAS 0–10)	–0.168	0.423	–0.516	0.008
amount of above-niveau-surfaces (% TBSA)	0.471	0.018	0.180	0.390
tonus	0.061	0.772	0.132	0.528
VSS – vascularity	–0.087	0.680	0.246	0.235
VSS – pliability	0.107	0.609	–0.282	0.172
VSS – height	–0.271	0.190	0.049	0.815
VSS – overall	0.107	0.609	–0.282	0.172

EL – extralesional, HTT – homogeneity, texture, tonus, IL – intralesional, TBSA – total body surface area, VSS – Vancouver Scar Scale

assessed by VAS decreased between H1 and H2 from 4 to 3; this decrease was statistically significant. Functional and esthetic outcome (FEV) showed a statistically significant improvement – a decrease in the categories of less satisfactory and unsatisfactory and an increase in the categories of good and very good FEV; P = 0.001 (Tab. 4). The greatest contribution was made by the improvement of the homogeneity of the intralesional texture and the improvement of the homogeneity of the relief of the scar towards healthy surroundings (Graph 1, Fig. 1, 2). For other parameters (vascularity, pigmentation, pliability, total VSS) no statistically significant changes between H1 and H2 were demonstrated, P > 0.05.

The homogeneity of the color of scars with the surroundings, the visibility of the grid after the mesh and the presence of relief unevenness did not show statistically significant changes between H1 and H2.

The key parameters of the fr-CO_2-LT treatment were recorded in the protocol and subsequently subjected to descriptive statistical analysis (Tab. 6). Scars with fr-CO_2-LT were most often treated with the energy 200 mJ, density 21, and depth 2.

The scar changes evident in the H1 and H2 clinical trials were subjected to the correlation analysis in relation to fr-CO_2-LT parameters. The correlation analysis revealed a statistically significant positive correlation between the energy of the laser beam and the change in the extent of the areas elevated above the level of healthy surroundings. Areas treated with higher energy showed a greater area reduction in height. Furthermore, a statistically significant negative correlation was detected between the density of fractional points (density of points in the scanned area per cm^2) and the change in contraction. In scars treated with a lower density of fractional points per cm^2 of treated scar area, less tissue contraction or less ten-

dency to shrink the scar was clinically evident (Tab. 7).

We consider the results of the correlation analysis to be the fundamental outcomes of our work.

Discussion

The efficiency of fr-CO_2-LT is given by a combination of the setting of optional parameters of the fractional CO_2 laser. We select the parameters based on clinical experience and published data, according to the current clinical findings and the intended severity of treatment, which is given by the level of laser output energy (fluence) in combination with setting the density of points in the scanned area (density level) and laser depth (depth level). The power of fr-CO_2-LT must be well tolerated by the patient, especially the pain during the treatment must not exceed VAS 2. The experience of the physician performing laser therapy and feedback based on long-term systematic continuous analysis of laser therapy results in relation to treatment parameters are very important for setting appropriate treatment parameters. To achieve a good effect, laser therapy must be sufficient, but not excessively aggressive. Excessive aggressive laser therapy alters normal healing, causing unwanted scarring and recurrence of scar hypertrophy [10]. If we choose a high laser output energy (> 200 mJ) for laser therapy, it is necessary to adequately reduce the density of points of the treated area to minimize the risk of complicated healing and subsequent unwanted scarring [10].

In CO_2 ablation laser therapy, a beam emerges from the laser and impinges on the skin surface. The beam is solid, unsplit, and the tissue is evaporated throughout the area, without leaving the islands of healthy tissue untouched by the laser. Full-format ablation is associated with the risk of deep thermal destruction of the dermis, resulting in prolonged healing and the occurrence of side effects – permanent dystrophy, infection and scar hypertrophy [23]. Due to the high degree of complications, widespread ablation treatment has not found routine application in clinical practice.

Fractional laser therapy, introduced into clinical practice in 2004 [11], works on the principle of splitting the laser beam into many micro-beams, which cause limited thermal microtrauma at the point of impact with the formation of so-called microscopic thermal zones (MTZ), among which there is a net of healthy tissue [8]. Depending on the set value of the energy, MTZ laser pulses with a diameter of < 400 µm penetrate to different depths of the skin, with the maximum up 1,300 µm. The essence of the effectiveness of fractional ablation laser therapy is the application of a laser beam with high energy and short duration of action.

The introduction of fractional lasers into clinical practice has significantly increased the safety of esthetic and therapeutic applications of these lasers. There is a general agreement that the effect of the therapy depends on the energy used, the treatment density and its depth [8].

There is no consensus on what the specific settings should be for each clinical application [24]. Literature data regarding laser therapy parameters vary considerably from author to author, depending on the type of the laser device used and the scars treated. Therefore, the evaluation, optimization and comparison of the effectiveness of laser therapy in individual studies and for individual types of lasers is problematic. One of the clues for optimizing treatment effectiveness and reaching general consensus could be the works by Bowen [25] and Levi et al [26], where a significant improvement in hypertrophic scars was achieved by adjusting the laser energy to values that led to spot bleeding from at least 50% of the fractional channels. Many authors recommend higher laser energy settings to achieve the best effects [10,27]. At the same time, at higher laser energies, some recommend reducing the treatment density to minimize the risk of complicated healing and unwanted scarring [10]. These general recommendations are in full agreement with our clinical experience.

There is no study that would accurately and objectively compare different specific laser settings and their results. If we compare our clinical experience with the fractional CO_2 and Erb:YAG lasers, we find approximately the same effectiveness of both of them in esthetic indications, where the treatment is performed more gently than in the treatment of hypertrophic scars. The experience with the treatment of hypertrophic scars based on a comparison of the work with both types of lasers in our clinical practice has clearly shown benefits of the fractional CO_2 laser compared to the Erb:YAG laser. The CO_2 laser works significantly faster in rapid fractional laser therapy. For the same depth of ablation that the CO_2 laser reaches with one pulse, the Erb:YAG fractional laser requires several pulses; the fractional Erb:YAG laser therapy is thus less vigorous in a single pulse and the individual treatment lasts considerably longer. The fractional CO_2 laser has better coagulation effects on surrounding tissue, with better potential for spontaneous hemostasis and good patient tolerance. Our experience is in full agreement with published data [10,28]. In favor of the erbium laser, the literature reports a lower risk of side effects, less edema after surgery and shorter healing times [29].

After initial treatment with fr-CO_2--LT, changes in vascularity were clinically evident: red, purple and normally colored scars decreased; on the contrary, pink scars were increased. These clinically apparent changes were not detected as statistically significant. Due to the fact that the scars fade over time with a maturation process with very different rates and intensities individ-

ually, the evaluation of the changes in vascularity after fr-CO_2-LT is clinically unfavorable.

In response to the initial fr-CO_2-LT, there were no clinically apparent changes in scar pigmentation in the intervention scars. Pigmentation can be removed by laser on the principle of selective photothermolysis, the target chromophore of which is melanin at the laser wavelengths 630–110 nm and the pulse length < 1 μs [30,31]. Q-switched type lasers predominantly serve to removing unwanted pigmentations, in particular Q-switched Nd:YAG (532 nm), Q-switched ruby (694 nm), Q-switched alexandrite (755 nm) and also intense pulsed light [22]. The wavelength of the CO_2 laser we use (λ = 10,600 nm) does not reach the target chromophore melanin and therefore no regression by pigmentation can be expected after fr-CO_2-LT. Our results on the sides of pigmentation and its influence are thus fully in line with available literature sources.

The height of the scars was assessed by a qualified clinical estimation. In 24% of the scars initially assessed by a qualified clinical estimation as higher than 2 mm, the height was reduced below 2 mm after the first treatment with fr-CO_2-LT. According to the statistical analysis of clinical data, these changes were detected as statistically significant. In routine clinical practice, the possibilities of the objective measurement of changes in the height of scars after laser therapy are limited by the availability of specific equipment. The clinical evaluation of scar height is most often visual; it is a simple qualified estimate before and after the laser therapy. It is certainly partly subjective and biased by the evaluator, but it is fully sufficient for routine medical practice. If the doctor and the patient perceive the changes as an improvement, it can be assumed that the "evaluators" around the patient in his daily life will be perceived similarly. We consider the improvement perceived by the doctor and the patient to be the primary goals of fr-CO_2-LT. Conversely, if the improvement were objectively measured after fr-CO_2-LT and at the same time no changes were evident in the clinical trial before and after fr-CO_2-LT, the changes would be invisible to the naked eye. In our opinion and experience, such laser therapy cannot be considered clinically beneficial.

The fact that as early as after the first treatment, there was a statistically significant reduction in the height of the scars below 2 mm, can be attributed in our group to the fact that the entry height of these scars was most often 2.5–3 mm. The achieved reduction in the height is in accordance with our clinical practice where we routinely reduce the scar by 0.5–1 mm in one treatment. A greater height reduction in a single treatment is not desirable, as it is associated with prolonged healing and the risk of unwanted scarring and recurrence of hypertrophy [32,33].

The pliability, vascularity, pigmentation and height are usually heterogeneous within the surface of hypertrophic scars after burns or dermoepidermal autotransplantation; individual areas of the scars differ in these qualities and have different proportions. After the treatment with fr-CO_2-LT, the individual monitored qualities and their relative representation within the scar area change. This fact cannot be affected by VSS, which can be considered a significant limitation when evaluating the response to fr-CO_2-LT. Thus, VSS can be considered for the needs of clinical monitoring of the response to laser therapy as a less robust evaluation tool, with suboptimal informative value, rather suitable for dichotomously evaluated characteristics only [34]. Thus, finding new assessment tools that better capture the qualitative and quantitative specters of scar changes after laser therapy is highly desirable. The HTT protocol designed by the authors of the project is a promising evaluation tool from this point of view, but it must be verified by further studies.

The changes evident in the area of the intervened scars are much better recorded by the evaluation, which focuses on the proportional representation of these changes in the area of the scar. An important quality of the scar perceived very sensitively by the patient and his surroundings is its color and color homogeneity within the scar (intralesional) and towards the surroundings (extralesional). It is referred to in English literature as the so-called "patch appearance". Due to the fact that scars gradually fade over time with different interindividual variability even without treatment, improving scar color in the sense of hyperemia regression accelerates spontaneous scar fading and improves the esthetic appearance of the scar that can be expected after further laser application.

In our group, there was a noticeable increase in the color homogeneity of the scars with the respect to the surroundings, given mainly by the improvement in the scars colors that were at the start of the treatment completely inhomogeneous with the surroundings. The statistical analysis found these changes statistically insignificant, but clinically evident and the patients perceived better color harmony of the scars with the surroundings very favorably.

The reduction in hypertonus of intervened scars was also clinically evident and significant, although it was not detected as statistically significant. The clinical significance of hypertonus reduction lies in the release of scar tension, thanks to which we can gradually release incipient or mild scarring contractures [35–37] and reduce the risk of functional consequences without the need for rapid indication of surgical treatment, which is another surgical burden for the patient with all its risks, including recurrence of hypertrophy [14].

Conclusion

Properly performed fractional scar laser therapy is an effective treatment modality for the treatment of functionally insufficient and esthetically unsightly extensive hypertrophic scars. Individual treatment of scars with fractional CO_2 laser therapy brings clinically evident and statistically significant improvement – reduction of scar height, decrease of its tension, improvement of homogeneity of scar relief intra- and extra-lesionally and reduction of the area of scar hypertrophy. This initial improvement positively motivates the patient for good cooperation and repetition of laser therapy, which is a necessary prerequisite for achieving an esthetically and functionally satisfactory result. By optimizing the parameters of fr-CO_2-LT, it is possible to achieve effective and safe flattening of the scar relief and release of its hypertonus with a minimum number of treatment sessions. To assess the effectiveness of laser therapy, a sufficiently specific and sensitive evaluation tool is necessary, which can more accurately identify the effect of fractional laser therapy. The HTT protocol proposed by the authors shows a very promising potential in this respect. Further studies of its possible use in clinical practice to evaluate the effectiveness of laser therapy are necessary.

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Anterior open bite – diagnostics and therapy

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Summary

An anterior open bite (AOB) is an occlusal disorder that causes the patient both an aesthetic and functional handicap. The lower third of the face is disproportionately larger. Patients are unable to properly occlude with the anterior part of dental arch and occlusion only happens in the premolar and/or molar regions. An anterior open bite may be the result of anatomical anomalies. Long term stability as well as an immediate outcome of the surgery depends on the choice of a suitable treatment strategy. In this article, we review options of AOB treatment, from classical orthodontic treatment to current combined orthodontic and surgical approach with a benefit of an anchor system.

Key words

anterior open bite – orthodontics – combined orthodontic-surgical therapy – anchor systems – transversal expansion – Le Fort I osteotomy – bimaxillary segmental osteotomy – result stability – bilateral sagittal split osteotomy (BSSO)

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Introduction

An open bite is defined as an occlusal condition in which opposing teeth do not come into contact. It is clinically manifested in the frontal or lateral part of the jaws. Our article focuses on the treatment modalities of an anterior open bite (AOB).

AOB brings complications for patients, which are both aesthetic and functional. Patients with AOB cannot properly use their front teeth. In extreme cases, we see bruxism issues in the posterior segment.

A frontal open bite is characterized as a condition with larger eruption of distal teeth and oval facial phenotype (long face). These patients may have an incompetent lip seal and there are changes in the sense of "clockwise" rotation on the cephalogram. The treatment is perceived in orthodontics as one of the most complex [1–6]. It is not only a complexity in terms of therapy, but also in the retention of the result. There are often various forms of recurrence of the defect with a reduction of the overbite in the area of upper incisors and the relapse of the negative depth of the occlusion.

Etiologically, it is a very heterogeneous unit. Reyneke and Ferreti [7] define two mechanisms of AOB formation: morphogenetic and adaptive theories. The morphogenetic theory is a growth disorder in the sense of the deviation of genetically conditioned control of the growth pattern with the occurrence of abnormal occlusion. In the adaptive theory, disrupted occlusion is caused by secondary adaptation to functional anomalies at the naso-oropharyngeal level.

Evaluation

There is no clear consensus on optimal AOB therapy [1]. Many articles focus on the effect of the treatment itself. However, it is very important to focus on the long-term stability of the outcome [8]. Unfortunately, relevant studies and meta-analyses do not provide a clear answer to the stability of the outcome [1,8]. As the group of patients is highly heterogeneous, there are often inconsistencies in baseline pre-treatment descriptions of the studies, as reported by Greenlee [1,9–16]. This applies in the surgical patients' group in particular, where it is often unclear whether the presence of an open bite was present prior to orthodontic treatment or occurred as a result of orthodontic decompensation.

Diagnostics

The incidence of AOB shows large variance among different ethnicities, which supports the theory of genetic influence on the development of the skeletal defect. According to Proffit et al [14], the incidence of AOB in the Caucasian population in the USA is 2.9%.

The phenotype of a patient with AOB is as follows: the vertical component of the growth can cause a narrowing of the palatal arch and the formation of crossbite. The incisors cannot compensate for the vertical direction of the growth and the space between the upper and lower

incisors begins to open, causing a negative overbite. An insufficient lip seal then leads to the tongue thrust in order to close the gap between the lips during swallowing. This mechanism of action applies pressure on the incisors which then leads to a further open bite.

The lateral cephagram shows posterior rotation, the angle formed by the lines Nasion – Sella (NS) and the mandibular line (ML) is increased, the so-called high angle of the mandibular line. We also find a significant antegonal notching on the lower edge of the mandible, receding chin, larger inter-incisal angle, smaller inter-molar angle and an enlarged lower third of the face.

For proper diagnosis, we focus on the location of the defect, whether it is located in the maxilla or mandible or whether it is a combination of both. The age of the patients is very important. In children, we focus on habits, such as thumb sucking. Sucking is a physiological phenomenon in children that should disappear by the age of 6. If present beyond the age of 6, it becomes a risk factor in terms of AOB [16] development. Airway obstructions at the level of the oropharynx and nasopharynx [17] is another causal factor, especially in the presence of hypertrophic adenoids. In patients with allergic rhinitis, there is an activation of adaptive neuromuscular compensation with the development of AOB as part of the image of the so-called "facies adenoidea". Masticatory palsy is considered as another risk factor for the development of an anterior open bite. Reduced muscle strength will allow molar eruption into supraocclusion [18] and thus may lead to the development of AOB.

In adult patients, the onset of AOB is due to excessive vertical growth of the upper jaw, shortening the ramus of the lower jaw, or a combination of both. Clinically, we find an extension of the vertical height of the face, paranasal flattening, a convex profile, a narrow base of the nose and incompetent lips [7].

Therapy

The treatment varies according to age of the patient.

If the cause of an open bite is a habit or airway obstruction as described in the previous section, stopping the habit (e.g. by wearing a ready-made vestibular veil), or removing the obstruction can lead to a causal adjustment of the condition without the need for further therapeutic intervention.

If an open bite is present even without an obvious cause, then we choose the "wait and see" method in deciduous dentition. In mixed dentition, orthodontic removable devices are a preferred method of treatment.

For an adult patient, there are two basic therapeutic approaches; orthodontic or combined orthodontic-surgical. The orthodontic closure of an anterior open bite consists of: transverse expansion of the upper dental arch, extrusion of the upper and lower incisors, extractions of the upper and lower premolars with retrusion of the upper and lower incisors. Other treatment options include intrusion of the molars, e.g. by means of temporary anchoring devices [19,20], a miniplate temporarily fixed to the facial bony structures [21], or extraoral traction with class III elastics [22,23]. Some authors argue that the transverse expansion of the distal part of the maxilla has debatable stability, as it may lead to tilting of the teeth rather than to widening of the palate. On the other hand, Angelieri et al presents a classification of the maturation of palatal suture independent on the age, where one can decide between the stable orthodontic expansion by the use of fixed palatal expander (rapid maxillary expansion-RME /HYRAX) or by surgically assisted expansion (SARME or segmental Le Fort I) [24].

Today, combined surgical-orthodontic therapy is the gold standard in anterior open bite therapy. This resolves both occlusion and aesthetic concerns. However, the prerequisite is a terminated growth (usually after 18 years of age in girls and a year later in boys) based on a wrist X-ray.

The treatment consists of four stages: decompensation, surgery, final orthodontic treatment phase and retention.

Decompensation phase

The patients are informed that during the decompensation phase their defect will be significantly overexpressed, as the compensatory mechanisms of their teeth will be reduced. In patients with AOB, we primarily focus on the presence of one or two occlusal planes (biplanar occlusal plane – BPO). In the case of BPO, we try to maintain both planes and place the teeth in the most stable position without trying to level the occlusal plane. We also avoid intrusion of the distal teeth or an attempt at transverse expansion in the distal part of the dental arch. In dental crowding, one of the premolars can be extracted to achieve a stable position of the teeth in the alveolus. If segmental surgery is planned in a patient with BPO, it is necessary to parallelize the roots of the teeth at the site of the intended osteotomy to minimize the risk of the damage to the roots during the surgery. During the orthodontic phase, we place great emphasis on the position of the lower teeth in the dental arch. This serves as a "splint" to which we adapt the maxillary teeth, especially in the case of segmental surgery [7].

Surgery

AOB can be closed by monomaxillary Le Fort I osteotomy non-segmentally or segmentally (we follow the number of occlusal planes, which is usually two in AOB [20]) and autorotation of the mandible. However, in most cases, bimaxillary segmental surgery is required. For each segmental operation, it is necessary to monitor the vertical position of the incisale (measured to the reference point, e.g. a screw inserted into the glabella area or to the inner corner of the eye). The most common forms of seg-

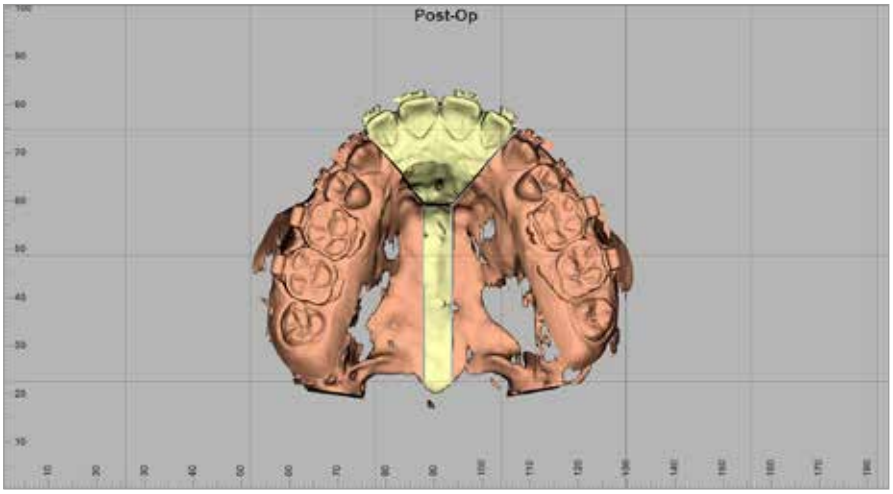

Fig. 1. "Y" osteotomy.

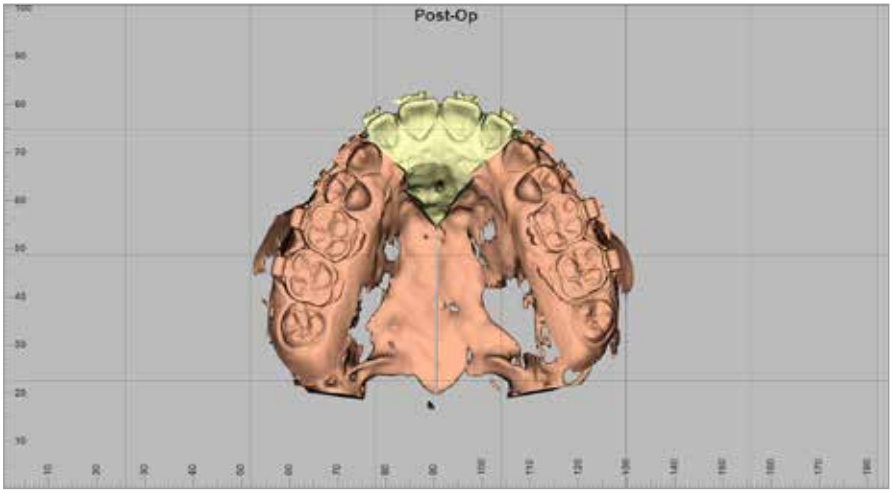

Fig. 2. "H" osteotomy.

mental osteotomy on the palate are the so-called: "Y" (Fig. 1) or "H" (Fig. 2) osteotomies, obtaining 3, resp. 4 fragments. These parts are then placed in the required vertical and horizontal position.

Final orthodontic treatment

There are minor adjustments in the position of individual teeth, or closing the gaps between them.

Retention

We perform retention using removable or fixed retainers on lingual surfaces of the frontal teeth in the upper and lower dental arches. In patients with AOB, it is necessary to regularly check the stability of the result due to a great tendency of the defect to relapse [25].

Conclusion

Frontal open bite therapy is the most demanding procedure in combined orthodontic-surgical therapy of this defect. It requires a highly motivated patient and an experienced team of orthodontist and surgeon. Careful case planning is a paramount for success. The experience of the members of the treatment team plays a vital role in choosing an appropriate treatment modality. Some authors describe the combined performance associated with upper jaw floor expansion in combination with BSSO [26]. The financial side of the treatment also plays an important role in author's opinion. In our region, the surgical portion of this treatment is fully covered by medical insurance; however, orthodontic treatment has a significant out-of-pocket portion.

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Cyanide poisoning in patients with inhalation injury – the phantom menace

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Summary

Inhalation injury is a serious complication in patients with burns that dramatically increases their morbidity and mortality. These patients are always suspected of having inhalation injury with potential intoxication. We usually encounter carbon monoxide intoxication, but it is necessary to think about the possibility of poisoning by other combustion products. Cyanide intoxications are less common, but their diagnosis and treatment are more complicated. The diagnosis can only be based on the history, clinical findings, and indirect laboratory signs. Direct determination of plasma cyanide levels is not generally adopted in routine clinical practice. Nowadays, several specific antidotes with different mechanisms of action are available. There are no clear guidelines on the antidote of choice, as the evidence base is limited by a lack of randomised controlled trials in humans. In two mini case reports, we present our experience with the diagnosis and therapy of patients with suspected cyanide poisoning.

Key words

inhalation injury – cyanide intoxication – hydroxocobalamin – sodium thiosulphate – nitrites-induced methaemoglobinaemia

Raška F., Lipový B., Hladík B., et al. Cyanide poisoning in patients with inhalation injury – the phantom menace. Acta Chir Plast. 2021, 63(4): 185–189.

Introduction

Respiratory complications caused by smoke inhalation and associated major burns are a challenge for physicians taking care of these patients [1]. Inhalation injury comprises direct thermal injury, chemical irritation of lung parenchyma and the systemic effects of absorption of the toxic products of combustion. It is well known that fire generates various gases, some of them are very toxic, such as carbon monoxide (CO) and hydrogen cyanide (HCN), which can be lethal on inhalation [2]. There is increasing evidence that cyanide toxicity plays an important role in smoke inhalation injury and its associated mortality [3].

Cyanide refers to any substance that contains the cyano (CN) group. This includes inorganic cyanides with a negatively charged cyanide ion, such as sodium cyanide, and organic cyanides with a covalent CN group, such as methyl cyanide. Inorganic cyanides are salts of hydrocyanic acid, also known as hydrogen cyanide [4]. Cyanide compounds are widely used in the production of resins, adhesives, explosives, or rubber products. They are essential in the electrochemical industry. They are used for hardening steel, for extracting gold and silver from ore minerals or for plating. Cyanides are released into the air during the combustion of substances containing carbon and nitrogen (plastics, glass wool, wool, silk, nylon, foam or varnishes).

Cyanide's mechanism of action as a poison lies in its inhibition of numerous enzyme systems, including xanthine oxidase, carbonic anhydrase, glutamate decarboxylase, and cytochrome oxidase. Binding to the ferric iron of cytochrome a3, the last enzyme in the mitochondrial electron transport chain, is considered cyanide's most important effect [5,6]. This leads to shutting down cellular aerobic phosphorylation. Whole blood cyanide levels above 0.5–1.0 mg/L (19–40 µmol/L) are regarded as toxic [7]. Untreated levels above 2.5–3 mg/L (96–115 µmol/L) are potentially fatal [8].

We present two mini case reports of patients with burn trauma associated with inhalation injury and very probable cyanide intoxication. Due to the urgency of the situation, the diagnosis of intoxication was made on the basis of clinical and laboratory evidence, without confirmation by determining plasma cyanide levels.

Mini case report I

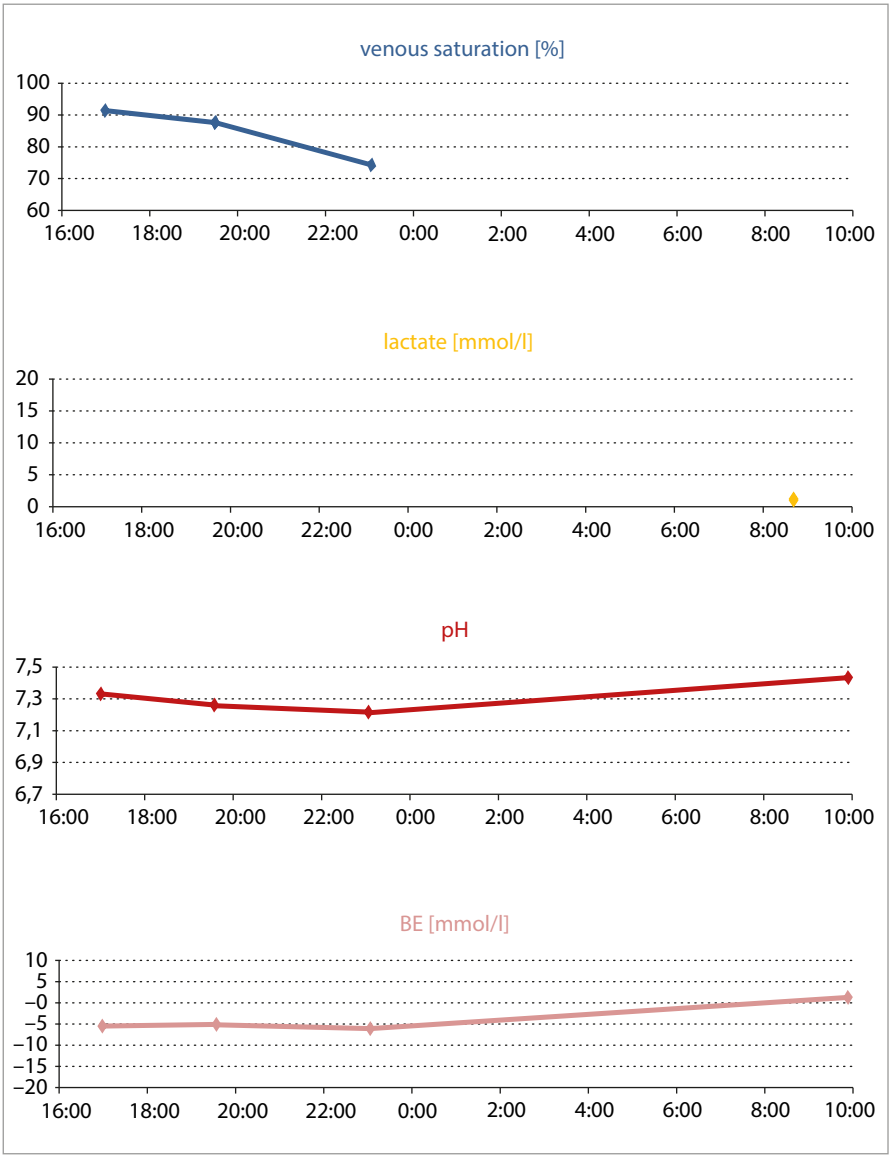
A 61-year-old woman was found in a burning house. The exact aetiology of the fire was unclear; the most probable version was burning a candle. The patient was intubated by the first responders, connected to mechanical ventilation and transferred to the Department of Burns and Plastic Surgery, University Hospital Brno.

The initial examination was performed in the operating theatre under general anaesthesia. A central venous catheter

(CVC) and arterial line (AL) were inserted and the burn wounds were treated. The total extent of the burns was 26% total body surface area (TBSA). As a part of the complex diagnosis, fibreoptic bronchoscopy (FOB) was performed and revealed grade III inhalation injury.

After the primary treatment, the patient was hospitalised at the Intensive Care Unit (ICU) of our department. The individual fluid resuscitation was initiated, using continuously administered balanced crystalloid solutions. Catecholamine support was needed due to circulatory instability. Active and passive tetanus immunization was also performed on admission. Inhalation therapy was introduced according to the standard inhalation injury algorithm (mucolytics, unfractionated heparin, salbutamol). Metabolic acidosis (pH 7.31) and increased venous oxygen saturation (0.906) predominate in the initial laboratory findings. Due to the high suspicion of cyanide intoxication, Cyanokit (hydroxocobalamin for injection) 5 g was administered intravenously. Arterial and venous blood gas parameters began to normalise at an early stage after antidote use (Graph 1).

In view of the location of the full-thickness burns on the face and ventral side of the neck, and in view of the expected long-term mechanical ventilation, surgical tracheostomy was performed on 1st day postburn. Bronchoscopy was performed regularly with gradual improvement of the findings in the upper and lower airways. After the successful management of the initial burn shock, surgical treatment followed, including surgical necrectomy, wound bed preparation and wound closure using split-thickness skin grafts. The grafts healed without any complications. Only a residual defect of the frontal area with exposed frontal bone had to be covered with a serratus anterior free flap [9]. After 114 days of hospitalization at our department, the patient was transferred to the Department of Eye Treatments of the University Hospital Brno to resolve corneal defects.



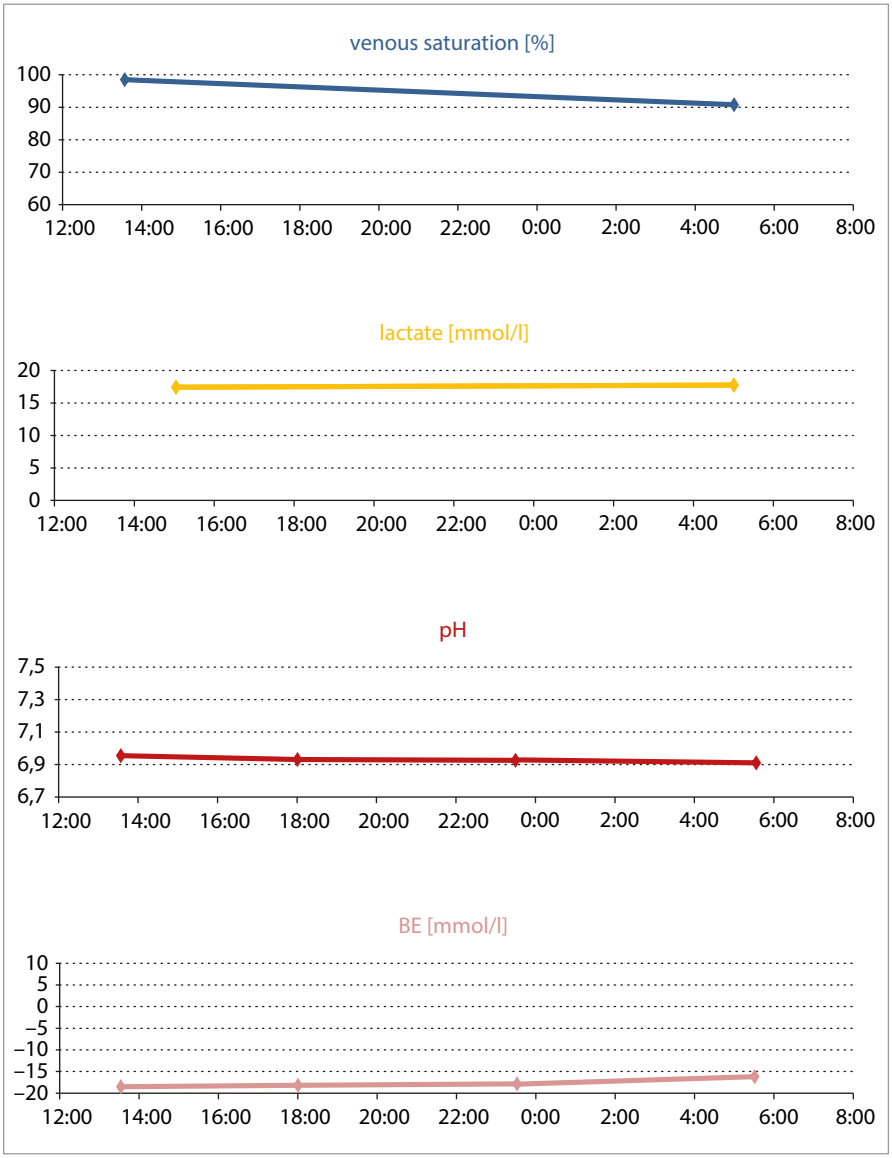
Graph 1. Progress of laboratory parameters in the early stages of hospitalisation (mini case report I).

Mini case report II

A 46-year-old man was found unconscious in a burning house, rescued by a fire brigade. An early ventricular fibrillation developed in the patient, for which cardiopulmonary resuscitation was initiated immediately. Blood circulation was successfully restored within 3 minutes. Then he was transported to our department under mechanical ventilation.

The initial examination was performed in the operating theatre under general anaesthesia. A CVC and AL were inserted and the local treatment was initiated. The total extent of the burns was 31% TBSA, most of them included full-thickness burns. FOB was also performed and revealed grade 3 inhalation injury. Bronchoalveolar lavage was performed.

After the primary treatment, the patient was hospitalised at ICU of our department. Despite the massive fluid resuscitation, the support the blood circulation with high doses of catecholamines was necessary. Inhalation therapy was introduced according to the standard inhalation injury algorithm. Signi-



Graph 1. Progress of laboratory parameters in the early stages of hospitalisation (mini case report I).

ficant metabolic acidosis (pH 6.96), lactate elevation (12.5 mmol/L) and venous blood arterialization (0.985) were detected in the laboratory analysis. Due to clear signs of cyanide intoxication, Cyanokit (hydroxocobalamin for injection) 5 g was administered immediately, followed by 10 mL natrium thiosulphate 10% administrated intravenously. At the same time, carbon monoxide intoxication was confirmed (COHb 0.179).

Despite all efforts, it was not possible to stabilise the patient's clinical condition as well as laboratory parameters (Graph 2). Gradually, symptoms of multiple organ dysfunction developed. The death caused by multiple organ failure was noted on 1st day postburn.

Discussion

Recognition of cyanide intoxication is more complicated than carbon monoxide intoxication. Clinical signs are non-specific and almost identical to carbon monoxide intoxication. Chronic low-dose exposure includes anxiety, dizziness, blurred vision, headache, nausea, hypertension, tachycardia, palpitations, or tachypnoea. In acute intoxication with higher doses, the main symptoms are somnolence to loss of consciousness, convulsions, bradycardia, hypotension, bradypnoea, development of pulmonary edema, cardiac arrhythmias, and circulatory instability [3]. However, patients with a history of burning in an enclosed space and with suspected inhalation injury are often intubated at the site of the accident already and connected to an artificial lung ventilation. Therefore, these clinical signs cannot always be reliably identified.

An increase in oxygen saturation of venous blood is typical for cyanide intoxication. This phenomenon is described as the arterialization of venous blood. On the other hand, arterial blood oxygen saturation is not reduced. Increased lactatemia along with an increase in the anion gap represents another laboratory sign of cyanide intoxication. We regularly find metabolic acidosis.

In contrast to the determination of carbonyl haemoglobin in carbon monoxide intoxication, the direct determination of plasma cyanide levels by atomic absorption spectrophotometry is almost unusable for routine clinical practice. This examination is performed in a few specialised laboratories only and usually takes several days. Therefore, it is necessary to start therapy even if poisoning is suspected, without definitive laboratory confirmation.

Cyanide intoxication therapy is based on supportive therapy in combination with the use of a specific antidote. Aggressive supportive care is critical to successful antidote use and survival in the cyanide-intoxicated patient. The goals of the treatment in the early stages of poisoning are to maintain adequate tissue perfusion and oxygenation while antidotal treatment and endogenous mechanisms reduce the availability of free cyanide at the sites of its toxic effects [10]. The therapy is based on high-flow oxygen. In more serious cases, airway management is required by endotracheal intubation, especially if intoxication is part of inhalation injury. The use of hyper-

baric oxygen therapy is also advocated. However, the evidence for its efficacy in this situation is limited and inconsistent [11–13]. On the other hand, hyperbaric oxygen therapy is essential in carbon monoxide poisoning. We immediately start volumotherapy in case of hypotension development, using vasopressors, if necessary. We take care of metabolic acidosis. Performing the supportive therapy should not delay the administration of a specific antidote in any way.

The first group of cyanide antidotes are cobalt compounds. Hydroxocobalamin (Cyanokit) is a natural form of vitamin B_{12}. It exchanges the hydroxy group for cyanide to form cyanocobalamin, a non-toxic substance that can be excreted by the kidneys [14]. Hydroxocobalamin has not been associated with clinically significant adverse effects with the exception of isolated allergic reactions, headache and transient, asymptomatic elevations in blood pressure [15]. It is also possible to observe skin and urine discolouration (Fig. 1). Dicobalt edetate (Kelocyanor) is the second antidote of this group. Dicobalt edetate chelates cyanide as cobalticyanide. It is associated with several serious side effects, including vomiting, anaphylaxis, hypotension and cardiac arrhythmias [16]. These side effects may be even more pronounced if dicobalt edetate is administered in the absence of cyanide toxicity; therefore, it is generally recommended to use it only as an antidote in severe confirmed cases of cyanide toxicity [17]. This medicinal product is not approved by the State Institute for Drug Control in the Czech Republic.

Another group consists of sulphur donors. Endogenous thiosulphate forms part of the body's normal excretion mechanism of cyanide, by transferring sulphur to cyanide to form thiocyanate which is excreted by the kidneys, under the action of the catalyst rhodanese [3]. Natriumthiosulphate 10% is approved by the State Institute for Drug Control in the Czech Republic. Much of the evidence in the literature assesses the efficacy of sodium thiosulphate when given in conjunction with other antidotes [18]. Thiosulfate is contraindicated in patients with renal insufficiency because the thiocyanate formed may cause toxicity [19].

The last group is represented by methaemoglobin inducers. Nitrites such as sodium nitrite or amyl nitrite oxidise iron in haemoglobin from ferrous to ferric iron, forming methaemoglobin. 4-dimethylaminopyridine (4-DMAP) works by a similar mechanism via methaemoglobin. This is usually facilitated by providing a large pool of ferric iron in the form of methaemoglobin to complex cyanide. Cyanide preferentially competes with Fe^{3+} of methaemoglobin as compared with that of cytochrome oxidase and eventually binds with the former to form cyanmethaemoglobin. Thereby, the activity of inhibited cytochrome oxidase is restored [20]. The effectiveness of amyl nitrite inhalation as a first aid for cyanide poisoning is often disputed because of its inability to generate methaemoglobin more than 6%. Approximately 15% of methaemoglobin is required to challenge one LD50 of cyanide [19]. On the other hand, higher levels of methaemoglobin may have a side effect on the oxygen carrying capacity of blood. Therefore, they are not suitable for patients with inhalation injury and concomitant carbon monoxide poisoning. In addition, nitrites cause vasodilation and consequently hypotension which can lead to circulation instability, a side effect which could be particularly dangerous in patients with major burns [21]. Nowadays, only 4-DMAP is approved by the State Institute for Drug Control in the Czech Republic.

The definitive treatment of cyanide poisoning differs in various countries because of different medical practices and guidelines. The Cyanide Antidote Kit is widely used in the United States. The kit has been previously known as the Lily or Pasadena kit, and now the Taylor Cyanide Antidote Package. The current Taylor kit contains three medications: amyl nitrite, sodium nitrite, and sodium thiosulphate [10]. In contrast, cobalt compounds are preferred in most European countries and in developed Asian countries. The safety and efficacy of all the antidotes are still being debated, with no worldwide consensus for first choice antidote [20]. There are no randomised controlled human trials to evaluate the efficacy of cyanide antidotes in the literature, only animal models and case series. There are several factors to account for this, including the relative rarity of cyanide poisoning, the lack of a rapid test to confirm the presence of cyanide toxicity and ethical issues which would prevent the use of a placebo when cyanide

Fig. 1. Red discolouration of the urine after Cyanokit administration.

toxicity is suspected. In the absence of controlled human studies, these animal models and case series become the only evidence on which we can base our practice [3].

Bebarta et al found that hydroxocobalamin with sodium thiosulphate led to a faster normalised mean arterial pressure compared with sodium nitrite with sodium thiosulphate. However, there was no difference between the antidote combinations in mortality, serum acidosis, or serum lactate [22]. The same author notes that sodium thiosulphate alone failed to reverse cyanide-induced hypotension and resulted in 100% mortality in the swine model of severe cyanide toxicity. The addition of sodium thiosulphate to hydroxocobalamin did not improve mortality, haemodynamic values, or biochemical markers such as lactic acidosis, acidaemia, or cyanide levels [23]. Moreover, if infused improperly, the combination may reduce hydroxocobalamin's effectiveness [24]. Due to its proven effect and minimal side effects, more and more authors are inclined to believe that hydroxocobalamin appears to be the most promising antidote for cyanide poisoning.

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Cooperation of the maxillofacial and plastic surgeon in reconstructive surgical procedures in gunshot injury – a case report

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Summary

Lower and middle face defects resulting from gunshot wounds often cause severe functional and cosmetic deformities. The purpose of this case report is to refer to our experiences in the treatment of facial gunshot trauma associated with attempted suicide that resulted in a complex facial injury. The goal of the treatment of complex facial injuries is a proper reconstruction of the hard and soft tissue defects and sufficient rehabilitation of the relevant functions, such as speech, nutrition and appearance. A close cooperation of the maxillofacial and plastic surgeon is essential to achieve a satisfactory outcome.

Key words

facial reconstruction – plastic surgery – maxillofacial trauma – facial gunshot injury – maxillofacial surgery

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Introduction

Facial gunshot injuries can result in devastating functional and aesthetic consequences for the patients. Surgical management of facial gunshot injuries is challenging and requires a multidisciplinary approach. The timing and sequence of the surgical procedures used in reconstruction and rehabilitation of maxillofacial gunshot wounds are crucial to a successful outcome and aesthetic result. This article is focused on the cooperation of oral and maxillofacial surgeons and plastic surgeons in surgical management of a self-inflicted maxillofacial gunshot trauma in a 25-year-old man. The suicide attempt resulted in the devastation of the central part of the face with a loss of the nose and anterior sections of the jaws. An important point of the primary surgery was to reconstruct the preserved parts of the face and to create a stable base for the reconstruction of the missing parts of the face. The reconstruction of the nose took place 1 year after the primary surgery. This case presents a 7-year stable, functionally and aesthetically satisfactory result of nasal reconstruction after a gunshot wound.

Description of the case

A 25-year-old Slovak male was referred to the Trauma Centre of the University Hospital in Martin on 17 September 2014, directly after a suicidal attempt with long-barrelled weapon. He fired the gun with the barrel placed under his chin. The bullet left the face in the central midfacial area, not causing the damage of the neurocranium. He suffered a devastating injury of the central lower face and midfacial area with penetration to the orbital spaces without damage of the eyes. On admission, the patient was sedated, the airway was secured by orotracheal intubation and the injured face was covered with dressing, without signs of severe bleeding. He underwent tracheostomy, superficial debridement and an adaptive suture of a soft tissue injury to ensure local haemostasis (Fig. 1). After his stabilization, the check of airways and bleeding as well as the radiological and laboratory investigations were performed. The patient received a tetanus prophylaxis and was commenced on broad-spectrum antibiotics. Blood loss was substituted. The tomographic examination confirmed a devastating and comminutive injury of the frontal part of the mandible and midfacial area involving maxilla, palatal and nasal bones, zygomatic and orbital bones (Fig. 2). Because the injury was partially avulsive and involved the hard and soft tissue of the face, maxillofacial surgeons were consulted with the indication for a surgical revision, debridement, fracture

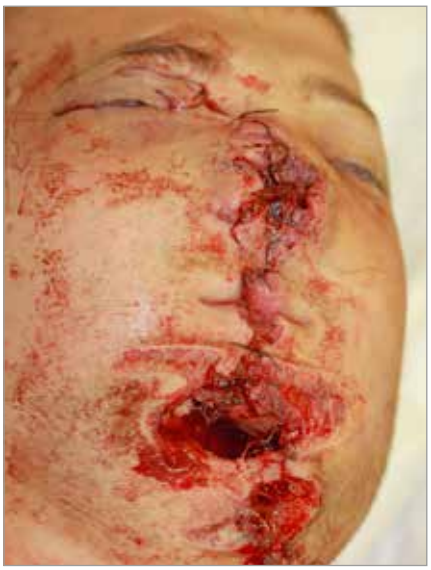

Fig. 1. Facial view of the patient on admission with an adaptation suture of the soft tissue; 1 day before the first surgical treatment.

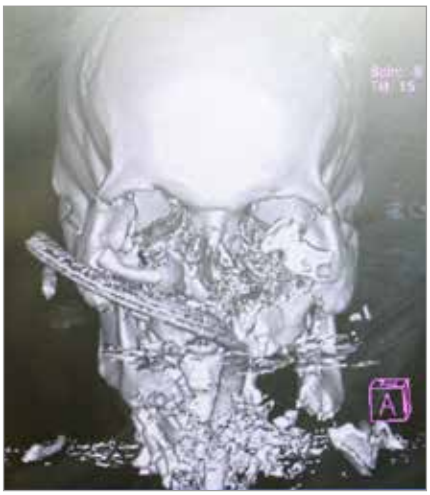

Fig. 2. Computed tomography image of devastating facial injury before the first surgical treatment.

Fig. 3. Facial view after the primary surgical treatment.

stabilisation and primary closure. Next day, surgery was performed under general anaesthesia.

The first operation began with careful debridement of the facial injury. During the exploration, the removal of nonviable bone fragments, foreign particles and contaminated soft tissue parts were performed with continuous haemostasis. For the open reduction and internal fixation of both zygomatic, nasoorbital and lateral maxillary fractures, the multiple plate osteosynthesis and wire osteosutures were used. After the reconstruction and stabilisation of lateral midfacial fragments, the real extent of central upper jaw defect with an avulsion of external nose was obvious. This central defect was supported with a long osteosynthetic titanium plate connecting both lateral maxillary segments. Subsequently the avulsive defect of the frontal part of the mandible was temporarily reconstructed with a prefabricated mandibular reconstruction plate. Satisfactory occlusion of the remaining distal teeth was achieved. The facial soft tissue wounds were than closed in layers. Local flaps were used for soft tissue reconstruction of skin and muconasal defects. Large plastic tubes were inserted to maintain the continuity of the inferior nasal meatus (Fig. 3). Postoperative computed tomography showed a good position of bony structures and reconstruction plates (Fig. 4, 5). For the enteral nutrition support, a gastrostomy tube was placed the next day. Nasal tubes were removed two weeks postoperatively. Tracheostomy tube was removed 3 weeks postoperatively and broad-spectrum antibiotic therapy was cancelled 28 days after the surgery. The wound healing was uneventful except of the area of soft tissue covering the reconstruction plate bridging the central

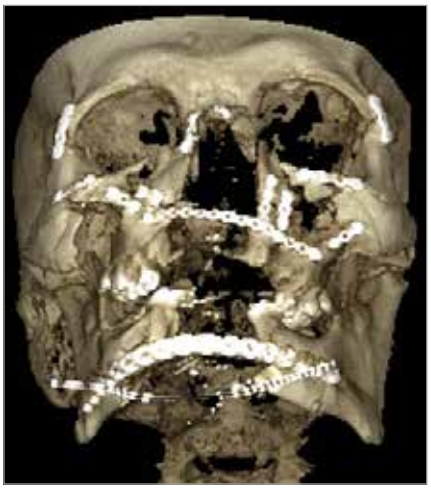

Fig. 4. Cone beam CT image after the first surgical treatment.

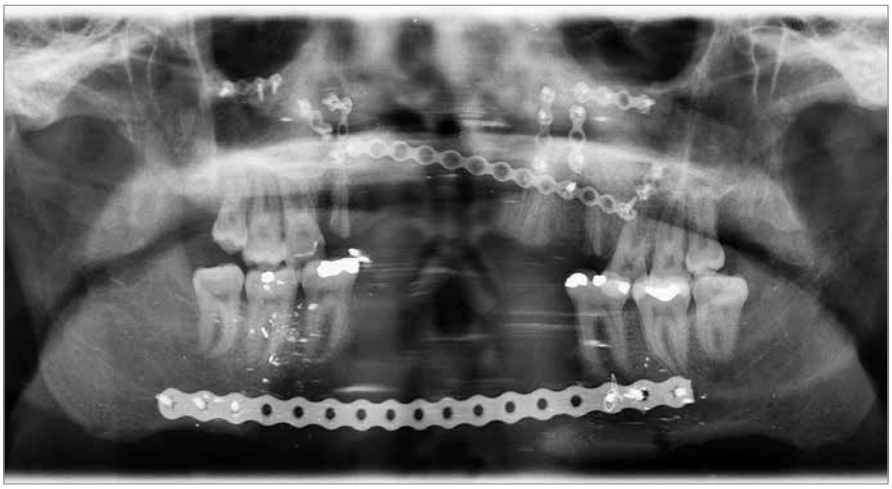

Fig. 5. Orthopantomogram after the first surgical treatment.

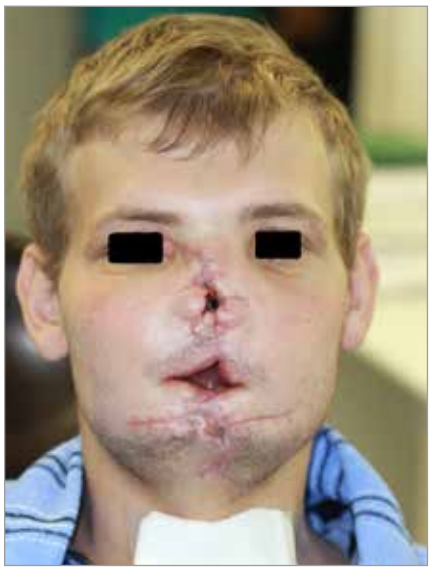

Fig. 6. Facial view ("en face") of the patient 2 months after the first surgical treatment with external exposure of reconstruction plate.

Fig. 7. Facial view (profile) of the patient 2 months after the first surgical treatment.

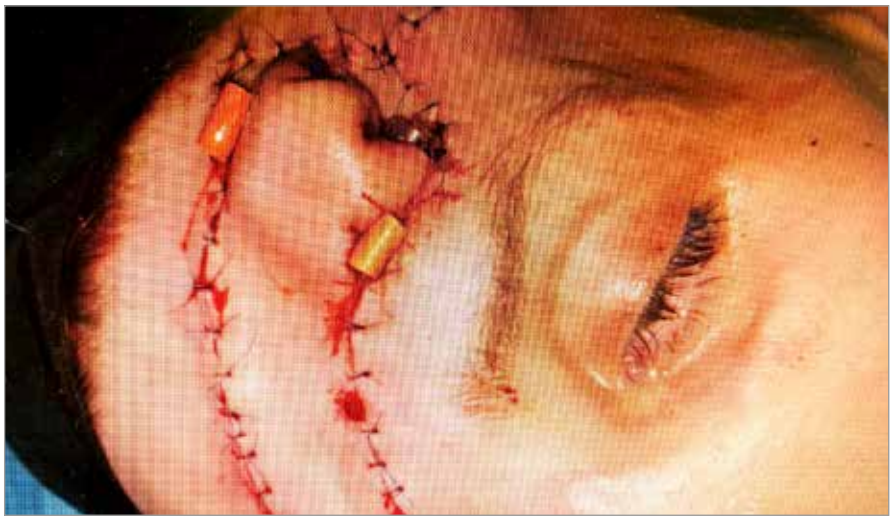

Fig. 8. Indian flap created on the forehead.

mandibular defect (Fig. 6, 7). In this area the healing was complicated with a partial external exposure of the reconstruction plate with a subsequent chronic infection. Two months after the first operation the prefabricated mandibular reconstruction plate had to be removed. Afterwards, the skin defect in the chin area healed normally. The decision was made to prepare a patient-specific titanium implant for the secondary reconstruction of the central mandibular defect. A postoperative CT examination was used for this purpose. The gastric tube was removed 4 months after the surgery. Subsequent oral feeding of the patient was complicated with a persistent oronasal communication. This was successfully closed under local anaesthesia 8 months after the primary surgery by a maxillofacial surgeon. After complete healing of the facial wounds, a plastic surgeon was consulted for the reconstruction of the missing nose.

One year after the injury incident, the plastic surgery team started to recreate the nose. After measurements, the delayed Indian flap was created under general anaesthesia. The segment of the left ear cartilage was used to support the new columella, and a split thickness skin graft from the upper left arm was used for reconstruction of the nasal lining and covering the defect on the forehead (Fig. 8). The nostrils were supported by plastic tubing. After 2 weeks, delayed flap was lifted from its base and transposed to the defect to reconstruct the new nose. The donor site was covered with a split thickness skin graft from the left arm to avoid the deformation of the left eyebrow. During each stage the patient was given broad-spectrum antibiotics to prevent infection. After 24 days from the last operation, when the flap at the recipient site was well healed, the pedicle of the flap was divided and the whole flap was tailored to achieve a better aesthetic result.

Two years after the injury, the patient underwent another operation under general anaesthesia. The patient-specific titanium implant for the reconstruction of the missing frontal part of the mandible was implanted from an extraoral approach by maxillofacial surgeons in cooperation with plastic surgeons. The next step of the reconstruction process was a medial canthoplasty of the right eye to correct epicanthal fold. The patient was placed on antibiotics and the postoperative course and wound healing was uneventful (Fig. 9).

Eight months after the reconstruction of the mandible with a patient-specific implant, the patient reported mandibular discomfort. The radiological examination revealed a fracture of the implant on the left side. Therefore, the re-operation with explantation of the broken implant and implantation of a new patient-specific implant was scheduled a month later. The second individual mandibular implant was than inserted through the same extraoral approach under general anaesthesia. Unfortunately, the healing was complicated with exposure of

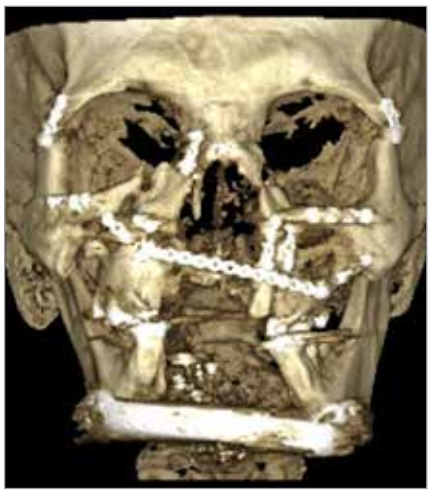

Fig. 9. Cone beam CT image after the insertion of the first patient-specific implant.

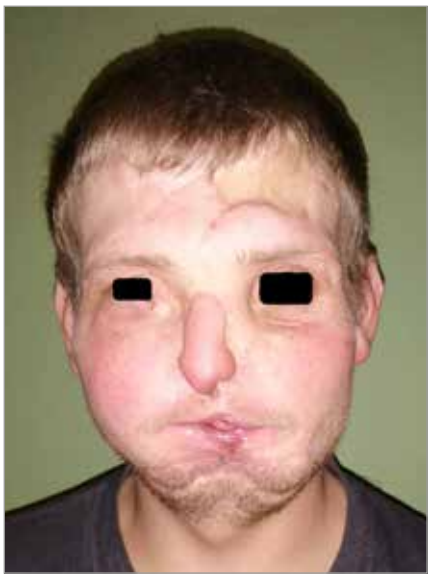

Fig. 10. Facial view ("en face") of the patient after the removal of the second patient-specific implant and before the definitive reconstruction of the mandible with a fibula free flap.

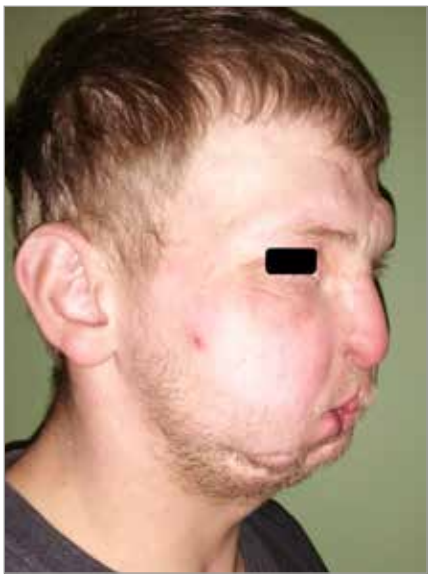

Fig. 11. Facial view (profile) of the patient after the removal of the second patient-specific implant and before the definitive reconstruction of the mandible with a fibula free flap.

the implant through the skin 2 months later. Finally, this second implant was removed 3 years after the injury and the defect of the mandible is planned for the secondary bone grafting with fibular flap to facilitate the reconstruction of missing teeth (Fig. 10, 11).

Discussion

The treatment of gunshot wounds in the maxillofacial region is a complex subject, with respect to treatment time [1]. This type of wounds represents a challenge in maxillofacial treatment for their heterogeneity and complexity [1]. Primary patient care of this case was provided in accordance with the recommendations of other authors for devastating gunshot wounds in the oromaxillofacial region [2]. In the literature, a disagreement exists regarding the proper timing of the treatment. The selection of therapeutic course depends on many factors such as experience, availability of means, lesion extent and general health circumstances of the patient [1]. The current literature supports immediate treatment [1]. These lesions are treated in two or three steps. The first one – debridement and primary closure; the second one – graft placement (bone, skin or myovascularized grafts), and the third one – correction of residual deformities and implant rehabilitation [3]. Stefanopoulos and Motamendi suggest immediate treatment of all lesions in order to optimize functional and aesthetic results [4,5]. They agreed with Holmes and Alper in leaving secondary treatments only for complex cases which involved the reconstruction with bone grafts, myocutaneous rotation or a microvascularized flap [6,7]. There is also a radical trend to conduct complex cases in primary phase, which includes harvesting of free grafts [8]. The presented case was an example of a complex facial injury, therefore the treatment of the missing external nose and the avulsive injury of frontal segment of the mandible was performed as delayed reconstruction in cooperation of maxillofacial and plastic surgeons. According to the literature, the secondary or delayed facial reconstruction in a patient after suicidal attempt should be considered carefully, because of low compliance or motivation of such patients for the secondary treatment. A part of the relatives of these patients believes that the repair of such deformities, even if it is a functional deformity, is not necessary [9]. Therefore, in such cases, one should do as much reconstruction as possible during the primary surgical intervention [9]. However, in the presented case, the patient resolved his psychological problems and was motivated for multiple secondary surgical reconstructive procedures.

The nose has a three-dimensional contour and represents a main aesthetic focus of the face. There are various options for nose reconstruction [10–12]. A forehead flap is the gold standard for nasal soft tissue reconstruction because of its size, good vascularity, texture, thickness and skin colour, which is very similar and matches the skin colour of the nose [13]. It has a strong pedicle, enough tissue and the forehead defect can be easily camouflaged. It possesses the capacity to result in the most natural appearance. That is why it was chosen for the reconstruction in this case. These types of wounds can be reconstructed both primarily and secondarily. In the present case, the nose reconstruc-

tion was started 1 year after the injury, once fractures of the middle part of the face were healed.

The most common complications are flap necrosis, infection and risk of eyebrow malposition. To avoid eyebrow deformity in this case, the forehead defect after forehead flap transposition was covered with a skin graft from the shoulder. Sometimes patients have breathing difficulties; dry mucosa and snoring can occur. However, these problems are not as serious as a noseless face, because it can also cause serious mental-health problems. The main goal of nasal reconstruction is to regain the maximum possible normal look and to restore the lost self-confidence, which was achieved in the presented case.

Different methods are used in the treatment of complex facial injuries associated with a partial avulsion of the mandible, e.g. distraction osteogenesis, patient-specific titanium implants, composite free flaps, etc. Autografts are the gold standard of the treatment of mandibular defects [14]. The reconstruction of mandibular defects is a challenge for the unique anatomy, the presence of vital structures, and the variety of defects [15]. These have, however, several disadvantages and contraindications, which led to research of alloplastic materials [15]. The choice of mandibular reconstruction should be carefully discussed with the patient, considering the patient factors, comorbidity, prognosis, and expectations regarding dental rehabilitation [16].

Free flap techniques are indicated in mandibular defects, especially in its anterior portion [17]. The soft tissue and bone are transplanted in composite free flaps, and dental implants can be inserted into the neo-mandible to facilitate occlusal rehabilitation. However, the use of composite free flaps has also some disadvantages. The surgery is time-consuming, two surgical teams have to work simultaneously to harvest the free flap; the volume and height of transplanted bone may be insufficient to achieve occlusal rehabilitation with an implant supported prosthesis; the shape of transplanted bone may not match the original contour of the mandible; there may be too much soft tissue and the restoration of sensation is usually unsatisfactory; and the harvest of composite free flaps is associated with variable donor-site morbidity [18,19].

Another way to restore the continuity of the mandible is to use the reconstruction plates or patient-specific implants. The use of a reconstruction plate has several advantages. The technique is safe and simple. One surgical team is sufficient for the procedure and donor-site morbidity is avoided. There is no need for special preparation. There are also potential complications of the technique: loosening of the screws, fracture of the reconstruction plate, plate exposure, infection, and fistula formation [20]. The aforementioned complications were also observed in the described case. A common argument to use composite free flaps instead of a reconstruction plate is the intention to insert dental implants into the transplanted bone to facilitate occlusal rehabilitation [16]. However, in practice, only a minority of patients reach the stage of dental rehabilitation following the reconstruction of the mandible with a composite free flap [21].

In the presented case, the first treatment for the frontal defect of injured mandible was the use of a prefabricated mandibular reconstruction plate. This is a simple and most available way to provisionally treat such a defect in urgent conditions. An external exposure of the plate and infection, a common complication of such procedure, occurred 2 months later and was the reason for removal of the reconstruction plate. The low quality and a scar nature of the soft tissue in chin area was probably the reason of the skin dehiscence over the plate. Subsequently, the decision was made for a secondary reconstruction of the mandible with a patient-specific titanium implant without a bone graft. Although it is not an optimal choice for the reconstruction of frontal defects of the mandible, this alternative treatment was chosen to prevent a donor-site morbidity and with respect to patient´s option. Unfortunately, both attempts to use the patient-specific titanium implant without a bone graft for mandibular reconstruction failed in this case because of implant-break in the first implant and the external exposure of the second implant. At the time, the patient consented to the use of bone graft and is planned for the reconstruction using a vascularized fibular flap to facilitate the reconstruction of missing teeth. The definitive reconstruction of the mandible is delayed because of an actual pandemic situation with COVID-19.

Conclusion

Multidisciplinary care is required for successful management of patients with facial gunshot injuries. Complex and perfected treatment of facial hard and soft-tissue gunshot injuries depends ultimately on the abilities and skills of the maxillofacial surgeons in cooperation with plastic surgeons. Complications in the treatment of facial gunshot wounds can be expressed as functional and aesthetic limitations in the patient's life, causing reduction in mastication ability with weight loss, reduction in the sense of taste, partial or total loss of visual acuity, speech difficulty and other daily-life restrictions. These complications can also produce aesthetic changes of the face with social and emotional consequences for the patient. The minimizing of secondary revisions and prevention of revisional operations for complications is of utmost importance in this respect. In the described case report, we achieved a stable, functionally and aesthetically satisfactory result of nasal reconstruction using only partial skeletal reconstruction.

Role of authors: Daniel Hvizdoš – manuscript writing, Igor Homola – plastic surgery, Dagmar Statelová – maxillofacial surgery, Mária Janíčková – manuscript reviews and formal and English language edits, Igor Malachovský – critical revision of the article, Katarína Mikušková – manuscript writing and selection of photographic documentation.

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Disclosure: All procedures performed in this case 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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Surgical treatment and management of cutaneous squamous cell carcinoma in patients with dystrophic epidermolysis bullosa – a case report

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Summary

Epidermolysis bullosa (EB) is a rare inherited disease which is characterized by blisters on the skin and mucous membranes. Some forms of EB are associated with a risk of squamous cell carcinoma (SCC) development, which, unlike in the general population, is formed at a young age. SCC is the most common cause of death in patients with a dystrophic form. It is necessary to examine chronic and non-healing wounds for an increased risk of SCC. The basic treatment consists of surgical excision of the tumor site with a wide margin into healthy tissue. The surgical wound can be healed by secondary intention to prevent further trauma of the patient. The radicality of the excision is influenced by the location of the tumor. On the body, it is considerably limited by the surrounding tissue; on the limb, it is necessary to consider its amputation. In case of dissemination of the disease, it is important to approach patients individually and discuss other treatment options, including palliative care, within the national EB Center. The therapy is focused on pain treatment, remedial surgical dressings and psychological support with an emphasis on maintaining the quality of life.

Key words

dystrophic epidermolysis bullosa – cutaneous squamous cell carcinoma – surgical excision – wound healing – multidisciplinary meeting

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Introduction

Epidermolysis bullosa (EB) is a group of rare diseases characterized by blistering of the skin and mucous membranes after mild trauma, friction or even spontaneously. The cause of the disease are mutations in various genes encoding different proteins of the skin. The inheritance may be of dominant or recessive types. Defective proteins are responsible for insufficient adherence between the epidermis and the dermis, causing blistering of the skin. EB is divided into four main forms according to the layer of the skin of blister formation. Recurrent blistering may lead to chronic wounds or scars. Some forms of EB are associated with the development of cutaneous squamous cell carcinoma (SCC). Unlike in the general population, aggressive SCC can occur in EB patients at a very young age at the site of chronic wounds, recurrent scars or non-healing granulation tissue. The risk of SCC increases with age and SCC is the leading cause of death in patients with recessive dystrophic EB (rDEB), especially in the severe generalized form (rDEB-SG). Patients with rDEB have periodical full skin examination by EB specialist and they are instructed to self-examine their wounds for early SCC detection.

The standard treatment of SCC is surgical excision with wide margins. Prior to the surgical excision, a histological verification of the tumor from biopsy and staging of the patient including evaluation of regional lymph nodes should be done. Wound closure after the excision is questionable, since minimally invasive techniques are required. Management and surgery planning with following check-ups are led by a plastic surgeon and a multidisciplinary approach is required. In this paper we present a clinical management of SCC including multiple surgical excisions of the tumor mass, palliative treatment and end-of-life care.

Description of the case

We present a case of 25-year-old male patient with rDEB-SG diagnosed by histological examination of the skin with electron microscopy within the first year of life. The patient was treated since birth at the Department of Pediatric Dermatology with regular check-ups which later transformed into the national EB Center. The majority of blister formation were localized on the patient's trunk with the most severe blister formation on his back. At the age of 22, he developed cutaneous SCC in the terrain of chronic wound at the center of his lower back. The histological examination of incisional biopsy showed moderately-differentiated SCC with the classification pT2 pNX pM0. The size of the tumor mass was approx. 10 cm in diameter and had typical clinical manifestations – raised edge, areas of hyperkeratosis and ulceration of the center. Staging of the patient via chest X-ray and ultrasonography of the abdomen including evaluation of regional axillar and inguinal lymph nodes showed no further dissemination of the tumor. Surgical excision of the tumor mass was executed by plastic surgeon under general anesthesia after careful preparation of the operating table. The excision was done with 2 cm margin around the tumor mass. The surgical wound was covered with low adherent polyamide net coated with soft silicon and soft foam dressing to avoid drying up with healing by secondary intention. The wound healed conservatively within the next two months. The histological examination by an experienced pathologist in EB biopsies showed clean resection margins. Regular check-ups and oncological staging were established.

After more than a year, there were several chronic wounds suspicious of SCC in different areas of the back. Incisional biopsy showed moderately-differentiated SCC and a plastic surgeon performed several excisions of the tumor mass including multiple excisions around the edge of the tumor (Fig. 1–3).

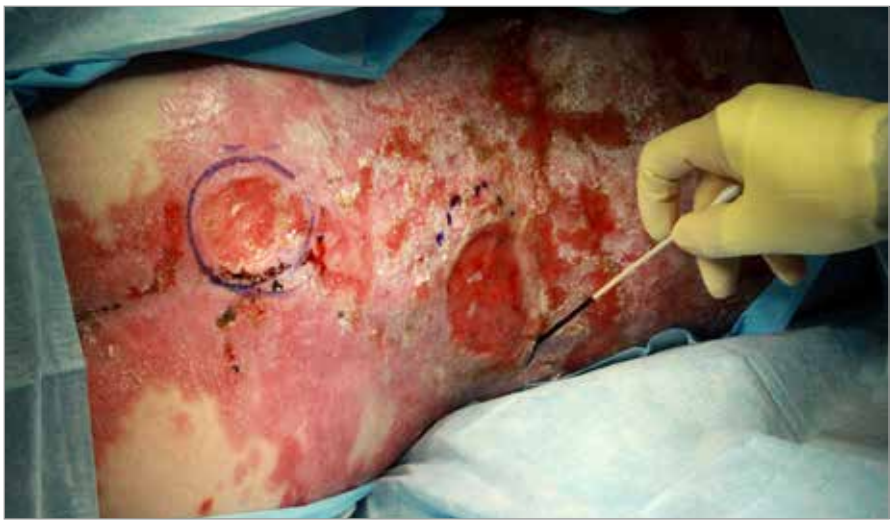

Fig. 1. Marking the outline of the incision with wide margins.

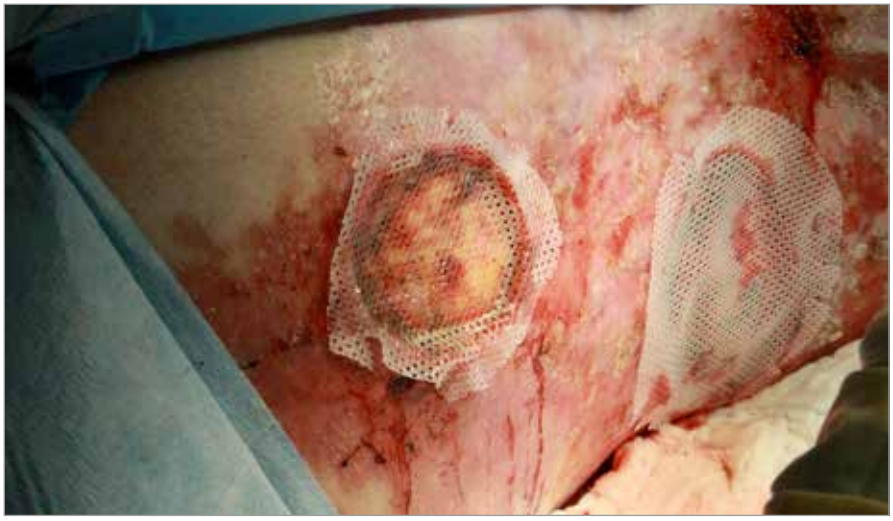

Fig. 2. Surgical wound covered with a low adherent polyamide net coated with soft silicon.

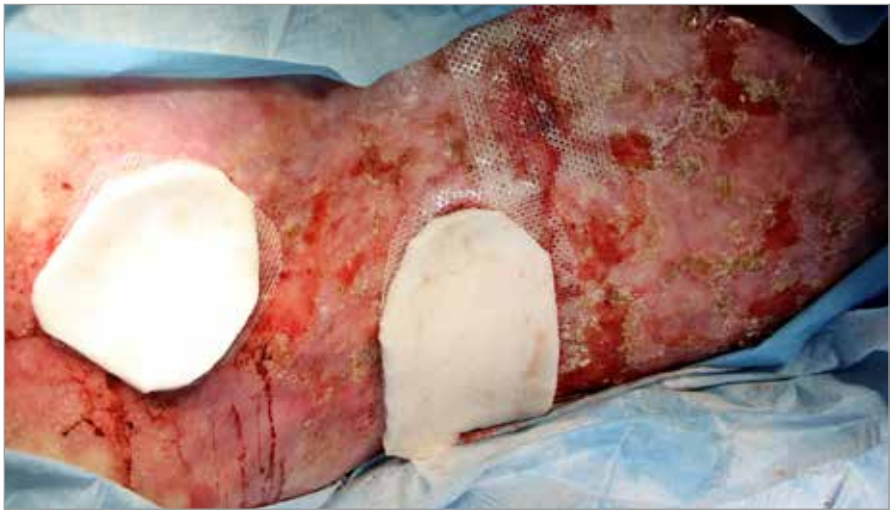

Fig. 3. Next layer of soft foam dressing impregnated with an antiseptic solution.

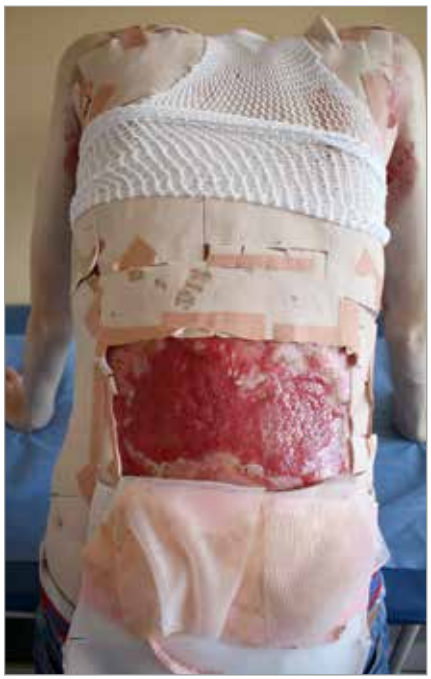

Fig. 4. Surgical wound healed by secondary intention (right side of the back) and chronic non-malignant wound typical for epidermolysis bullosa patients (left side of the back).

All defects healed by secondary intention (Fig. 4). Despite clean resection margins, in the following months, there was a growth of new SCCs not associated with the previously removed tumors which required multiple surgical excisions. At the age of 25, an enlarged lymph node was observed in the right groin together with new tumors at his back. Ultrasonography of the node showed suspicious metastasis of SCC which was later confirmed by histological examination after surgical excision (Fig. 5). The lymph node was infiltrated by a bulky metastasis of SCC replacing lymphatic tissue and spreading through the lymphatics. The positron emission tomography/computed tomography (PET/CT) scan showed a metastatic disease of the right lateral chest wall with osteolysis of the ribs and central necrosis (Fig. 6).

The patient was reviewed by oncologists at Masaryk Memorial Cancer Institute and at multidisciplinary meeting of EB specialists consisting of a dermatologist, a plastic surgeon, a clinical oncologist, a radiation oncologist, a palliative care specialist, a chest surgeon, a hematologist, a psychologist and a gastroenterologist. The conclusion of the committee was not to continue with further surgical excisions due to metastatic disease with a high risk of secondary damage. The recommendation was to switch to palliative care with the biological treatment with cemiplimab (Libtayo®, Regeneron Pharmaceuticals, Inc., NY, USA). Psychological support of the patient and his family was established through the patient organization Debra Czech Republic.

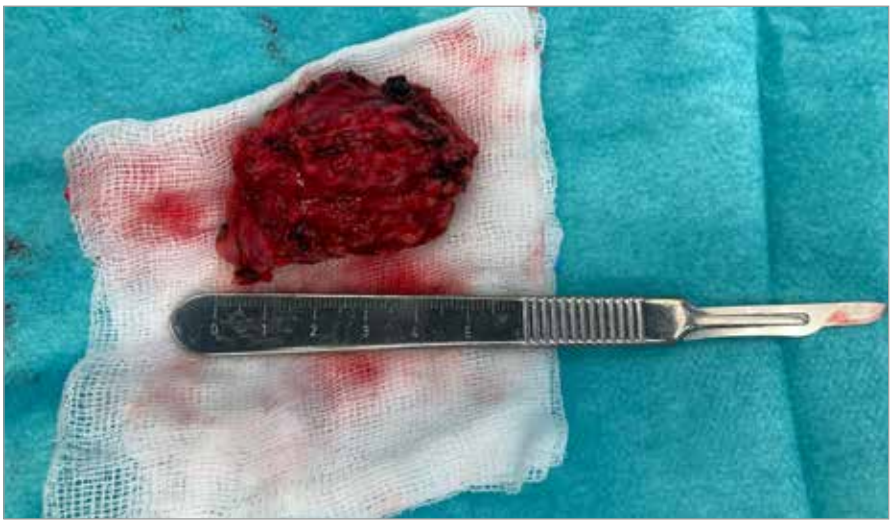

Fig. 5. Metastatic lymph node removed from the right groin.

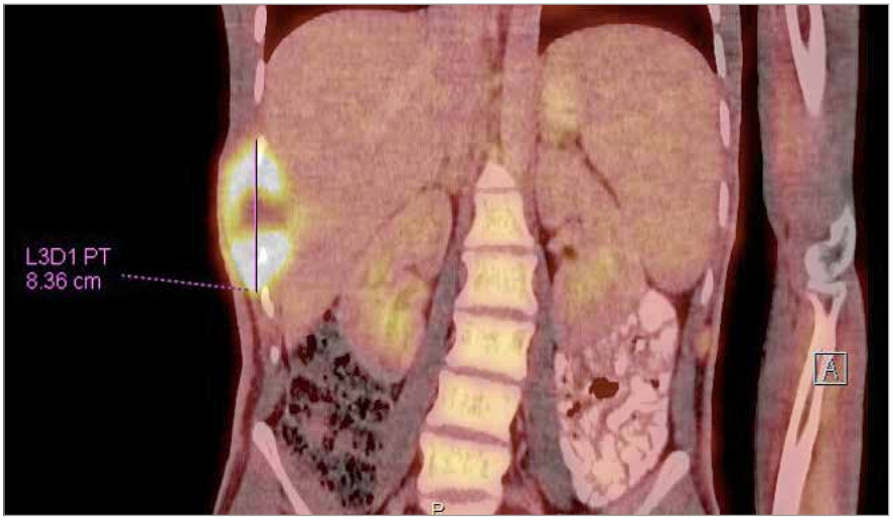

Fig. 6. Metastatic disease of the right lateral chest wall with osteolysis of the ribs and central necrosis on PET/CT scan.

Discussion

EB represents a rare complex disease which can be classified into 4 main forms with more than 30 different clinical subtypes. The most common form is EB simplex (EBS), which represents approx. 70% of all EB cases, followed by 20% of dystrophic EB (DEB), 10% of junctional EB (JEB) and very rare Kindler syndrome (up to 1%) [1]. While EBS has mild clinical manifestations and is not associated with an increased risk of SCC, patients with DEB suffer from severe recurrent blistering leading to chronic wounds and scars. DEB form is caused by a mutation in the COL7A1 gene, which encodes

defective collagen VII making insufficient anchoring fibrils between dermis and epidermis [2]. Patients with DEB are at high risk of developing SCC which is a leading cause of death in a group of patients with severe generalized forms of recessive dystrophic epidermolysis bullosa (rDEB-SG) [3].

In general population, cutaneous SCC is the second most common form of skin cancer. It is considered as a slow growing malignancy of elderly people and it is usually found on the areas of the body which have been exposed to the UV rays [4]. On the contrary, SCC in patients with DEB behaves more aggressively and may firstly occur in their adolescence. The cumulative risk of having SCC rises with age, from 7.5% by the age of 20, through 67.8% at 35 years to 90.1% at 55 years. Alongside with this, the cumulative risk of death increases to 38.7%, 70.0% and 78.7% by the age of 35, 45 and 55 years, respectively [5]. SCC usually arises from chronic wounds, non-healing defects and recurrent scarring with no causal relationship with the exposure to UV rays. SCC may be well-differentiated (grade I), moderately-differentiated (grade II) and poorly-differentiated (grade III). In situ SCC, such as actinic keratosis or Bowen's disease, are extremely rare in patients with EB [6].

Since SCC in patients with DEB usually origins from chronic non-healing wounds or scars, it is hard to distinguish between a non-tumorous ulceration and SCC [7]. Patients with DEB have large areas of blister formations at various predilection sites resembling the tumor mass. It is recommended that patients with DEB should undergo a full skin examination every 3–6 months by an EB specialist. It is important to mention that EB patients know the process of healing of their wounds and they are instructed to see a specialist whenever they encounter a non-healing or atypically healing wound. A wound suspicious of SCC growth includes rapidly growing granulation tissue, hyperkeratosis, raised edges or sensitivity change in the wound or its neighborhood [3]. Modern bandage materials contributed to faster and safer wound healing, so any prolonged healing may also be a sign of a growing tumor. If there is a suspicion of SCC, incisional biopsy should be performed by an EB plastic surgeon [8]. At our workplace, we take multiple biopsies under local anesthesia from the center and margins of the lesion. If the lesion is smaller than 2 cm in diameter, we usually perform a total excision. Every excision should be examined by a pathologist experienced in EB biopsies since the microscopic picture of the granulation tissue or hyperplasia may be similar to the tumor mass.

In case of SCC confirmation from incisional biopsy, the plastic surgeon in cooperation with other EB specialists leads the subsequent treatment. Surgical removal of the tumor mass with wide margins is the method of choice. Prior to the surgery, evaluation of regional lymph nodes and staging for distant metastases is necessary [9]. The radicality of excision is limited by the localization on the patient's body. Extensive SCC localized on the patient's limb without clear margins may be an indication for amputation of the digit or limb [10]. On the contrary, extensive tumor mass localized on patient's trunk is limited by the anatomical location and involvement of underlying structures.

The surgical excision is usually performed under general anesthesia with respect to the patient skin – at our workplace, the operating table is padded out, patient's skin being in contact with oxygen mask or electrodes is covered in soft foam dressings and the patient does not have endotracheal intubation, but deep sedation with monitored anesthesia by an experienced EB anesthesiologist [11]. After marking the outline of the incision (Fig. 1), the tissue surrounding and underlying the tumor mass is infiltrated with local anesthetics consisting of trimecaine (Mesocain®, Zentiva, Prague, Czech Republic) with epinephrine to prevent bleeding and reduce pain. The tumor mass is removed in one part and the orientation is marked perioperatively in at least two directions with different colors of surgical suture. Attention must be paid to the surrounding skin with no-touch technique in order to avoid massive blistering after the surgery. Bleeding from the wound is stopped by electrocoagulation, ligature and surgical gauze with hydrogen peroxide. Several biopsies of the underlying tissue are taken and all samples are separately sent to the histopathological examination.

The closure of the surgical wound is problematic due to the state of the surrounding tissue and patient's overall condition. Numerous approaches were described by various authors including healing by secondary intention, autologous split-thickness skin graft transplantation, flaps or artificial skin equivalents [3,12–14]. Every method has its advantages, limits and needs to be selected strictly individually. At our workplace, we always discuss the possibilities with the patient. In our described case, the patient and his family decided to heal the surgical wound by secondary intention since they were used to change the dressings daily and they didn't want to take care of the donor site. In healing by secondary intention, we must keep the wound moist to prevent drying up, because changing of dried-up gauze is very poorly tolerated by EB patients in general. In our case, we applied low adherent polyamide net coated with soft silicon directly on the surgical wound and soft foam dressing impregnated with antiseptic solution on the top of it (Fig. 2, 3). The family of the patient changed dressing every other day and the defect was fully healed in the next 2 months (Fig. 4). Regular check-ups were established every month with staging twice a year.

Non-surgical treatment is considered in cases where surgical excision of SCC

is not possible or if the patient has metastatic dissemination of SCC. Radiotherapy can be used as primary treatment or palliative local treatment of metastases. It should be delivered in smaller fractions to prevent severe skin desquamation. Chemotherapy is used as palliative care and there were only few cases described. Other treatment includes biologic approach, such as monoclonal antibodies blocking programmed cell death protein 1 / programmed death ligand 1 (PD-1/PD-L1) pathway, epidermal growth factor receptor antagonists or tyrosine kinase inhibitors [3,15]. Non-surgical treatment is led by a clinical oncologist, but has dubious results.

The progression of SCC can lead to metastatic dissemination, the treatment of which is no longer curative. The EB specialists need to focus on quality palliative care with effective pain management and complex end-of-life care. Since every patient requires individual treatment, there are no universal oncological protocols and every patient should be discussed at a multidisciplinary meeting consisting of a dermatologist, a plastic surgeon, an oncologist, a palliative care specialist, a psychologist and other EB specialists involved in the treatment. It is an effort to maximize the quality of life while relieving pain. In our described case, the oncologist indicated biological treatment with cemiplimab, which is a monoclonal antibody binding to the PD-1 receptor acting as a checkpoint inhibitor. Palliative care specialist regularly reviewed the patient and his family to adequately increase pain medication. In this stage of the disease, surgical treatment consists of changing the dressing and sanitation of smell. Psychological support is important for both the patient and the family. Complex care concentrated in the national EB center with the support of patient organizations, such as Debra Czech Republic, is a step forward.

Conclusion

Patients with DEB are at a great risk of developing aggressive SCC in their adulthood. Early detection of the tumor is important for overall outcome and patients should be regularly examined by EB specialists. In case of suspicion of SCC, multiple incisional biopsies from the wound are taken by an EB plastic surgeon and examined by a pathologist experienced in EB biopsies. If SCC is confirmed, the method of choice is surgical excision of the tumor mass with wide margins. In some cases, amputation of the limb is necessary. Other treatment options have specific limits and are used as support therapy. If SCC is metastatically spreading, palliative care with the focus on preserving adequate quality of life should be discussed at multidisciplinary meeting of EB specialists. Every patient requires individual approach which is provided by concentrating complex care in the specialized national EB center.

Role of authors: All the authors listed above contributed equally to this article.

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Combined fungal and bacterial infection in deep burns of the lower limb – a case report

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Summary

Fungal infections are one of the most common diseases. Superficial mycoses affect the skin and visible mucous membranes. Deep mycoses include organ and systemic mycoses. The incidence of these diseases is increasing due to the use of broad-spectrum antibiotics, corticosteroids and cytostatics. Mycoses (yeasts and filamentous fungi) occur more often in patients with burns than in other patients; especially in patients with large and deep extent burns. In this case report, we are presenting a case of a 62-year-old patient hospitalized at the Department of Burns and Plastic Surgery, University Hospital Brno, with extensive deep burns (2nd–4th degree) covering 35% total body surface area (TBSA), predominantly in both lower limbs. During hospitalization, the patient was diagnosed with a combined bacterial and fungal infection for which targeted therapy was indicated.

Key words

burn wound infection – micromycetes – diagnostics of fungal infection – antifungal therapy

Tresnerová I., Fiamoli M., Lipový B., et al. Combined fungal and bacterial infection in deep burns of the lower limb – case report. Acta Chir Plast. 2021, 63(4): 201–204.

Introduction

Fungal infections are caused by microscopic fungi. These microorganisms are widespread both in the environment and on the skin of the humans and animals [1]. They are eukaryotic organisms, formerly being part of the fungal kingdom; however, they currently form a separate entity. Fungi differ from plants in the absence of chlorophyll. It also differs from plants in the structure of the cell wall that contains complex sugars, especially chitin, but also chitosan, mannan, and glucan. Some dyes specifically bind to these substances and therefore they are important for the diagnosis of micromycetes in clinical material [2]. The vast majority of medically important micromycetes are not primary pathogens in most cases and they do not attack a healthy macroorganism, but they are opportunistic pathogens. Accordingly, it is necessary to assess the individual findings of fungi in the clinical material in the context of the patient's health. Superficial mycoses affect the skin and visible mucous membranes. Deep mycoses include organ and systemic forms. The incidence of these diseases is increasing due to the use of broad-spectrum antibiotics, corticosteroids and cytostatics. The following patients are most at risk: the patients with long-term treatment in intensive care units, patients after transplants with subsequent immunosuppression, patients with oncological diseases, patients after complicated injuries and extensive burns, and patients with HIV. Serious fungal infections are often complicated by a combination of multiple pathogens – other mycoses and bacteria. The course of mycoses often tends to be chronic and allergic. Their wall is very antigenic for the macro-organism and very difficult to remove due to the lack of effective enzymes. Fungal infections occur mostly sporadically, the epidemic occurrence is not typical for them. Mycotoxin production plays an important role in the pathogenicity of some micromycetes. Producers of these toxins might not damage the macro-organism by themselves. The disease caused by the ingestion of mycotoxins is called mycotoxicosis [3].

Burned patients suffer from a higher risk of fungal infection compared to other hospitalized patients. Although infections caused by *Candida spp., Aspergillus spp*. and by other opportunistic fungi become a major cause of delayed morbidity and mortality, they are often underestimated and late diagnosed. The main risk factor for the development of a fungal infection in burn patients is the overall extent of the burn, immune disorders associated with severe burn trauma. The occurrence of fungal infections is also adversely affected with the frequent use of antibiotics in burn patients; at this occasion, the patient's natural microbial flora is disrupted (Tab. 1).

The diagnosis of fungal infections is possible in several ways: microscopic detection of hyphae in a sample from wound exudate, bronchoalveolar lavage or sputum; cultivation of fungal colonies from smear from the wounds, sputum or

Tab. 1. Classification of medically important fungi.

Yeasts	*Candida spp., Trichosporon spp., Cryptococcus spp.*
Filamentous fungi – molds	*Aspergillus spp., Fusarium spp., zygomycetes – Rhizopus spp., Mucor spp., pigm. micromycetes – Scedosporium spp., Alternaria spp., dermatophyte – Trichophyton spp., Microsporum spp.*
Dimorphic fungi	*Histoplasma spp., Blastomyces spp.*
Other micromycetes reclassified from parasites	*Pneumocystis jiroveci, Microsporidium spp.*

Tab. 2. Antifungals overview.

Polyenes	amphotericin and its lipid forms, nystatin
Azoles	fluconazole, itraconazole, voriconazole, clotrimazole, isavuconazole
Echinocandins	caspofungin, micafungin, anidulafungin
Antimetabolites	flucytosine
Allylamines	terbinafine
Other	undecylenic acid, cyclopiroxolamine

bronchoalveolar lavage [4]; histological evidence of fungal cells in a tissue sample taken at biopsy from a burned area [5]; serological detection of fungal infection by detection of antigen or antibodies. The serological tests used include latex agglutination, ELISA, G-test and complement fixation reaction [6]. Molecular biological diagnostics of DNA and RNA of fungi by polymerase chain reaction (PCR) is a very sensitive method for the detection of mycosis [7].

The treatment of mycoses has undergone rapid development in recent decades. The first antifungals were synthesized in the 1950s, and the development of new systemic antifungals has been still ongoing. Antifungals are divided according to their chemical structure (polyenes, azoles, echinocandins, antimetabolites). It is further divided according to the method of administration into systemic and local. The mechanism of action of antifungals is also different. In terms of toxicity, it is necessary to ensure in therapy that the toxicity of the drug is always higher for the pathogenic cell than for the patient's cells (Tab. 2) [8].

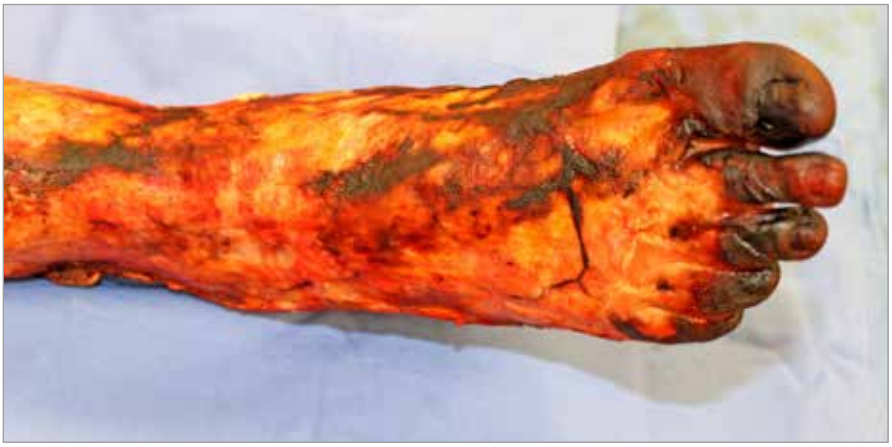

Fig. 1. Right foot before amputation.

Case report

A 62-years-old male patient was hospitalized at the Department of Burns and Plastic Surgery, University Hospital Brno, with extensive burns over 35% total body surface area (TBSA), predominantly in the area of both lower extremities. The depth of burns was of 3rd degree (in the full thickness of the skin) in most areas; on the fingers, it reached up to 4th degree (affecting deeper structures, i.e. subcutaneous tissue, muscles). The man was injured when his shoes and clothes caught fire while he was burning leaves in the garden. The patient was not seriously ill before the injury and was without chronical medication. The primary treatment was performed in the operating theatre under general anaesthesia. The burned areas on the lower limbs were deep and circular, so it was necessary to perform escharotomies to prevent compartment syndrome that can occur due to massive soft tissue swelling in deep circular burns. As early as during the primary treatment, the patient showed mummification on the toes of the right lower limb extending to the Chopart joint (Fig. 1, 2). Only the distal toe joints were mummified in the left lower limb (Fig. 3). The patient was hospitalized in the intensive care unit. There was further progression of necrosis during his hospitalization, probably also due to massive circulation support with noradrenaline (norepinephrine). Necrotic soft tissues of the distal half of the shin, including muscles, were found on the right lower limb during dressing changes. On 16th day of hospitalization, local situation with progression of the necrosis to the deeper layers resulted in a below knee amputation on the right. The soft tissues and muscles of the left lower limb were less affected and amputation was necessary only for the distal

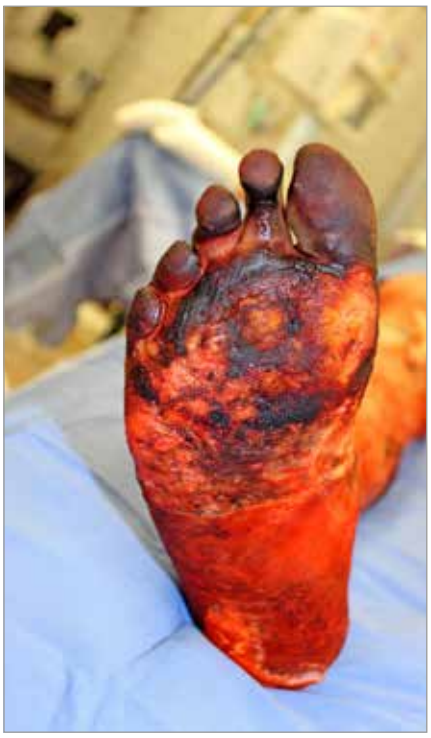

Fig. 2. Planta pedis of the right foot before amputation.

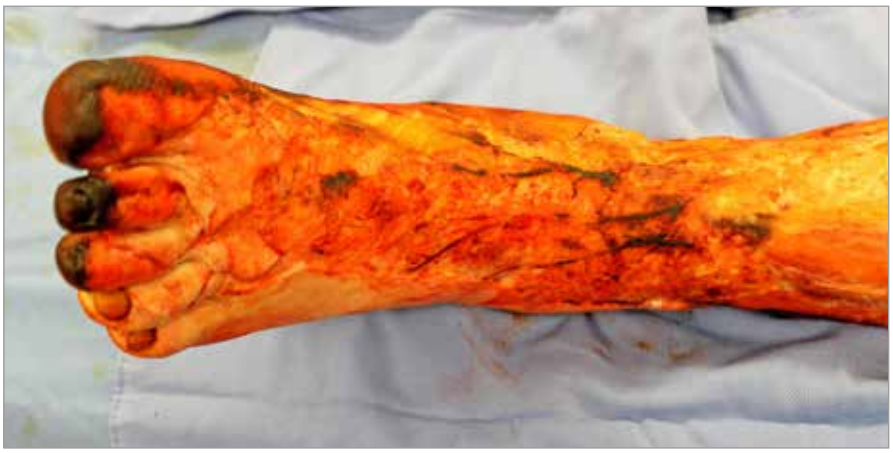

Fig. 3. Left foot before amputation.

joints of the 1st–3rd toe. In several stages, a combined surgical (fascial and tangential) and chemical necrectomy (with 40% benzoic acid) was performed. Subsequently, the areas after necrectomies were covered with split-thickness skin grafts (STSGs). Donor sites were localized on the both thighs, buttocks, hips and abdomen. In total, 26% TBSA was transplanted. Swabs and imprints for bacterial and fungal testing from the affected areas were taken for microbiological analysis regularly every 2 days. During microbiological surveillance, several bacterial pathogens were cultured from the burned areas, of which *Klebsiella pneumoniae* dominated, firstly wild type, then ESBL+ (extended spectrum beta-lactamases) bacterial strains and also gram-positive cocci. Targeted antibiotic therapy was promptly applied as the response to bacterial infection. According to microbiological cultivation results, several antibiotics and chemotherapeutics were used gradually – sulfamethoxazole/trimethoprim, piperacillin/tazobactam, metronidazole, vancomycin, meropenem, tigecycline. On 17th day of hospitalization, at the phase of progression of necrosis, several species of micromycetes were also cultured from burn-wounds in the lower extremities. It was a combination of filamentous fungi (zygomycetes) – *Lichtheimia corymbifera, Mucor circinelloides, Rhizomucor sp*. and yeast (*Candida catenulata*). The pan-fungal test was borderline positive. Amphotericin B (Abelcet lipid complex) was therefore introduced into therapy at a usual dose of 5 mg/kg (450 mg per day). After 8 days of application of amphotericin B, it was de-escalated to posaconazole (Noxafil) at a dose of 300 mg per day. No specific topical therapy was used. After this therapy, further cultures were no longer found in the micromycetes and there was a significant improvement in the local finding and the patient's overall condition. After 72 days of hospitalization and 32 surgeries under general anaesthesia, the patient was transferred to a surgery ward at his place of residence.

Discussion

Patients with deep and extensive burns are confronted with numerous microbiological pathogens on a daily basis. Thus, combating infectious complications is one of the greatest challenges in the treatment of thermal trauma. In deep burns, the most common infectious agent is bacteria, causing 70% of infectious complications in burn patients. Another common agent is fungi, causing 20% of infectious complications. Viral infections are the least common in deep burns (10%) [9]. Complications associated with bacterial or fungal infection are very closely related to the incidence of late morbidity and mortality in burn patients [10,11]. The risk of infection in patients after thermal trauma is primarily increased by the loss of skin cover and thus by the barrier function of the skin. Furthermore, the incidence of infections increases down-regulation of the immune system (specific immunosupression), invasive vascular access, and permanent urinary catheters [12]. Significant advances in the treatment of burns in the second half of the 20th century, fluid resuscitation, such as early necrectomy, wound bed preparation, and especially STSGs application, have significantly increased patients' chances of survival after severe thermal trauma [13]. The massive use of broad-spectrum antibiotics has gradually become part of modern treatment of burns. This led to a significant reduction in the incidence of bacterial infections, but at the same time it also caused an increased incidence of fungal infections [14,15]. Since the 1960s, we have seen an up to ten-fold increase in the prevalence of fungal infections in burns [16].

Mycoses are often part of polymicrobial infections of burned areas. Risk

factors for mycosis in burn patients include age, depth and extent of burns (above 30% TBSA), inhalation injury, delayed burn necrectomy, antibiotic therapy, corticosteroid therapy, hyperglycaemic episodes, central venous catheter and mechanical ventilation. Early and effective diagnosis and subsequent targeted treatment can be life-saving for a patient with many fungal infections. The diagnosis of fungal infections can be performed in several ways, depending on the severity of the infection. Microscopic methods are the standard for the detection of mycosis. Fungi can be observed either directly in the exudate, or cultured in colonies, or observed in biopsy material within incisional biopsy. More modern methods in the diagnosis of fungi use serological tests or a very sensitive molecular biological method for the detection of nucleic acids (DNA, RNA) by PCR.

If yeasts and/or moulds are detected in the region of the burn-wound, it is necessary to strictly distinguish between fungal wound colonization (FWC) and fungal wound infection (FWI). FWC is defined as the identification of fungal elements in the burn necrosis not penetrating deeper into the deeper viable tissue. FWI, on the other hand, is defined as a fungal invasion into the viable tissue [17].

Treatment options for fungal infections have improved significantly in recent years. The first antibiotics were synthesized in the mid-twentieth century, and since then a number of effective drugs have been developed and new ones are still being developed. The goal of developing new antifungals is to maximize antifungal efficiency with the lowest possible toxicity to users.

Conclusion

The case report in this article points to the severity of fungal infections in severely burned patients. In the described case, a dangerous infection of fibrous fungi was diagnosed in time due to regular and especially frequent, microbiological examination. This early-recognized fungal infection was cured within a few days thanks to adequately guided therapy. As a result, the infection did not endanger the patient's life or worsen the local findings in the affected areas.

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Celebrating the career and retirement of Dr Hana Řihová

Dr Hana Řihová graduated from the Faculty of Medicine of Jan Evangelista Purkyně University in Brno in 1979. Her interest in surgery led her to the first clinical appointment. In 1979, she took up the position of a physician at the Department of Surgery, Hospital Nové Město na Moravě and, subsequently, at the Surgical Department of the Military Hospital Brno. In 1981, she started working as a secondary physician at the Department of Plastic Surgery in Brno. Due to several major events and mass accidents in local heating plants in the late 1970s, it was necessary to build from scratch a specialized Burns Unit at the Trauma Hospital in Brno. Together with the Head Physician Vladimír Michálek, she was the central person of this effort in 1982; at the same time, she found interest in this field, which subsequently became her lifelong mission. This burns unit began to provide complex centralized care for adult burn patients. In 1989, the unit was moved from the Trauma Hospital to the newly completed Brno University Hospital in Brno-Bohunice, where a standalone Burns Centre was established.

This centre broadened its scope to providing complex care for patients with thermal trauma as well as with conditions of extensive non-thermal loss of skin cover (toxic epidermal necrolysis, skin manifestations of meningococcal sepsis, etc.) not only in adult patients, as was the case in the Trauma Hospital, but also in children. This was to a large degree enabled by the arrival of the paediatrician Dr Ivan Suchánek and a team of paediatric nurses from the Department of Paediatric Medicine at University Hospital Brno. Thus, in the early 1990s, a stable team of the pioneers of burn care in Brno was formed: Dr Hana Řihová, Dr Ivan Suchánek, Dr Pavel Brychta, Dr Yvona Kaloudová and Dr Martin Jonášek. Thanks to their unrelenting enthusiasm and work commitment, which seems almost impossible from today's perspective, it was possible to gradually recruit other doctors, expand the range of provided services and ensure comprehensive erudition in this very complicated and multidisciplinary field of medicine.

Dr Řihová took the most complicated role, i.e. the head of the intensive care unit providing intensive treatment to patients with severe and critical thermal trauma, and patients with inhalation trauma requiring different levels of organ support. Thanks to the contacts abroad and internships of individual team members, it was possible to raise the standards of burn care at this department to the level of advanced centres in Europe and North America. The need for precise microbiological surveillance in burn patients was one of the key topics emphasized by Dr Řihová; for this reason, she created a system of sophisticated antimicrobial control. Despite her focus on intensive care, she also excelled in the operating room as an outstanding surgeon with great sensitivity in the surgical treatment of acute burns as well as in reconstructive procedures, drawing on her high-level surgical training in both general and plastic surgery.

Although she herself did not seek active participation in congresses, she was always ready to contribute to the quality of lectures or publications with her knowledge, experience and valuable advice. I myself remember that my academic beginnings were often accompanied by her harsh criticism of my presentations; in retrospect, however, I am very grateful for all her objections. Personally, I respect Dr Řihová from many perspectives and in my clinical practice, her words have come back to me many times. Of all her qualities, the one that was perhaps the most important to me is her openness and willingness to pass on her years of experience to younger colleagues, keeping nothing just to herself. Thanks to this, she educated or helped to educate many outstanding professionals.

By the end of 2020, she took a well-deserved retirement, having devoted a hardly believable 38 years to her work; during that time, she managed to return several thousand burn patients to normal life with an acceptable quality of life, including social life. She cared for these patients with unflagging enthusiasm. It is the merit of Dr Řihová and her colleagues that Brno Burn Centre now enjoys the status of a centre meeting the strictest criteria and can easily compare to the best centres in Western Europe, Japan or the United States.

Both me and our colleagues would like to personally wish her a long and fulfilled retirement as well as many happy moments with her family and friends.

On a personal level, I would like to join in with a big thank for what she has done not only for our clinic and colleagues but especially for patients and, last but not least, for my professional development.

Dear Hana, all I am able to do at my work now is a result of your willingness to be my mentor and a close friend. I firmly believe that one day I will be able to pass on my knowledge to my students with the same noblesse and patience as you did it for me.

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ČESKÉ SOUHRNY

Moriartyho znamení – prediktor přihojení kožního štěpu

P. W. Veena, S. Shanthakumar, M. Kumaraswamy, O. Udayashankar

Úvod: Obnovení kožního povrchu dermoepidermálním štěpem je nejběžnější postupem v plastické chirurgii. Asociace větší bolestivosti s donorským místem než příjmovým byla použita jako prediktor úspěšného přihojení štěpu Starkem v roce 1962, který jej nazval Moriartyho znamením. **Cíl:** Cílem studie bylo: 1) Předvídat úspěšné přihojení kožního štěpu podle přítomnosti Moriartyho znamení; 2) rozhodnout o prvním převazu štěpu na základě Moriartyho znamení. **Metody:** Autoři prezentují prospektivní studii se 100 pacienty, kteří podstoupili transplantaci rány tenkým kožním štěpem na oddělení plastické chirurgie v centru terciární péče v období od ledna 2014 do června 2015. Oblast s větší bolestí, absencí bolesti nebo nejednoznačná odpověď v místě štěpu byla zaznamenávána na stupnici Visual Analog po dobu 10 dnů. **Výsledky:** V této studii mělo 80 pacientů pozitivní Moriartyho znamení, 12 nejednoznačnou odpověď a 8 vykazovalo negativní znamení. Pacienti s pozitivním Moriartyho znamením podstoupili první inspekci štěpu 10. pooperační den a prokázali 100% přihojení štěpu. První kontrolu štěpu 5. dne podstoupilo 12 pacientů s nejednoznačnou odpovědí; štěp byl přihojen z 70–80 %. U 8 pacientů s negativním Moriartyho znamením byla první kontrola štěpu provedena 3. den, přičemž štěp byl přihojen v < 50 %. **Závěr:** Studie ukazuje, že Moriartyho znamení je spolehlivým klinickým prediktorem přihojení dermoepidermálního štěpu a může být užitečný jako vodítko pro stanovení dne první kontroly štěpu. Jedná se o účinnou metodu ke sledování parametrů ve vztahu k tomuto znamení, vhodnou i pro mladší členy chirurgického a ošetřovatelského týmu. Lze ji praktikovat i v menší skupině nemocnic. Autoři proto doporučují začlenit toto klinické hodnocení do rutinní praxe.

Frontálně otevřený skus – diagnostika a léčba

P. Michl, T. Broniš, E. Sedlatá Jurásková, P. Heinz, R. Pink, J. Šebek, R. Mottl, Z. Dvořák, P. Tvrdý

Frontálně otevřený skus (anterior open bite – AOB) je porucha skusu způsobující pacientům jak hendikep estetický, kdy je dolní třetina obličeje disproporcionálně větší než zbývající dvě, tak především funkční. Ten spočívá v nemožnosti fyziologicky ukusovat stravu frontálními zuby s nutností využívat distální část zubořadí. Frontálně otevřený skus může navíc vznikat v důsledku anatomických překážek v dýchacích cestách i následkem určitých zlozvyků. Předkládané přehledové sdělení se zabývá možnostmi léčby AOB, od klasické ortodontické terapie až po současné možnosti ortodonticko-chirurgické léčby, vč. využití kotevních systémů. Na volbě vhodné terapeutické strategie je závislý nejen okamžitý výsledek léčby, ale i jeho dlouhodobá stabilita.

Spolupráce maxilofaciálního a plastického chirurga při chirurgické rekonstrukci v maxilofaciální oblasti – kazuistika

D. Hvizdoš, I. Homola, D. Statelová, M. Janíčková, I. Malachovský, K. Mikušková

Defekty dolní a střední tváře způsobené střelnými ranami často způsobují vážné funkční a kosmetické deformace. Účelem této kazuistiky je podělit se o naše zkušenosti s léčbou střelného poranění obličeje spojeného s pokusem o sebevraždu, které mělo za následek komplexní poranění obličeje. Cílem léčby komplexních poranění obličeje je správná rekonstrukce defektů tvrdé a měkké tkáně a dostatečná rehabilitace příslušných funkcí, jako je řeč, výživa a vzhled. K dosažení uspokojivého výsledku je nezbytná úzká spolupráce maxilofaciálního a plastického chirurga.

Chirurgická léčba a management kožního spinocelulárního karcinomu u pacienta s dystrofickou bulózní epidermolýzou

P. Rotschein, J. Vokurková, H. Bučková

Bulózní epidermolýza (epidermolysis bullosa – EB) je vzácné dědičné onemocnění, které se projevuje puchýři na kůži a sliznicích. U některých forem EB je riziko vzniku spinocelulárního karcinomu (SCC), který se na rozdíl od běžné populace tvoří již v mladém věku a bývá nejčastější příčinou úmrtí nemocných s dystrofickou formou. Je nezbytné sledovat chronické a nehojící se rány pro zvýšené riziko vzniku SCC. Základní léčbu tvoří chirurgická excize nádorového ložiska se širokým okrajem do zdravé tkáně. Vzniklý defekt je možné nechat dohojit sekundárně, aby nevznikala další traumatizace pacienta. Radikalita excize je ovlivněna

lokalizací nádoru. Na trupu je značně limitovaná okolními tkáněmi, v lokalizaci na končetinách je nutné zvážit jejich amputaci. Při diseminaci onemocnění je důležité přistupovat k pacientům individuálně a v rámci národního EB centra probrat v multioborovém týmu další léčebné možnosti vč. paliativní péče. Při paliaci dominuje zaměření se na léčbu bolesti, sanační chirurgické převazy a psychologická podpora s důrazem na zachování kvality života.

Kombinovaná mykotická a bakteriální infekce u hlubokých popálenin dolní končetiny

I. Tresnerová, M. Fiamoli, B. Lipový, J. Bartošková

Mykotické infekce jsou jednou z nejčastějších onemocnění. Povrchové mykózy postihují kůži a sliznice. Hluboké mykózy jsou orgánové a systémové. Výskyt těchto onemocnění se zvyšuje díky používání širokospektrálních antibiotik, kortikosteroidů a cytostatik. Mykózy (vyvolané kvasinkami nebo vláknitými houbami) se vyskytují častěji u pacientů s popáleninami než u jiných pacientů; zejména u pacientů s velkým a hlubokým rozsahem popálenin. V této kazuistice představujeme případ 62letého pacienta hospitalizovaného na Klinice popálenin a plastické chirurgie FN Brno s rozsáhlými hlubokými popáleninami (2.–4. stupně) pokrývajícími 35 % povrchu celého těla, převážně na obou dolních končetinách. Během hospitalizace byla pacientovi diagnostikována kombinovaná bakteriální a mykotická infekce, pro kterou byla indikována cílená terapie.

Otrava kyanidem u pacientů s inhalačním poraněním – skrytá hrozba

F. Raška, B. Lipový, M. Hladík, J. Holoubek

Inhalační trauma je závažnou komplikací u pacientů s popáleninami, která dramaticky zvyšuje jejich morbiditu a mortalitu. U těchto pacientů je obvykle podezření na inhalační poranění s možnou systémovou intoxikací. Obvykle se setkáváme s intoxikací oxidem uhelnatým, ale je třeba myslet i na možnost otravy jinými produkty hoření. Intoxikace kyanidy jsou méně časté, ale jejich diagnostika a léčba je o to složitější. Diagnóza může být stanovena pouze na základě anamnézy, klinického nálezu a nepřímých laboratorních známek Přímé stanovení plazmatických hladin kyanidů není v běžné klinické praxi použitelné. V současné době je k dispozici několik specifických antidot s různým mechanizmem účinku. Neexistují žádná jasná doporučení ohledně výběru konkrétního antidota, a to z důvodu nedostatku důkazů založených na randomizovaných kontrolovaných studií na lidech. Ve dvou minikazuistikách uvádíme naše zkušenosti s diagnostikou a terapií pacientů s podezřením na otravu kyanidy.

Léčba hypertrofických jizev frakčním CO_2 laserem – hodnocení účinnosti a optimalizace léčebného protokolu

H. Klosová, B. Zálešák, P. Xinopulos, K. Langová

Úvod: Hypertrofické jizvy jsou nechtěným a mutilujícím následkem hlubokých popálenin, dále vystupňovány jsou u rozsáhlých popáleninových úrazů. Frakční CO_2 laserová terapie je jednou z metod komplexní léčby hypertrofických jizev a používá se od roku 2007. Přestože její účinnost byla v klinické praxi objektivně prokázána, nebyly stanoveny optimální parametry nastavení. Pro hodnocení účinku laserové terapie se používají dříve navržené hodnotící nástroje, které dobře postihují kvalitu jizev, ale nedokáží postihnout specifické změny pro provedené laserové terapii. **Materiál a metody:** Frakční CO_2 laserová terapie hypertrofických jizev je na Oddělení plastické a estetické chirurgie FN Olomouc prováděna od roku 2017; systematická studie účinků probíhala v letech 2019–2020. Celkem bylo léčeno 25 hypertrofických jizev u 13 pacientů, každá z jizev byla frakční CO_2 laser terapií ošetřena více než jednou. **Výsledky:** Statistickou analýzou dat bylo detekováno statisticky významné zlepšení textury jizev a zlepšení celkového funkčního a estetického výsledku. U jizev, jejichž výška byla před zahájením laserové terapie vyšší než 2 mm, došlo k signifikantní redukci výšky pod 2 mm (62,5 % jizev). Korelační analýzou byla detekována statisticky signifikantní pozitivní korelace mezi energií laserového paprsku a redukcí rozsahu jizev prominujících nad nivó zdravého okolí. Frakční CO_2 laserová terapie ukázala statisticky významnou účinnost při redukci rizik spojených s plnoformátovou CO_2 laserovou terapií. Frakční ošetření bylo pacienty velmi dobře tolerováno, topická anestezie 5% gelem lidokainu byla dostatečná u 24 z 25 pacientů. Následné hojení probíhalo u všech pacientů bez komplikací. **Závěr:** Frakční CO_2 laserovou terapií bylo dosaženo statisticky významného zlepšení textury a redukce výšky hypertrofických jizev a zlepšení celkového funkčního i estetického výsledku.

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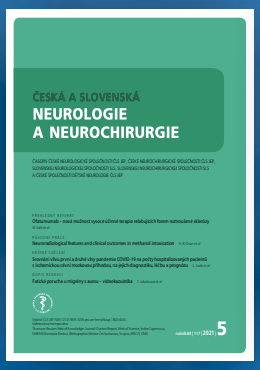

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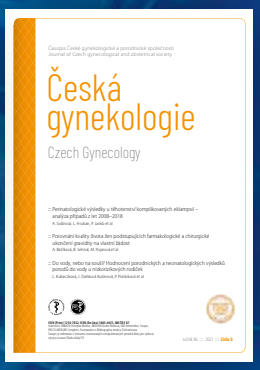

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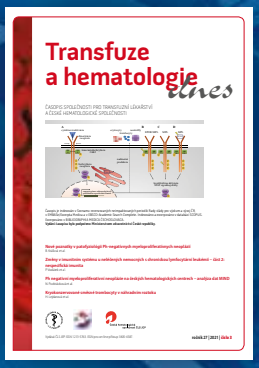

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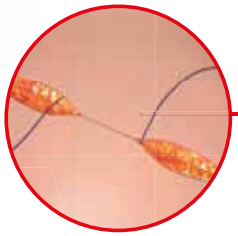

Dvousměrný design umožňuje řešení tahu směrem od středu incize.[1]

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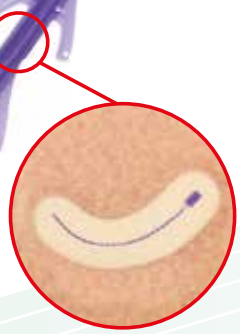

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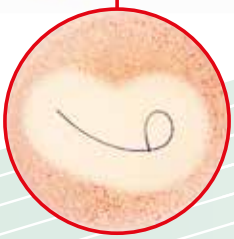

Jednosměrný design **s antibakteriální technologií Plus** má na jednom svém konci nastavitelné očko.[1]

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1. Data on file, Ethicon, Inc.: STRATAFIX Knotless Tissue Control Device Claims Matrix. 060056-160915 EMEA **2.** Moran ME, Marsh C, Perrotti M. Bidirectional-barbed sutured knotless running anastomosis v classic Van Velthoven in a model system. J Endourol. 2007;21(10):1175-1177. **3.** Rodeheaver GT, Piñeros-Fernandez A, Salopek LS, et al. Barbed sutures for wound closure: in vivo wound security, tissue compatibility and cosmesis measurements. In: Transactions from the 30th Annual Meeting of the Society for Biomaterials; Mount Laurel, NJ; 2005. p. 232. **4.** Vakil JJ, O'Reilly MP, Sutter EG, Mears SC, Belkoff SM, Khanuja HS. Knee arthrotomy repair with a continuous barbed suture: a biomechanical study. J Arthroplasty. 2011;26(5):710-713. **5.** Data on file, Ethicon, Inc.: 100326296: Time Zero Tissue Holding - Competitive Claims Comparisons for STRATAFIX Knotless Tissue Control Devices vs Various Products. 2015

Stratafix Symmetric Ethicon

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