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Dear readers,

We are starting the new year of our journal with this first issue and we hope, as every year, that the coming year will be better than the previous one. Our main goal for 2017 is to prepare and publish the complete set of issues. This was not possible in the past years, mainly from financial reasons, but for the current year, the journal obtained a significant financial support, which we think enables us to accomplish our goal. Please cross your fingers in order for us to manage this great amount of tiny and invisible work with the journal also this year.

The journal could not exist without many people, who contribute on its production and without whom the journal could not be produced. I would like to thank all reviewers of previously published articles for their expert work and mainly for their time, which they provided to the journal and which they had to take from their busy professional and personal life. I would also like to thank all guarantors of previously published issues, who took care of their uneasy task honestly and conscientiously enabled preparation of inspiring issues. I also would like to thank the technical editor of our journal, Michaela Malinová, for her diligent work and technical preparation of the journal, which obtains the final print form in her hands.

The journal could not be published without the authors, who provide their articles. Their expert and formal level has been increasing every year, however, there is always something to improve. Virtually every article needs major or minor amendments during the review process. In spite of that I would like to thank to all of our authors for their work, because writing a good article and successful passage through the review process is difficult and time demanding work. I would also like to notify possible future authors that we are of course interested in their articles. With regards to our experience, however, we would like to add a few advices and recommendations.

Every author, when he/she prepares an article, should remember whether their information reflect some relevant or current topic with regards to the topic of the journal, whether the article contains some new information, whether it is possible to consider its conclusions to be important and whether these conclusions are sufficiently scientifically based. Such articles have a chance to be accepted. The ability to write a good article is not a characteristic of everyone, but it could be learned. However, it needs certain practice, carefulness and optimally also a good teacher or supervisor. This may help to save a lot of work with repeated amendments of the text and to reduce the risk of not accepting the article for the journal.

Apart from these difficult skills there are also "simple" skills, which is mainly observation of formal requirements, which are requested by our editors. These requirements are clearly specified in the instructions for authors, which may be found always at the end of each issue. Therefore, we ask every future author to read these instructions before submitting his/her manuscript. Essential is mainly observation of formal structure of the paper with regards to its type, i.e. the classic: introduction, material and methods, results, discussion and conclusion. The same structure should also have the abstract of the paper, which, if written well and comprehensibly, determines whether the potential reader reads the whole article.

The "attractiveness" of the article for specialized searching machines is also defined by correctly chosen key words, optimally according to the MeSH standards. Even correctly chosen title is able to determine whether someone reads the article. It should reflect the basis of the paper in order to attract the attention of the reader, who is currently overloaded by information. Even if other formal rules are observed, such as format of references, ethical principles, correctly chosen statistical method, disclosure, technical requirements to the images, tables and charts, or correctly written cover letter, could decide whether the manuscript will be accepted for publication or not.

To conclude, let me wish our coming year a lot of success. On behalf of the editorial board I promise that we shall continue to try offering future authors a quality platform for publication of their scientific knowledge. And not to forget the most important, I would like to wish our readers an inspiring reading.

Aleš Fibír, M. D., Ph.D.
Editor-in-chief
Acta chirurgiae plasticae

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CURRENT STANDARDS OF BURNS TREATMENT

In accordance with a long-anticipated publishing plan, the editorial board has dedicated Issue 1 of Volume 59 to the vastly extensive topic of burn treatment. We do so in the spirit of tradition and the legacy of Professor František Burian, founder of this very journal and world renown pioneer of plastic surgery. As a plastic surgeon who routinely encountered the severe functional and cosmetic consequences suffered by burn survivors, Burian defined burns as trauma and advocated for an active surgical approach to their treatment. His meritorious efforts resulted in the first specialized burn center in Continental Europe, which he established in Prague in 1953. A disciple of Prof. Burian, Professor Radana Königová served as his successor by further developing a separate field of burn medicine, and contributing significantly to national policy on burn treatment, in the former Czechoslovakia. Since that time, the quality of our comprehensive and continuous approach to burn treatment has consistently remained comparable to leading burn centers around the world.

The contributions included in this issue were selected in an effort to present a conspectus of some of the major phases of burn injury treatment. One of the initial steps is the removal of all non-vital tissues that have been destroyed by burn trauma. Necrectomy of extensive burns is a demanding treatment phase not only for patients but also for surgeons. Seeking out the least invasive and most expedient method, e.g. chemical or enzymatic necrectomy, is one of several possible approaches. The next step toward full body surface restoration is skin grafting, which may prove to be highly complicated in cases with insufficient donor site availability. Thus, any improvement in the ability to use smaller donor sites to restore larger necrectomized areas is absolutely invaluable, as has been described in a contribution on Meek micrografting from Ostrava. A modern cutting-edge approach, which enables survival even in critical burn patients, employs the use of permanent dermal substitutes, i.e. artificial skin that can be used in patients undergoing treatment for acute conditions or reconstructive surgery. Authors from the Prague Burn Center present a contribution that documents their experience with roughly 50 patients who were treated with Integra® permanent dermal regeneration templates. The most serious complication (and one of the most common) that burn survivors face throughout the course of treatment is infection. Another contribution from Brno addresses this topic in detail with a particular focus on yeast and fungal infections, which occur relatively less frequently. Thanks to the advances in medicine and technical equipment over the last few decades, the goal of burn treatment has shifted from the primary struggle for survival, to achieving the best possible quality of life with full somatic and psychosocial rehabilitation. Much attention has been devoted to the healing process, especially scar formation and the factors that influence it. One contribution discusses the new micro-needling method used in the treatment of scarred areas.

All of the papers presented in this issue are based upon the authors' own clinical practice and scientific research conducted at their specialized institutions. Despite significant technical and instrumental improvements, particularly those in intensive care units, the long-term conditions under which clinicians have worked have not been ideal due to e.g. unclear funding rules for this demanding form of medical care, rather frequent changes in the legislative conditions for specialized medical training, etc., as Prof. Brychta, Chairman of the Czech Society of Burn Medicine, reports in this issue. Ensuring proper staffing and recruiting young physicians is crucial to the security and future of the entire field. At the same time, we appreciate the current opportunities for young physicians to participate in foreign internships and fellowships, which enable them to acquire, and return home with, valuable experience from prestigious institutions. In stark contrast to this, from time to time we must face terribly sad news when a prominent figure leaves the ranks of plastic or burn surgeons, such as the eminent Associate Professor Konstantin Troshev who, among many other things, was a long-time member of this journal's editorial board (contributions from Hradec Králové).

During the last 2–3 decades, we have seen great improvements in burn prevention, significantly improved prognoses after severe burn trauma, reduced lethality, and increased quality of life of burn survivors. This characterization, however, is marked by tremendous variation across continents and throughout different world regions. During its 2012 Congress in Edinburgh, the International Society for Burn Injuries (ISBI) announced its motto for the then-upcoming period: "One world, one standard of burn care." One of the concrete outcomes of that multi-year endeavor is the recently published worldwide guideline entitled, "*ISBI Practice Guidelines for Burn Care*" (*Burns*, 42, 2016, 5, pp. 951–1021). The Czech Republic's consistently high level of burn care management is well documented by the papers published in this topic-oriented and specially dedicated issue; a level of care that was also acknowledged by the ISBI when they requested our active participation in the creation of their latest directives. During the creation process, we felt an enormous and legitimate sense of pride knowing that, in many ways, the world recommendations would be based upon guidelines that have long been well-established procedures in our own country. I trust that, as the reader becomes familiar with the papers published in this issue of *Acta Chirurgiae Plasticae*, they, too, will be convinced of that reality.

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OUR EXPERIENCE WITH THE USE OF 40% BENZOIC ACID FOR NECRECTOMY IN DEEP BURNS

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ACTA CHIRURGIAE PLASTICAE, 59, 1, 2017, pp. 5-10

ABSTRACT

Introduction: Chemical necrectomy of deep burns using 40% benzoic acid has been used extensively by the Department of Burns and Reconstructive Surgery at the University Hospital since its establishment in 1982. In spite of definite advantages for the patient and medical staff, hard data concerning benzoic acid absorption through skin necrosis and patient safety was missing.

Material and methods: We examined 22 burn patients in collaboration with the University Hospital Brno, Department of Clinical Biochemistry. The plasmatic levels of benzoic acid, hippuric acids and glycine, which is consumed during the metabolism of benzoic acid, were measured. Urine samples were collected to determine the total amount of hippuric acid that is excreted. We were able to determine the total amount of absorbed and excreted benzoic acid from these values.

Results: We consistently found that there was a rapid and short-term increase of plasmatic levels of benzoic acid (maximum 1.3 mmol/l). This value is about 5 times lower than the minimum toxic level of this acid (6.5 mmol/l). The same course has been observed in hippuric acid. The level of glycine dropped slightly, but was still within the normal range.

Discussion: Typical and atypical courses of the levels of both acids were discussed as well as the correlation of the dynamics of elimination with the extent of benzoic acid application in relationship with the clinical status of the patient. The effectiveness and safety of this method was evaluated.

Conclusion: After summarizing the observations, it was demonstrated that chemical necrectomy using 40% benzoic acid is a selective method comparable with other types of sharp necrectomy. Chemical necrectomy is inexpensive, easy to perform and also reduces blood loss. Toxicity of absorbed benzoic acid is clinically negligible. Furthermore, benzoic acid's antimycotic and antibacterial properties prevent the development of wound infection.

KEYWORDS

Burn wound, skin necrosis, necrectomy, chemical necrectomy, selectivity, benzoic acid, hippuric acid, glycine, toxicity

INTRODUCTION

Chemical necrectomy has been used for more than 33 years (in approximately 6000 patients) successfully at the Department of Burns and Reconstructive Surgery of the University Hospital in Brno. There is not much data available in Czech or worldwide literature about this method and there is even missing data from any serious analysis of clinical efficiency, comparison with other necrectomy methods and mainly possible complications for the patient.[1,2] Ointment with benzoic acid in white vaseline is applied on demarcated deep burns at the earliest on the sixth day after the burn. Layer of benzoic acid in white vaseline is applied on tulle de grass, which has a size approximately as the burn surface area and it is placed on the wound. It is fixed with several metal clips. The actual necrectomy is performed 48 hours later, usually under general anaesthesia (according to the extent). Necrosis either falls off with the dressing or after easy release with blunt instruments. The base of the wound is usually clean, there is mild bleeding and it is possible to apply a skin graft. The ointment is applied in one stage maximally on 10% of body surface area (see Figure 1–3). Toxicity of benzoic acid for human is generally very low. There has been only irritation of skin with pseudoallergic rash and eye damage reported.[3] Literature reports that the minimal level of benzoic acid associated with toxic symptoms in human is 6.5 mmol/l.[4,5] Benzoic acid is completely absorbed from the gastrointestinal tract, it is incompletely absorbed through intact skin. Absorbed benzoic acid is relatively quickly metabolized in the liver by conjugation with glycine producing hippuric acid, which is then excreted by urine. There is no accumulation in the body.[6] We have performed a clinical study with the goal to monitor the dynamics of absorption and elimination of benzoic acid applied on burned skin. This study documents how fast and in what extent there is absorption of benzoic acid through burned skin taking place, what plasmatic levels are achieved, how fast it is metabolized to hippuric acid, which is excreted in urine. We collected urine and calculated the quantity of excreted hippuric acid and correlated these calculations with plasmatic

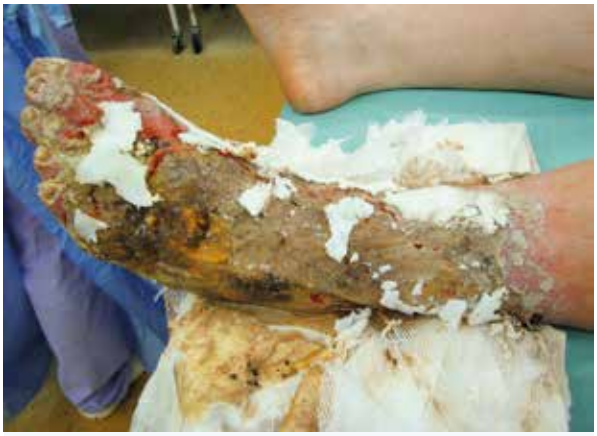

Fig. 1. Burn area after two-day action of 40% benzoic acid dots was assigned as the perforator. By this way a preoperative map was created

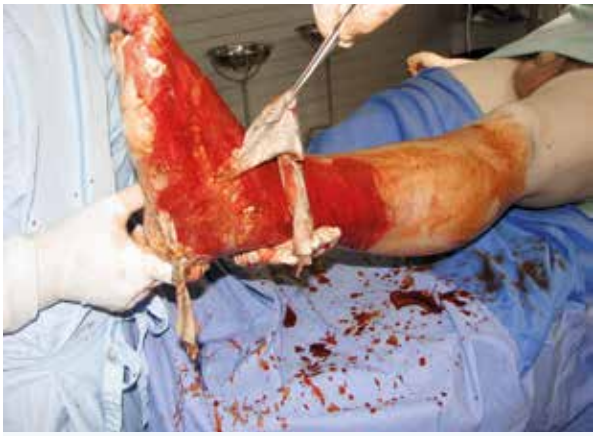

Fig. 2. Easy removal of necrosis with minimal bleeding after 48 hours

concentrations of both acids and extent of absorption surface and we also investigated, whether conjugation of benzoic acid with glycine producing hippuric acid does not lead to reduced plasmatic levels. Supplementary part of our study was monitoring of microbial colonization of areas after chemical necrectomy.

MATERIAL AND METHODS

There were totally 22 patients aged 6–85 years with skin burn IIb–III degree studied. There was 40% benzoic acid in white vaseline applied for 48 hours on burn area of 0.5–10% total body surface area. Venous blood was collected in the first 10 patients before application (0 minutes) and in 10, 20, 60 minutes and then 2, 4, 6, 12, 24 and 48 hours after application on burn area in order to determine benzoic acid, hippuric acid and glycine in serum. In the subsequent patients, when we knew the rough dynamics of absorption, we reduced the frequency of blood collections to half and we omitted collections in 10 and 20 minutes and after 2 and 4 hours. Urine for determination of hippuric acid was collected in four 12hourly intervals. Examination took place in the laboratories of the Department of Clinical Biochemistry, University Hospital in Brno-Bohunice. Determination of benzoic acid and hippuric acid in serum and hippuric acid in urine was performed using HPLC method – high performance liquid chromatography on HPLC Waters 2695–Alliance with diode array detector Waters 2996. Automatic analyser of amino acids Biochrom 20 (Biochrom-Pharmacia) was used for determination of glycine in serum.[7,8] Collections were performed according to the same time schedule as in case of benzoic and hippuric acid.

In all 22 patients were performed imprints or smears before chemical necrectomy for microbiological examination of the presence of potentially pathogenic microorganisms. The same was performed after removal of necroses 2 days later. (Fig. 1, 2, 3.)

RESULTS

1. Serum concentration of benzoic acid

The values in Chart 1 show that there is a quick rise of benzoic acid level in serum within the first hours after application. Most frequently measured maximal serum levels were 1–2 hours after application of ointment. Therefore we did not proceed with collections in the first hour in patients No. 11–22 and we also skipped the collections after four and six hours. In some patients we also collected sample after 72 hours; the levels were usually lower than the initial levels, therefore we also skipped them. Next stage of benzoic acid application on residual necroses followed in some patients after 48 hours and we either did not perform collections, or, if these were performed, concentration raised quickly again. Next 12 patients were already examined according to a reduced scheme.

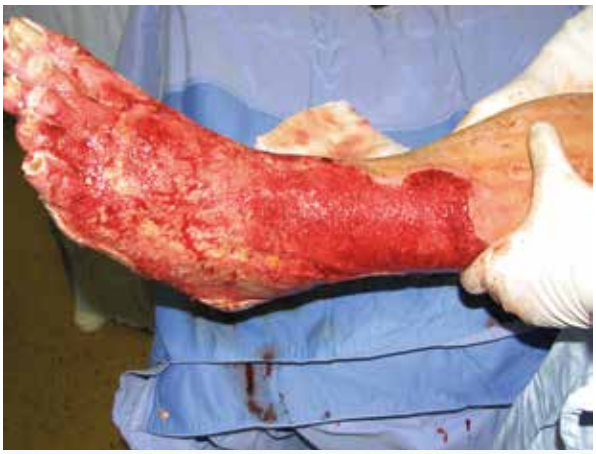

Fig. 3. Non-bleeding base of the wound ready for transplantation

We notice a relatively large difference between arithmetic means and median. It is due to the fact that the range of measured absolute concentrations is 0.008 mmol/l to 1.3 mmol/l, which is mainly dependent on the extent of surface with applied acid. Therefore, while median in 2nd hour is 0.08 mmol/l, arithmetic means is severely biased by two patients with the highest levels (patient 6 and 9, the maximum of whom is around 1.0 mmol/l) and reaches the level of 0.226 within the same time. Curves and courses are relatively coherent in all patients.

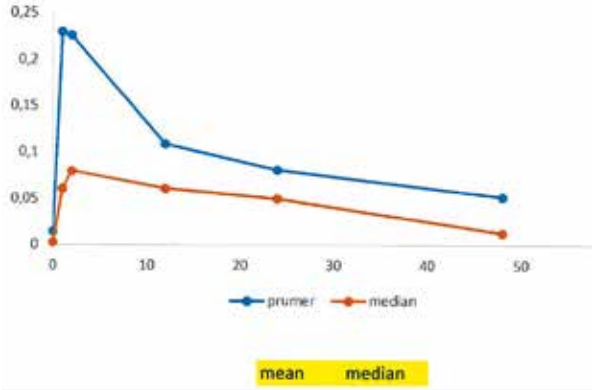

Chart 1. Mean and median of benzoic acid levels

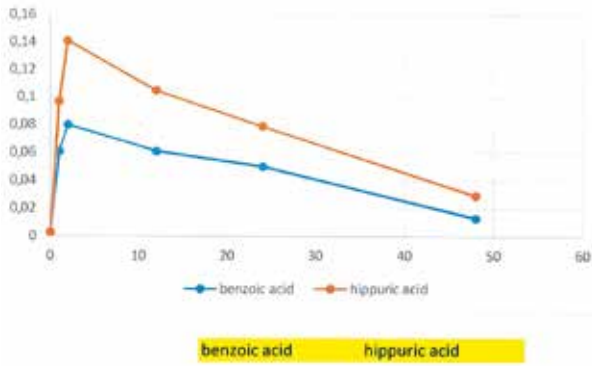

Chart 2. Medians of levels of both acids together

2. Serum concentration of hippuric acid

Similarly to benzoic acid, also hippuric acid was examined in the first 10 patients more frequently and in the remaining 12 according to a reduced scheme (Chart 2). Measured variability of absolute serum concentrations must have some cause. The most logic hypothesis is that patients with higher extent of applied ointment will have higher concentrations. Table 1 summarizes basic facts about each patient.

3. Plasma concentrations of glycine

Serum concentrations of glycine during application of benzoic acid are quickly declining in the first hours after application, which demonstrates consumption of glycine for conjugation with benzoic acid to produce hippuric acid (Chart 3). All patients have initially higher levels than after 48 hours, but none of them demonstrated decline below the lower reference range. Reference range for glycine in adults is 120–554 µmol/l and in children 117–223 µmol/l.

	Age	Gender	Total burn extent (%TBSA)	Absorption area	Maximal benzoic acid level	Maximal hippuric acid level	Total absorbed quantity (g)
Patient 1	76	M	16%	10%	0.565	0,221	22.4
Patient 2	77	M	7%	3%	0.075	0,163	16
Patient 3	26	M	7%	4%	0.034	0,06	6.1
Patient 4	18	M	M	7%	0.657	0,269	65
Patient 5	44	M	35%	7%	0.234	0,258	not found
Patient 6	29	M	40%	8%	1,3	0,17	not found
Patient 7	32	M	28%	8%	0.82	0,21	not found
Patient 8	54	M	13%	8%	0.04	0.096	not found
Patient 9	63	M	65%	10%	1	2,229	not found
Patient 10	85	F	6%	6%	0.134	0.296	14.1
Patient 11	46	F	11%	1.50%	0.08	0.156	30
Patient 12	47	F	4%	4%	0.084	0.048	7.58
Patient 13	40	F	14%	4%	0.053	0.088	21.1
Patient 14	44	M	5%	4%	0.073	0.176	11.7
Patient 15	6	M	16%	8%	0.186	0.251	14.9
Patient 16	42	M	1.5%	1%	0.008	0.009	1.04
Patient 17	63	F	3%	2.50%	0.037	0.078	5.5
Patient 18	59	M	2%	0.50%	0	0.014	0.11
Patient 19	18	M	9%	9%	0.125	0.183	12.6
Patient 20	57	M	16%	10%	0.61	0.475	30.6
Patient 21	53	M	6%	2.50%	0.027	0.049	2.6
Patient 22	70	M	10%	10%	0.518	0.286	15.5

Table 1. Correlation of maximal levels of benzoic acid. hippuric acid and extent of application

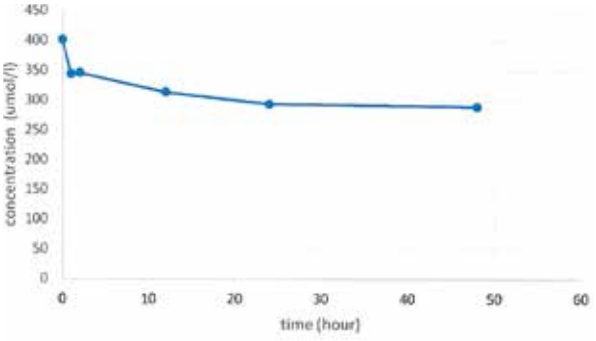

Chart 3. Median of plasmatic concentrations of glycine in time

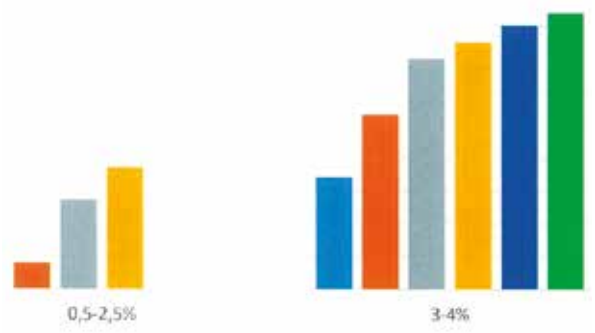

Chart 4. Concentration of benzoic acid according to % TBSA of application

4. Total absorbed quantity of benzoic acid during chemical necrectomy

The total absorbed and excreted quantity of benzoic acid may be theoretically calculated from collected urine, while we assume that 1 molecule of hippuric acid developed from 1 molecule of benzoic acid. The total amount of excreted hippuric acid is then multiplied by molecular weight of benzoic acid (M = 122) and we obtain an approximate quantity of absorbed acid. It should be noted, however, that part of benzoic acid is metabolized by glucuronization, i.e. another, minor pathway. Furthermore, not all benzoic acid in blood and urine is due to chemical necrectomy, since it is widely used as a preservative in cosmetics, food and drinks. One mol of hippuric acid produces 1 mol of benzoic acid and if multiplied by molar concentration of benzoic acid, which is 122 g/mol, we obtain total weight of benzoic acid, from which hippuric acid developed: m = n x M

Results after 48 hours are listed in the last column of Table 1. However, in comparison with serum concentrations, the quantity of applied benzoic acid correlate only little and seem to be very inaccurate and unsuitable for possible monitoring of safety of chemical necrectomy. Collection of urine is demanding with regards to good cooperation of the patient and medical staff and there is more space for failures and inaccuracies. This examination could not be performed at all in 5 patients.

5. Microbiological examination of areas after necrectomy

Imprints for culture before application of benzoic acid and after 2 days were collected in all patients. No microbes were cultured in most patients or their quantity declined. Only in 3 patients the finding worsened and there was positive culture of *coagulase negative Staphylococcus* or once higher count of *Staphylococcus aureus*.

DISCUSSION

Absorption and elimination of benzoic acid

Obtained results indicate that benzoic acid is absorbed during chemical necrectomy as performed by our method. It is understandable, since the main barrier of skin is stratum corneum, which is completely missing in burn skin. The quantity of absorbed acid depends mainly on the extent of the area, on which it is applied as shown in Chart 4. This shows maximal levels of benzoic acid in patients up to 4% of applied benzoic acid. Concentrations range from 0.008–0.084

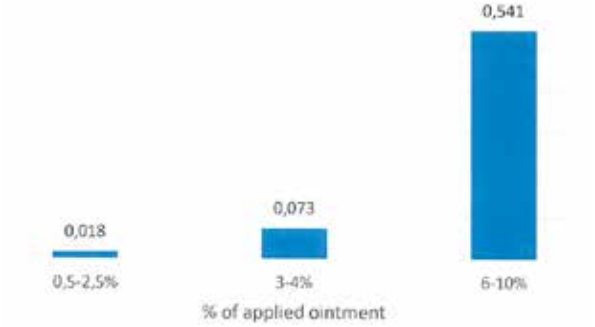

Chart 5. Medians of maximal concentrations according to the extent

mmol/l and very well correlate with the extent of absorption area. In case of greater extents of absorption area, the variability of serum concentrations is already higher but ranges in the extent from 0.125–1.3 (Chart 5). Peak plasmatic concentration of benzoic acid may be moved to later hours in patients with thicker layer of necrosis. Our explanation is that there is also thermal damage to the subdermal vascular plexus and since subcutaneous tissue is not well vascularized, there is slower and apparently also incomplete absorption of benzoic acid taking place. Metabolism of benzoic acid to hippuric acid depends on good liver function. Excretion of hippuric acid is then influenced by kidney function.

In our group we demonstrated 2 types of absorption and metabolism of benzoic acid and divided them into two groups. The first group includes patients, who quickly metabolize benzoic acid to hippuric acid and levels of hippuric acid exceed concentration of benzoic acid in each sample. This type of metabolism correlates mostly with uncomplicated course and successful chemical necrectomy. This group included 15 patients (patient No. 2, 3, 5, 8, 10, 11, 12, 13, 14, 15, 16, 17, 19, 20, 21). The second group included patients in whom the ratio of both acids is the opposite (patient No. 1, 4, 6, 7, 9, 22). Common feature is higher age, greater total extent of the burn, development of burn shock or possible co-morbidities. The cause of this feature is not very clear. It should not be a lack of glycine with regards to the aforementioned results. With increasing plasmatic concentration of benzoic acid rises also concentration of hippuric acid. However, at some point, it seems as if there was conjuga-

Tangential necrectomy	
Advantages	**Disadvantages**
May be performed soon after the injury	Great blood losses by capillary bleeding
Less damage to body contour	Need for general anaesthesia
Preservation of vital parts of subcutaneous tissue	Difficulties to stop bleeding
Chemical necrectomy	
Advantages	**Disadvantages**
Simple technique of performance	Use at the earliest 6 days after trauma
Minimal blood losses	Maximal surface 10% TBSA
Selective removal of necrotic tissue	Painful
Cheap	Elevated level of hippuric acid in blood
Very gentle in children and elderly patients	Excessive inflammatory reaction with
Preserves contour of body surface	production of a quantity of substances Possible allergic reaction
	(very rare and usually with mild course)

Table 2. Efficiency comparison of chemical and classical tangential necrectomy

tion capacity of hepatocytes exceeded and even in spite of high level of benzoic acid, concentration of hippuric acid does not continue to rise and starts to decline. In spite of that, however, there continues rapid decline of plasmatic concentration of benzoic acid. Is there a different route of elimination used or benzoic acid is excreted to urine in unchanged form? Reduced capacity of the liver to produce adequate quantity of hippuric acid could be due to a lack of ATP, which is apparently a common feature in patients, who suffered burn shock. This however does not explain continuing rapid elimination of benzoic acid from plasma.

Mechanism of action on necrosis, histology

The exact mechanism of action of benzoic acid during chemical necrectomy has not been clarified yet. There were initial thoughts that there is some kind of necrolysis, i.e. caustic effect on necrotic part of burn skin. It seems, however, from clinical observation and several collected histological samples that benzoic acid acts as a strong chemoattractant to immunocompetent cells, which intensively and rapidly migrate to the layer between vital and non-vital tissues and by the production of colagenases and proteases cause release of the bonds between necrosis and undamaged tissue. The principle is therefore based on significant acceleration of physiological inflammatory reaction, when the body after several weeks is able to remove non-vital tissue alone. When lifting the necrosis after application of benzoic acid, we observe collection of "pus-like" fluid, which is however mostly sterile. It is logical with regards to the antimicrobial and anti-mycotic effect of benzoic acid and verified by routine practice of collecting microbial imprints from areas after necrectomy. The following cellular components contribute on the release: neutrophils – polymorphonuclears, macrophages producing collagenases, metalloproteinases, interleukins and cytokines. Possible predictive factors of failure of this method seem to be generally poor medical condition leading to induced immunosuppression of the organism, which clearly does not respond to an immune stimulus, and also thermal destruction of skin reaching to subcutaneous fat. Our hypothesis is based on the fact that in case there is damage to subdermal vascular plexus, then immunocompetent cells penetrate slower to less perfused fatty tissue and the method of chemical necrectomy for this type of damage is not effective.

We attempted to compare the efficiency of chemical and classical tangential necrectomy with the following conclusions (Table 2).

CONCLUSION

Efficiency of benzoic acid during necrectomy of burns according to our long-term clinical practice and performed study is characterized as follows:

– 40% benzoic acid in white vaseline is effective in most skin necroses caused by all types of burns. Healing of grafts on wound bases after chemical necretomy is the same – almost hundred percent – as after all types of sharp necrectomy

– The main advantage of necrectomy with benzoic acid is its selectivity and significantly lower blood losses.

– The disadvantage is moderate pain several hours after application of benzoic acid and efficiency at the earliest 6 days after burn. It is less successful or unsuccessful in patients who are immunocompromised due to any reason.

– Our study demonstrated absorption of benzoic acid through skin necrosis, however its level in blood remains always low and below the toxicity level – i.e. it is a safe method.

– There was antibacterial and anti-mycotic effect of benzoic acid on wound area demonstrated. In most patients there were no microbes or their quantity declined in the area after chemical necrectomy.

– The method is suitable mainly at suboptimal clinical conditions, where it is not possible to provide perfect sterility and sufficient amount of blood derivatives to supplement blood losses.

– Very suitable indication for chemical necrectomy is the use in the elderly and polymorbid patients, since it is possible to avoid general anaesthesia in patients during removal of necroses.

– This method seems advantageous in some areas, such as dorsum of the hands, feet, pretibial area, where tangential necrectomy could result in damage of deep structures.

– In case of extensive burns, we consider to be optimal combination of benzoic acid with other types of necrectomy, which enables removal of necrosis from the patient in shorter period of time with less blood loss.

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Estetická plastická chirurgie a korektivní dermatologie

Brychta Pavel, Stanek Jan (ed.)

Odborná monografie komplexně popisuje současný stav estetické plastické chirurgie, korektivní dermatologie a laserové estetické chirurgie, které jsou v současné době mimořádně populární a veřejností intenzivně sledované. Kniha by měla pomoci lékařům, kteří se touto problematikou zabývají, orientovat se hlouběji v možnostech, které jsou dnes dostupné. Publikace je bohatě dokumentována téměř 300 barevnými fotografiemi a kresbami. Nedílnou součástí publikace je i DVD s dalšími více než 1100 obrázky a dvěma videosekvencemi.

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MEEK MICROGRAFTING TECHNIQUE AND ITS USE IN THE TREATMENT OF SEVERE BURN INJURIES AT THE UNIVERSITY HOSPITAL OSTRAVA BURN CENTER

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ABSTRACT

Background: Early necrectomy and skin autotransplantation are prerequisites for successful treatment of extensive burns. Insufficient autograft donor site availability is a limiting factor. The Meek micrografting technique, published by C. P. Meek in 1958, appears to be a potential solution. Skin grafts are cut into micrografts and expanded at a ratio of 1:3, 1:4, 1:6 or 1:9. Thus, even in cases with limited donor site availability, it is possible to cover large areas after necrectomy.
Material and Methods: Meek micrografting was first used at the University Hospital Ostrava Burns Centre in 2013. To date, 14 operations have been performed in 4 patients with extensive burn trauma. Engraftment, healing rate, and subsequent scarring (with a particular focus on scar contracture formation) were observed postoperatively.
Results: The average micrograft success rate was 86.5%. The best success rates were observed in areas with deferred transplantation after necrectomy. Hypertrophic scarring occurred in both Meek and meshed transplant areas. No scar contractures requiring surgical management developed in micrografted areas. Surgical scar contracture release was required in 1 patient who underwent meshed graft transplantation.
Discussion: The Meek technique demonstrated significant advantages. Micrografts can be prepared with very small skin grafts, which is impossible with the mesh technique. Meshed grafts with expansion ratios of 1:3 or higher require allograft or xenograft coverage. In our experience, overlays were not necessary for micrografts with a 1:6 expansion ratio. Given that no serious scar contractures developed in micrografted areas, we speculate that micrografts may pose a lower risk for their development when compared to meshed grafts. The disadvantage of the Meek technique is greater economic demands.
Conclusion: Meek micrografting is effective in the surgical management of deep burns in extensive thermal injuries with limited donor site availability...

KEYWORDS

Extensive burns, skin autotransplantation, Meek micrografting, skin expansion, healing and results, own experience

INTRODUCTION

Insufficient autograft donor site availability is a limiting factor in the surgical management of extensive burns and early wound closure after necrectomy. Surgeons have, therefore, long sought new and enhanced methods of skin transplantation that have already been proven in clinical practice. In 1958, American physician Cicero Parker Meek at the Aiken County Hospital in South Carolina published a new skin graft technique, which he called "micrografting".[1] This method was novel in that small skin grafts were not prepared manually, but rather with the "Meek-Wall microdermatome" device that he had developed in cooperation with engineer S.P. Wall. Between 1958–1965, Meek published 4 additional papers further describing his micrografting technique and its results.[2,3,4,5] In 1963, Meek and Wall patented their device in the USA as the "Microdermatome". Despite promising results, however, Meek's method did not receive wider application at that time due to high hopes for the mesh skin graft technique (introduced in 1964), which was simpler and less costly to perform. Advances in resuscitation and complex intensive care for burns led to increased survival of patients with severe extensive burns. With increasing frequency, situations arose (and continue to arise) wherein skin grafting with meshed grafts was insufficient due to lack of donor sites. In the 1990s, Meek micrografting was "rediscovered" and refined by Dutch surgeons Rudy Hermans and Robert Kreis in Beverwijk, The Netherlands.[6] In

collaboration with engineers from Humeca[6], they introduced the "Humeca dermatome" into clinical practice. At present, the Meek technique is most commonly employed in cases of extensive thermal trauma with insufficient donor sites.[7] The method provides effective and aesthetic results[7] which, at a minimum, correspond to results achieved with meshed skin grafts.[8,9] The Meek technique was first used at our facility in 2013 in a patient with extensive burn trauma to 91% of the total body surface area (TBSA). In this paper, we present our results and experience pertaining to the healing process, micrograft engraftment, and subsequent scar development.

MATERIAL AND METHODS

Patient sample and surgical approach

Between March 1, 2013 and September 30, 2015 the Meek technique was used in 4 adult patients (3 men and 1 woman; mean age 40 years) with extensive burn injuries. In all 4 patients, the burns were caused by fire; 3 cases resulted from an explosion and 1 case was a suicide attempt. The average burn size was 75% TBSA with 36% TBSA third-degree (Table 1). The mean hospitalization was 129 days (range 83–194), of which 79 days (range 62–99) were spent in an intensive care unit. Three patients required artificial ventilation, escharotomy in areas of deep circumferential burns, and tracheostomy. The mean duration of artificial ventilation was 69 days (range 61–74). On average, necrectomies were performed on 30% TBSA (range 8.5–65). Of these, fascial necrectomy was performed on about 12.8% TBSA; tangential necrectomy on about 12.8% TBSA; and chemical necrectomy, using with 20% or 40% benzoic acid in an ointment, on about 4.6% TBSA. In 3 patients, skin autografts were immediately transplanted to the area after necrectomy or abrasion. In 1 patient, an Integra® (Integra Life Sciences Corp., USA) biosynthetic skin substitute was used first on an area of about 17% TBSA, and was then followed by subsequent autografting. In all 4 patients, the Meek technique was used for the greater part of autografting and smaller remaining sites were covered with meshed dermoepidermal grafts (see Table 1). A total of 14 operations were performed with the Meek micrografting technique, during which an area approximately equal to 2 m^2 was gradually transplanted.

Postoperatively, each patient's healing process was monitored every 2–3 days during dressing changes in the operating room. Clinical estimates were conducted via visual assessment of the Meek micrograft engraftment percentage and epithelialization progress between autograft islands. Engraftment was confirmed on the postoperative day (POD) during which micrografts achieved complete adhesion to more than 90% of the transplanted site with no secretions and clear vitality. Epithelialization progress between micrografts was clinically evaluated with the following three-level scale: 1) incipient epithelialization, 2) proliferative epithelialization, and 3) total epithelialization. During the subsequent course of 1 year after healing or longer, scars were monitored for the development of hypertrophy and scar contractures. Red or reddish rigid scars rising above the surface of healthy surrounding areas were assessed as hypertrophic.

Meek micrografting preparation procedure

1. Dermoepidermal autografts (DEAs) are harvested via electrodermatome (preferred) or skin graft knife (e.g. Watson or Goulian).
2. DEAs are placed on a cutting surface, superficial side up.
3. Special 42 x 42 mm cork plates are placed on the DEA cutting surfaces.
4. DEAs are cut using a scalpel to precisely duplicate the shape and size of the cork plates. Micrografts can be prepared with very small DEAs (or even DEA remnants), thereby achieving maximum efficiency in the use of harvested tissue.
5. DEAs on cork plates are placed in a special cutting block, the upper side of which has parallel holes for 13 dermatome knives along the length, through which skin grafts are linearly sectioned in parallel. The graft-covered cork plate is then rotated 90° and the knives linearly section the skin graft once more. This produces a total of 196 (14 cuts x 14 cuts) small autograft islands that are 3 x 3 mm in size (Figure 1).
6. Micrografts are sprayed with Leukospray® (an adhesive specially designed for this purpose) and applied to prefolded bilayered gauze (polyamide fabric top layer + aluminium foil backing) that will enable the appropriate degree of expansion. Once applied, the micrografts are manually pressed onto the gauze using a special instrument, which results in their adhesion.
7. Micrograft backing gauzes are then wrapped in saline-moistened gauze to prevent drying out prior to their transplantation.
8. Shortly prior to wound bed application, the bilayered backing gauze is gently separated from the cork plate. The prefolded gauze is then firmly pulled in 2 mutually perpendicular directions to achieve the desired micrograft expansion. Possible expansion ratios include 1:3, 1:4, 1:6, and even up to 1:9. Expansion ratio is determined by the number of available donor sites and according to local area findings. The fewer the number of available donor sites, the greater the required degree of expansion.

ID	Total burns extent [% TBSA]	Burns depth gr.I. [% TBSA]	Burns depth gr.IIa-b [% TBSA]	Burns depth gr.III. [% TBSA]
1	91	15	42	34
2	61	-	4	57
3	60	-	25,5	34,5
4	**88**	**-**	**66**	**22**
Mean	75	-	34,4	36,9
Median	74,5	-	33,8	34,3

Table 1. Extent of burns

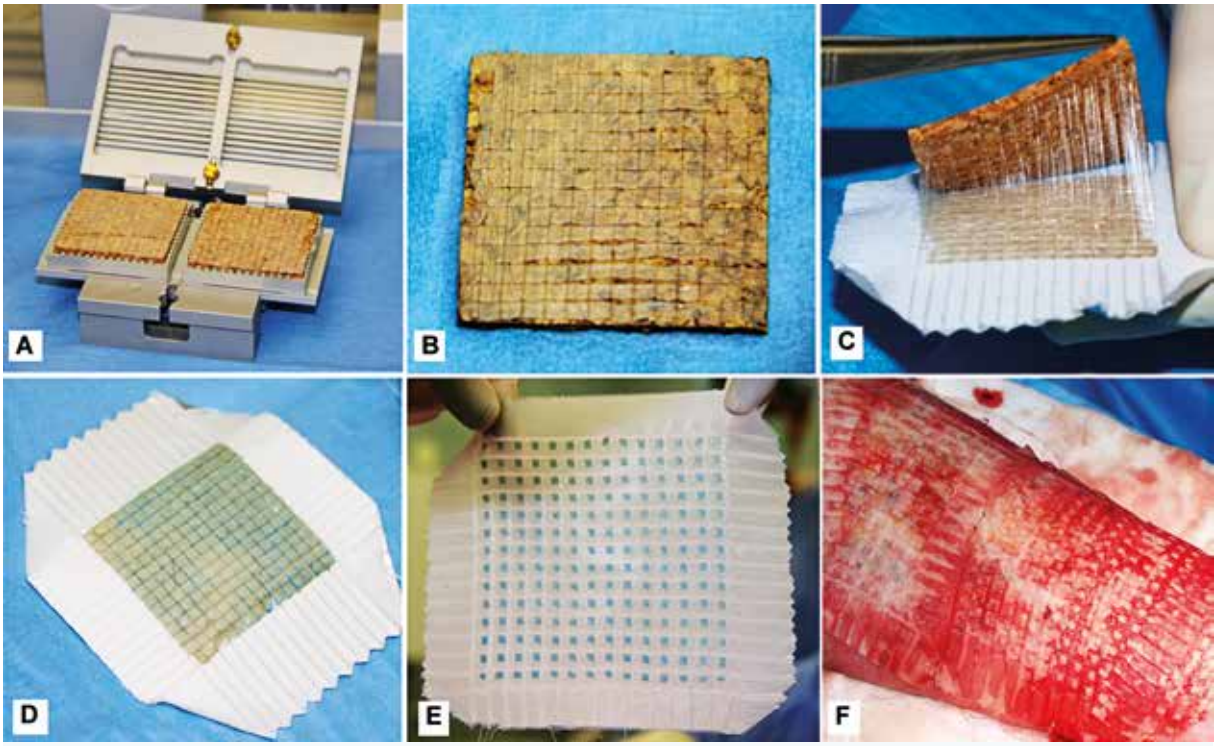

Fig. 1. Meek micrografting preparation procedure. A – dermoepidermal autografts cut vertically and horizontally by the Humeca dermatome, B – detail of dermoepidermal autografts – individual micrografts are obvious, C – removal of the cork plate of micrografts placed on double-layer carrier, D – micrografts on double-layer carrier prefabricated by expansion foil, E – micrografts after foil expansion and removal of its aluminium layer, F – areas with micrografts immediately after transplantation
(Photo: Táňa Malá, Burn Center, UH Ostrava)

9. Expanded micrografts are applied to the wound bed. The aluminium foil layer is removed from the backing gauze, while the polyamide fabric layer with the adherent autograft islands remains. The edges of the polyamide gauze carrier are then secured with metal staples (Figure 2).

10. The gauze carrier remains in situ for 7–10 days (in cases of uncomplicated healing). The metal staples are then removed and the gauze is removed. At this stage, the micrografts typically show engraftment with the first signs of incipient epithelialization between them.

Statistical method

Due to the small patient sample and small number of operations, the study statistically corresponds to a small selection and the obtained data was evaluated using conventional descriptive statistical methods.

RESULTS

Micrograft engraftment and epithelialization of the wound bed between islands without the need for reoperation was observed over an area of about 1.73 m^2. Reoperations in areas with insufficient micrograft engraftment (i.e. areas without pre-epithelialization of the wound bed between islands), were performed on a total area of 0.27 m^2. Thus, 86.5% of autografts performed with the Meek technique were successful. In terms of relative value, nearly 50% of non-engraftment involved a single patient with partial micrografting failure due to non-viable (the cause for which was uncertain) Meek micrografts. Postoperative healing showed only 10% of the micrografts to be viable, and with too low a density to produce pre-epithelialized areas. Therefore, retransplantation was required over about 6% of TBSA. In another patient, 1 of 3 micrograft transplant operations showed only 50% engraftment and epithelialization between islands. This was caused by a pseudomonas infection that was verified with bacterial culture. In half of the cases, areas were transplanted immediately after necrectomy, and necrectomies were either tangential (4), fascial (2), or chemical (1). The remaining half of transplants were deferred in areas with wound base granulation. The lowest success rate of Meek micrograft engraftment and epithelialization progress was clinically apparent in areas transplanted immediately after fascial necrectomy (22.5%). The highest success rate of Meek micrograft engraftment and epithelialization progress was observed in areas with deferred transplantation, i.e. areas with wound bed granulation (82%). The shortest interval between necrectomy and transplant surgery was 16 days. The longest interval (28 days) occurred in 2 transplant procedures, during which necrectomy was followed by Integra® synthetic skin substitutes, which required a waiting period for the neodermis to form. During the interval between necrectomy and transplant operation, wound beds were regularly rebandaged and dressed, most commonly with COM® synthetic dressings (VUP Medical, Czech Republic), or Xe-Derma® xenografts (MEDICEM International CR, Czech Republic). Wound beds dressed with Integra® were treated and covered with Betadine ointment (Egis Pharmaceuticals,

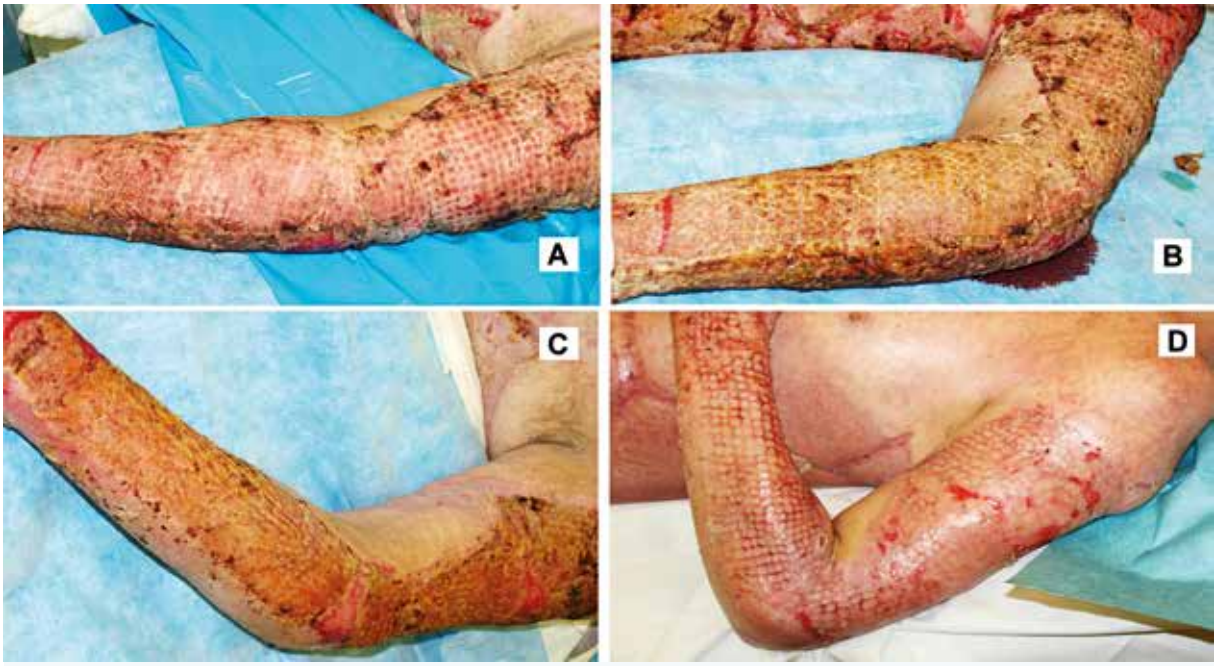

Fig. 2. Meek-micrografts on the left upper extremity – course of healing. A – 7th POD, B – 10th POD, C – 25th POD, D – 52th POD, POD – postoperative day (day after surgery)
(Photo: Táňa Malá, Burn Center, UH Ostrava)

Hungary), impregnated Xeroform gauze, and compresses with antiseptic solutions (Prontosan®, B. Braun Medical, Czech Republic; Microdacyn®, Oculus Innovative Sciences, The Netherlands).

Unambiguous micrograft engraftment was clinically evident as early as the 12th POD (range 12–18). Epithelialization between islands, the progress or speed of which was also monitored, occurred simultaneously with micrograft engraftment. An autograft expansion ratio of 1:4 was used in 7 transplant operations and total epithelialization between islands was apparent, on average, by the 16th POD (Table 2). An autograft expansion ratio of 1:6 was used in 6 operations and total epithelialization between micrografts was achieved, on average, on the 17th POD. An autograft expansion ratio of 1:3 was used in 1 operation and total epithelialization between autograft islands was observed on the 17th POD.

In terms of microbiological surveillance, areas were regularly examined for indications of infection. In 1 patient, a clinically apparent and microbiologically verified infected area resulted in a significant portion of Meek micrograft non-engraftment. On the 7th POD, a *Pseudomonas aeruginosa* infection was cultured at a level of $1x10^5$ per 25 cm^2. This area only achieved a 35% engraftment and subsequently required retransplantation over an area of about 6% of TBSA, which corresponded to half of the transplanted area.

Three patients were monitored for hypertrophic scar formation and scar contractures for a period of at least 1 year after healing (1 patient relocated abroad permanently after healing and thus was not monitored during the follow-up course of treatment). The 3 monitored patients developed scattered areas of hypertrophic scarring on the neck, trunk, and extremities both in areas with transplanted Meek micrografts, and areas with transplanted meshed grafts. Hypertrophic scars were treated with a combination of elastic pressure dressings, pressure massage, topical applications, and rehabilitation. Two patients also underwent laser treatment as a part of their scar therapy. No patients developed scar contractures that required reconstructive surgery in areas that had been transplanted with Meek micrografts. One patient required surgery for scar contractures on the neck in an area where dermoepidermal autografting with meshed

Complete epithelisation of transplanted areas [POD]	Meek micrograft´s expansion		
	1:6	1:4	1:3
Mean	17	16	17
Median	17	16	-
Modus	17	16	-
Minimum	14	14	-
Maximum	21	19	-

Table 2. Complete epithelisation of transplanted areas

grafts had been performed. The scars were released with multiple Z-plasties. Of the areas with transplanted Meek micrografts, 1 patient developed slight scar contractures in each axilla with mildly restricted upper limb elevation. During the course of conservative therapy, the left axilla scar contracture was released and a mild contracture persisted in the right axilla (the latter of which restricted right arm elevation to an insignificant degree.) The patient was offered surgical correction but refused because they did not consider the restriction to be serious. Another patient developed mild contractures in the 2nd to 4th interdigital spaces on both hands but responded well to laser therapy and the contractures gradually subsided without the need for surgical treatment.

DISCUSSION

The Meek technique was rediscovered in the 1990s in conjunction with advances in intensive care medicine for extensively burned patients and the need for efficacious surgical treatment. When compared with other skin graft methods, the Meek technique is associated with better viability[2,10,11] and, therefore, better autograft engraftment, which ultimately shortens hospitalization and leads to greater economic efficiency of treatment.[6] When using comparable expansion ratios, epithelialization occurs faster in comparison with the more frequently used mesh graft method due to the smaller distances between skin micrografts.[6] The distance between individual Meek islands when using a 1:9 expansion ratio is 8–9 mm compared with 11–12 mm when using an expansion ratio of 1:6 with meshed grafts (Hsieh, 2008). Despite higher expansion, the distance between skin graft edges in Meek micrografts is smaller than that used in meshed grafts[6] and is directly associated with faster epithelialization in areas with transplanted Meek grafts.[7, 8,12,13]

Total epithelialization between Meek autografts is typically achieved within 3–4 weeks after transplantation, depending on the expansion used.[7,8,14] On average, total epithelialization was evident in our patients on the 16th POD when a 1:4 expansion ratio was used, and on the 17th POD when expansion ratios of 1:3 and 1:6 were used. However, the expansion ratios used in our patients did not significantly impact the rate of epithelialization between micrografts. Total re-epithelialization has been described 1 month after surgery when using a micrograft expansion ratio of 1:9.[7] We have not yet used this expansion ratio in our practice. If we evaluate the epithelialization rate in terms of transplantation timing (i.e. areas transplanted immediately after necrectomy vs. areas with deferred transplantation due to base granulation), differences in epithelialization rates between micrografts were minor and clinically insignificant. Likewise, there was no apparent correlation between the epithelialization rate and the size of the transplanted area. Engraftment using the largest possible number of Meek micrografts was vital to satisfactory healing in the context of the patient's overall condition. Some sources indicate that use of a 1:6 expansion ratio or greater requires that Meek autografts be covered with an allograft overlay.[14] In our clinical practice, we used a 1:4 expansion ratio most often, which was a total of 8 times. A 1:6 expansion ratio was used 5 times, and a 1:3 expansion ratio was only used once. Regardless of the expansion ratio, we performed the Meek technique without the use of xenografts or allografts and our patients showed satisfactory healing. The observed rates of Meek autograft engraftment and subsequent epithelialization correspond to current published data.[8,9,12] Based on our experience, we can confidently state that Meek micrografts with a 1:6 expansion ratio do not require xenograft or allograft overlays to ensure satisfactory healing.

In cases of transplant area healing complications, the most common cause of autograft non-engraftment is infection. Some studies have shown that Meek micrografts are more resistant to infection than meshed grafts.[7,8] It appears that micrografts are more resistant to infection than meshed grafts because, unlike the later, they are not connected by skin graft bridges. Therefore, should infection occur, only a specific portion of the micrografts in the affected area are at risk of uncertain vitality. Micrograft engraftment outside of these areas often takes place without complication. Successful Meek micrograft engraftment with a 1:6 expansion ratio has also been described in infected wound areas.[7] Micrograft non-engraftment caused by infection, which results in the need for retransplantation of the affected areas, is a relatively infrequent complication. In our sample, it only occurred once. Method failure also occurred only once in another patient when the Meek grafts we prepared proved to be non-viable. We were unable to precisely determine the cause of this failure, but it can be assumed that human error during micrograft preparation was to blame.

In our view, a significant advantage of the Meek technique was the precise approximation of the chosen expansion dimension. It is possible to preoperatively calculate and plan transplant options for individual stages of surgery and, in uncomplicated healing, the rate of epithelialization and healing can be predicted quite well. Thereby, management of overall treatment becomes more easily guided and more precise. The disadvantages of micrografting are reported to be greater economic demands, longer graft preparation time, and greater demands on medical personnel.[14] While the greater financial burden of Meek micrografting cannot be disputed, our experience leads us to believe that the issues of longer graft preparation and higher demands on medical personnel are debatable. Meek dermoepidermal autografts are harvested in the same manner as with mesh grafting; the difference lies in the potential to even use very small areas of healthy skin with the Meek technique. Micrograft preparation at our facility was performed by only 1 surgeon who used an electric Humeca dermatome. Perioperative nurses sprayed the graft islands and followed the exact time interval until the adhesive dried. Necrectomy, or abrasion of granulated areas when using deferred transplantation, were conducted in parallel with micrograft preparation. Necrectomy and micrograft preparation durations were approximately the same; at the time of necrectomy completion, micrografts were usually fully prepared for transplantation. At the time of granulation abrasion completion (which is less time-demanding compared to necrectomy), micrografts were only partially prepared; further micrograft preparation was carried out in parallel with transplantation and it was often necessary to wait. Meek micrografts were always prepared on a series of 2 gauze carriers since the cutting machine (in which grafts on cork plates are sectioned into square autograft islands), only has space to insert 2 cork plates at a time.

It takes approximately 15 minutes to prepare 1 pair of micrografts. Nearly half of this period is spent waiting for the Leukospray adhesive to dry (7 minutes). While the adhesive dries, the surgeon is already preparing the next

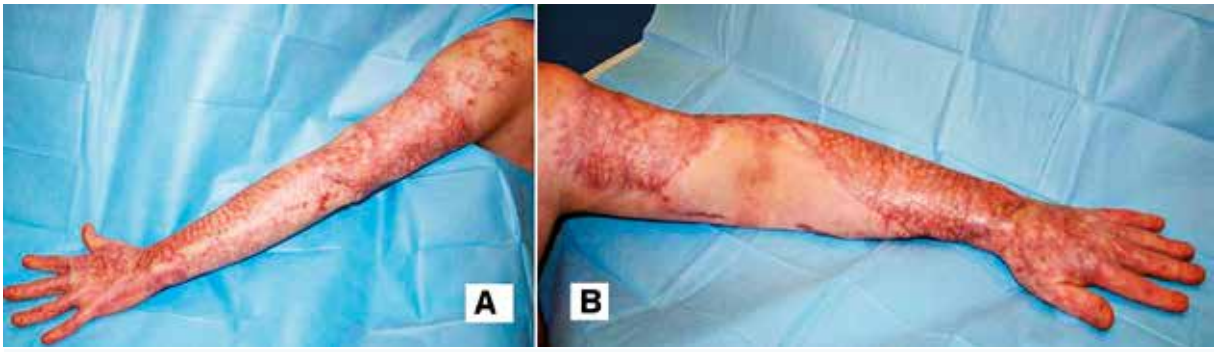

Fig. 3. Scars on the left upper extremity 1 year after surgery – esthetically acceptable, no functional limits, minor contractures of the hand interdigital spaces with good reaction on Erb-YAG laser therapy. A – dorsal site, B – ventral site
(Photo: Táňa Malá, Burn Center, UH Ostrava)

pair of micrografts. The first pair of micrograft backing gauzes is ready for transplantation in 15 minutes; and each additional pair follows at regular intervals of approximately 8 minutes. With precise knowledge of this method, the time-demanding preparation of Meek micrografts is not a limiting factor that prolongs surgical time to the point of endangering the patient.

A great advantage of the Meek technique is that autograft preparation can be performed with very small skin grafts of highly diverse shapes that are virtually impossible to use in mesh grafting; this advantage is due to Humeca dermatome sectioning and expansion, which ensures highly efficacious use of donor sites. This allows surgeons to harvest and use autografts from unburned areas from virtually any location and size. The Meek technique is therefore the most suitable method for extensive burn trauma with insufficient donor sites, because it enables harvesting and precise expansion from very small areas of healthy skin. The Meek technique enables higher quality transplantations in more extensively burned areas compared to mesh grafting because meshed grafts are rather problematic in small areas of skin, which results in unequivocally lower success rates compared to Meek micrografting. Thanks to the bilayered gauze, manipulating highly expanded Meek micrografts is not complicated; the graft islands are virtually untraumatized during handling and the gauze enables precise graft placement and fixation. By contrast, manipulation of widely meshed dermoepidermal grafts is far more difficult; the grafts are very delicate and always traumatized, to a certain extent, during removal from the paper carrier (which may impair the viability of grafts). Wide expansion of meshed grafts with ratios of 1:3 or higher requires use of the sandwich-technique (based on the principle of mixed transplantation) to stimulate healing and protect the grafts. Meshed autografts are covered with meshed non-expanded xenografts. In our experience, transplantation with the sandwich-technique was comparable to the Meek technique with respect to surgical time, but it was more demanding in terms of implementation.

The subsequent course of scarring has only been mentioned sporadically in previous works. Authors have reported that no significant functional or aesthetic differences have been observed when comparing scarring after using Meek and mesh grafting techniques.[7,8,9,14] Three of our patients underwent follow-up monitoring of scar maturation and development during the course of at least 1 year after transplantation, and this monitoring is still on-going. Scattered areas of hypertrophic scarring occurred both in Meek and meshed transplant areas. None of the monitored patients developed severe scar contractures that required reconstructive surgery in areas with Meek micrografts. One patient required surgical treatment for a scar contracture on the neck in an area where dermoepidermal mesh autografting had been performed. In our group, the need for surgical scar contracture release in areas that had been transplanted with meshed grafts was relatively high despite the use of combination therapy (e.g. rehabilitation, elastic pressure dressings, pressure massage, and topical treatment). At our facility, laser therapy significantly contributes to successful treatment of hypertrophic scars and incipient scar contractures. Laser therapy accelerates scar maturation and remodelling, reduces scar height, leads to scars fading and softening more rapidly and diminishes pruritus.[15] In our experience, early and effectively applied laser therapy for incipient scar contractures was associated with significantly reduced need for reconstructive surgery. Since areas transplanted with the Meek technique did not form severe scar contractures requiring surgical treatment, we speculate that the Meek technique may possibly represent a lower risk than the mesh method (Figure 3). Mesh grafts are subject to subsequent contraction, which is greatest in the cleavage axis line of the donor site. Thus, this axis has the greatest risk of scar contractures. Based on our observations, this risk is smaller when using micrografts because individual graft islands are completely isolated and uniformly distributed in precise square patterns without mutual connections. This advantage is particularly highlighted in bending locations where the risk of scar contractures is the greatest. All 3 patients who underwent long-term follow-up and monitoring are presently fully self-sufficient and none have serious scar contractures. Superficial scars are in the hypertrophy regression phase.

CONCLUSION

We have used the Meek micrografting technique at our facility since 2013. In the Czech Republic, it is considered to be a newly introduced method that necessitates acquiring personal experience to ensure optimal performance of the procedure. Despite the small number of patients who have undergone this procedure yet, our experience has been posi-

tive and the effectiveness of the procedure has been clearly demonstrated. In the context of overall treatment management, we consider the Meek technique to be fully indicated and unambiguously beneficial for the surgical treatment of deep second- and third-degree burns in extensive thermal injuries associated with insufficient autograft donor sites.

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EXPERIENCE WITH INTEGRA® AT THE PRAGUE BURNS CENTRE 2002–2016

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ABSTRACT

Introduction: Integra® dermal replacement has a wide spectrum of use both in burn medicine as well as in reconstructive plastic surgery and traumatology. Since 2002, it has been a part of surgical treatment of patients at Prague Burns Centre of the Královské Vinohrady Teaching Hospital.
Study group: Integra® was used in 47 patients in total between years 2002 and 2016. In this group there were 28 paediatric patients and 19 adult patients. Eleven children were operated during the reconstructive period, 8 children had an acute injury. There were 11 adult patients with Integra® applied within the trauma treatment, another 9 during reconstructive surgery. In 2016, we examined 11 patients treated by Integra®, at least 2 years ago. The average time since the application was 9 years. All examined patients had Integra® primarily applied to treat an acute injury.
Method: Scars after the application of Integra® were compared with scars after dermoepidermal grafts (DE) in respective patients. Evaluation was performed on the basis of subjective and objective assessment by means of the modified Vancouver Scale (VSS). Samples were submitted for a histological and immunohistochemical analysis.
Results: Areas with Integra® coverage scored 1.4 points on average on the VSS. The scars after dermoepidermal graft scored 4 points on the same scale. Subjective assessment of functional and cosmetic quality of scars by patients was better in all cases in comparison to DE grafting. Notable differences were found between scars following Integra® application and those after DE grafting on histological assessment, namely in the organization and quality of collagen and elastin fibres as well as in tissue revascularization.
Conclusion: The Integra® artificial skin replacement is a part of surgical strategy in management of extensive burn trauma and plays an important role in reconstructive surgery. The resulting scar quality when using Integra® seems to be better than in DE grafting both from an objective and subjective points of view..

KEYWORDS

Integra®, dermoepidermal grafting, Vancouver scale

INTRODUCTION

Integra® (Dermal regeneration template, Integra Life Sciences, Plainsboro, USA) is a biosynthetic skin replacement made of network of bovine collagen fibres and glycosaminoglycane (GAG) that is covered by a semipermeable silicone foil serving as a temporary epidermal cover. After placing the template into a skin defect, a gradual vascularization and replacement of bovine collagen by patient´s own collagen takes place, and so-called „neodermis“ is formed within several weeks. The silicone foil cover of a fully vascularized tissue is then removed and a thin dermoepidermal (DE) graft is applied. When the DE graft successfully heals in, the bi-laminar tissue has better functional and cosmetic features as compared to the standard method of DE grafting.[1,2] The main advantages of Integra® include a better coverage of extensive skin losses, transplantation of thin DE grafts with a minimal morbidity of a harvested area, excellent cosmetic and functional effects due to a high elasticity of bi-laminar tissue, zero immunological intolerance and a reduced number of follow-up reconstructive surgeries.[3,4] The application of Integra® is indicated in burns medicine as well as in reconstructive surgery and traumatology for the coverage of soft tissue defects.[5]

Integra® was first used in the Czech Republic in 2002 at the Prague Burns Centre, Královské Vinohrady Teaching Hospital to manage an extensive burn trauma in a child. Since then it has become an inseparable part of treatment of burn patients.[6] This article presents our experience with the use of Integra® skin replacement in clinical practice since 2002. We evaluated even the early patients after a long period from the first application. The obtained clinical data were correlated with the results of histological

	children	adults
total	28	19
acute	8	11
reconstruction	20	9
death	0	3
repeated application	3	0
subsequent application	3	2
other indications	nevus pigmentosus 1x	decollement 1x

Table 1. The group of patients treated by Integra® skin replacement in 2002–2016

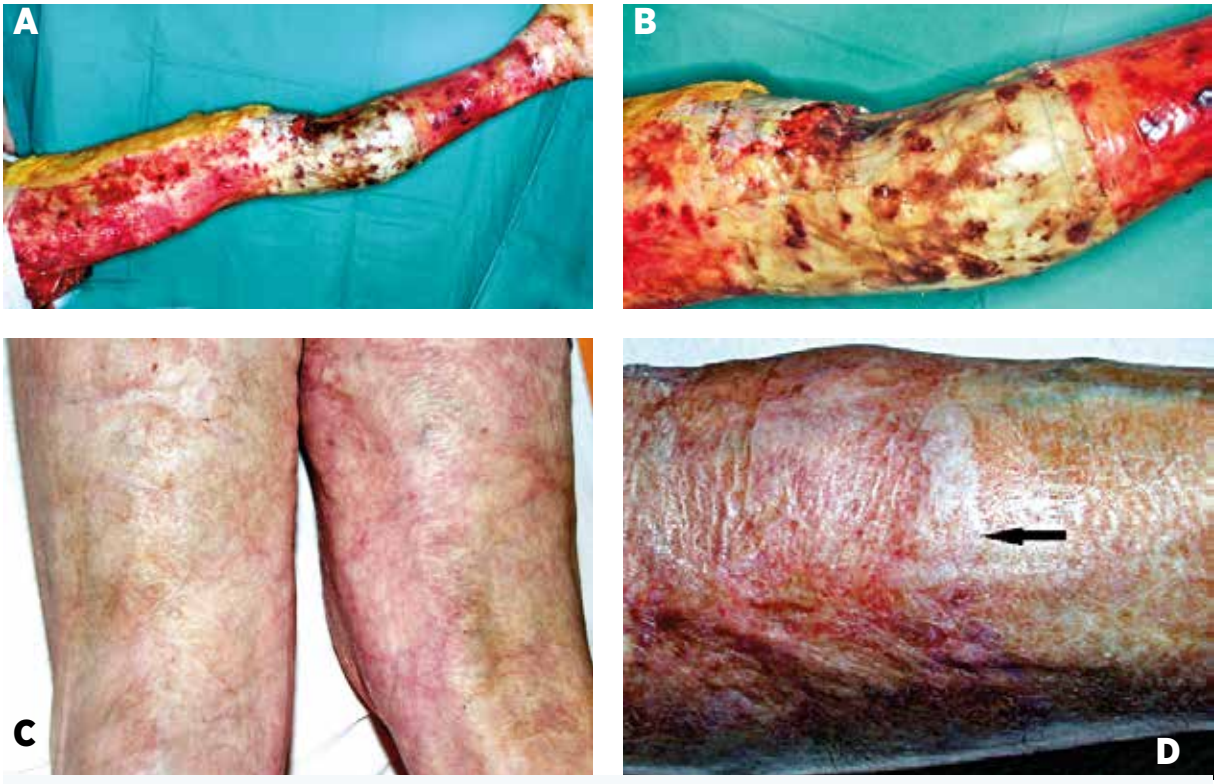

Fig.1. Comparison of scars after the application of Integra® 13 years after the injury in the patient with 2nd–3rd degree burns of 75% body surface area
A. The condition after placing Integra® on the left lower limb in an extensively burnt patient, **B.** The site of infectious complication in popples resulting in Integra® rejection from the wound bed, **C.** The condition after 13 years since application with a visible cosmetic difference between scars on the left lower limb (Integra®) and right lower limb (DE graft), **D.** The site of transition (arrow) from the healed Integra® and the area where the DE graft was applied after rejection

assessment of scar tissue after the application of Integra® and DE graft.

Study group Integra® was applied in total in 47 patients from July 2002 till May 2016 (Table 1). Two patients from this group were treated in another workplace. A 4-year-old girl after a car accident with skin avulsion of 25% body surface area was operated on in the Child Trauma Centre of Thomayer Hospital and a 10-year-old girl with an extensive pigment naevus on her knee was operated on at the Clinic of Plastic Surgery, Královské Vinohrady Teaching Hospital, both in Prague.

In total, there were 28 patients of child age at the time of application, another 19 patients were adults. The main indication for the child group was reconstruction of scar contractures following a burn trauma. Eight children were treated by skin replacement within the surgical management of an acute trauma. In these cases, Integra® was used to quickly cover the body surface in patients loosing over 50% of their skin and with limited harvesting possibilities. In adult patients, we used Integra® to treat an acute burn trauma in 11 patients. Another 9 patients received it to cover defects following a release of scar contractures. Of the paediatric patients, three had Integra® applied both in acute and reconstruction periods. Three patients were operated on with a repeated application of Integra® on different body parts in various time intervals. Three adult patients from our group died of the complications of their burn injury.

During 2016, we invited 11 patients treated by Integra® in the past for a follow-up visit. The interval from the last application was at least 2 years. The average time since application was 9 years. Originally, our subjects were 3 adults and 8 children. At the follow-up visit, their average age was 30 years. All these patients had primarily received Integra® during acute trauma management. Their scars were objectively evaluated by the modified Vancouver Scar Scale (VSS). A subjective assessment of scar quality was performed by means of a questionnaire. The area covered by Integra® was compared with the scar after the application of DE graft in anatomically similar localisation. Questions of the subjective assessment were focused on a functional result, cosmetic effect and innervation, always in comparison with the scar after DE transplantation. Having signed an informed consent, patients then underwent a punch biopsy of 2–5 mm in diameter (according to the localisation), which was later evaluated histologically. (Table 2.)

RESULTS

On the subjective assessment, all patients reported an improvement of functional and aesthetic perception of the Integra®-covered sites in comparison with the scars where the primary treatment consisted of DE grafting only. Patients observed no significant difference in the innervation be-

Patient No.	Sex	Age (years)	Follow-up (years)	Area	VSS Integra	VSS scar
1	F	42	3	face	0	4
2	M	23	14	lower extremity	2	5
3	M	27	12	neck	1	2
4	M	15	2	thorax	3	7
5	M	44	13	lower extremity	4	6
6	F	20	15	forearm	0	2
7	F	26	9	face	0	4
8	M	25	13	thorax, upper exstremity	2	7

Table 2. Scar follow-up in patients after at least 2 years since the application of Integra®

tween these sites. One of the patients operated on in 2002 noticed absent perception of warmth in lower limbs where the replacement had been used.

On the objective assessment by means of VSS, sites covered by Integra® scored 1.4 points on average, whereas scars after DE transplantation scored on average 4 points on the same scale.

Case report No.1

Male, 33 years old, injured in 2003, suffered 2nd and 3rd degree burns from burning of construction foam on 75% body surface area. Integra® had been applied after a fascial necrectomy to cover an area on his left lower limb (Fig.1A). The healing was complicated by *Staphylococcus aureus* infection resulting in the loss of coverage on and under the poples (Fig. 1B). Thirteen years after the injury, a cosmetic difference of scars was obvious between the right lower limb, where medium-thickness dermoepidermal grafts were used, and the left one, where Integra® was applied (Fig.1C). The left side exhibited a clearly visible border at the proximal part of crus between the scar, where Integra® successfully healed, and the site where Integra® was rejected due to an infection with a subsequent transplantation of skin grafts on the basis lacking neodermis (Fig.1D). On histological assessment, we found characteristic differences between the scars on the left and right lower limbs (Fig. 2).

Case report No. 2, extensive burn trauma

A 9-year-old boy was burnt in 2002 on 85% of body surface area, of which 75% were 3rd degree burns. In his case, Integra® was used for the first time in the Czech Republic to cover lower extremities (Fig. 3A–3C).

No scar contracture on the lower limbs has developed during the growth of this child. On the out-patient follow-up, after 14 years, there is a visible cosmetic difference between the scars on the lower limbs and the upper limb, where a mixed transplantation of DE grafts and allografts from his father was performed (Fig. 4A, 4B).

On immunohistochemical comparison of revascularization and reinnervation of Integra®, we were surprised to find a reconstituted superficial dermal plexus in a virtually normal quality. The restitution of superficial vascular plexus within

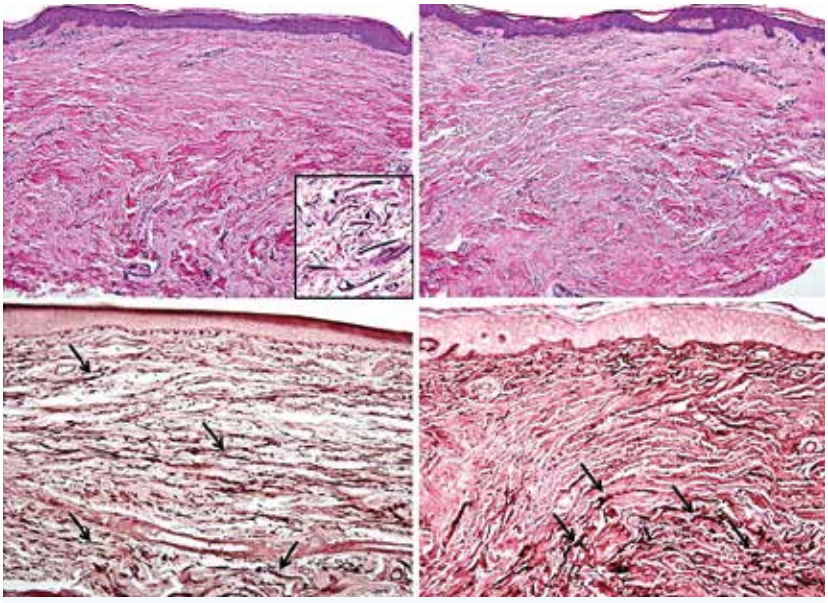

Fig. 2. The comparison of histological structure of the scar after the application of Integra® 13 years ago with the scar after the transplantation of DE grafts

Fig. 2A. The scar after application of Integra® with collagen fascicles oriented roughly in parallel to the skin surface. Deeper parts of neodermis contained detectable residues of original bovine collagen matrix even after 13 years (inserted image). Stained by haematoxylin & eosin, original image scale 100x, image insert 600x

Fig. 2B. Chaotic course of collagen fibres in the scar after DE grafting. Stained by haematoxylin & eosin, original image scale 100x

Fig. 2C. Elastic fibres are thin and often fragmented in case of Integra® application with relatively even distribution in the sample (arrows). Stained by orcein, original image scale 200x

Fig. 2D. The scar after DE grafting contains thick, fragmented and unevenly distributed elastic fibres (arrows). Stained by orcein, original image scale 200x

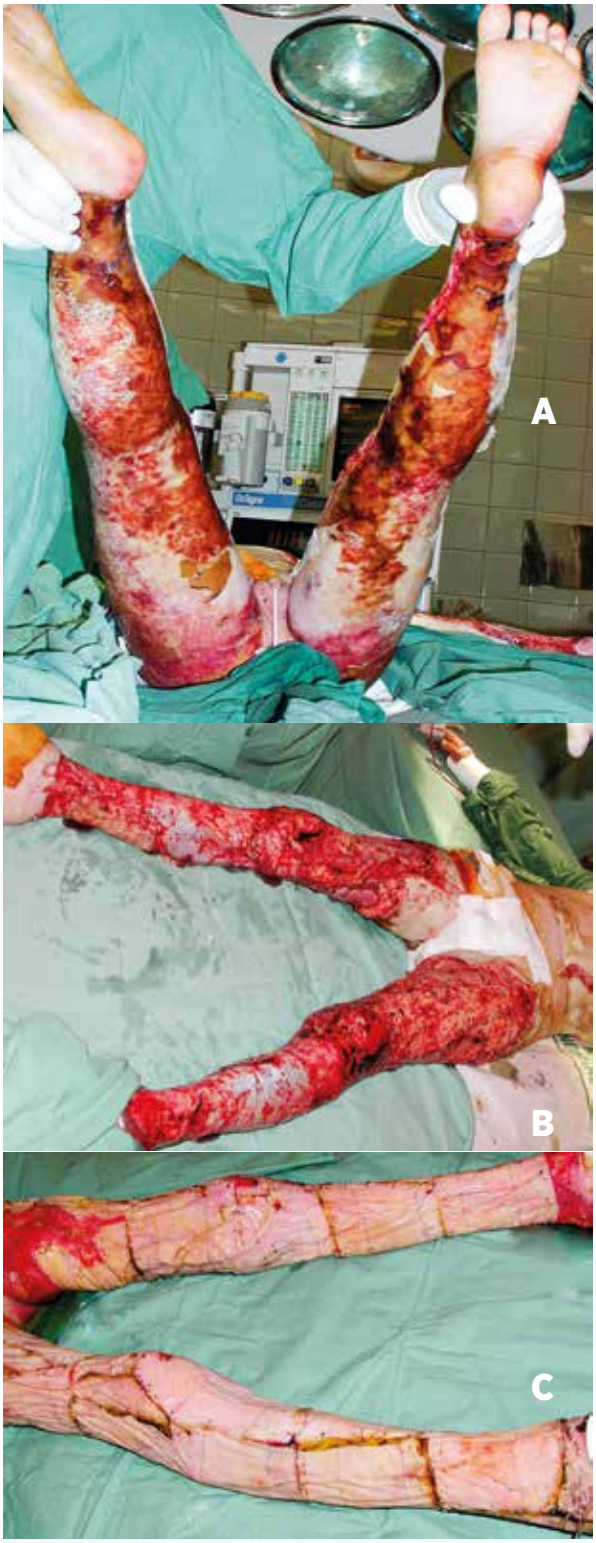

Fig. 3. The course of treatment by Integra® on lower limbs in the patient with 75% burns of 3rd degree
A. The area with 3rd degree burns on both lower limbs, **B.** The condition following fascial necrectomy of burnt area, **C.** The healed Integra® prior to the transplantation of DE grafts

the scar was imperfect. The reinnervation was observed in both samples. The scar after Integra® application had less peripheral nerve fibres in comparison with the scar after application of DE grafts. No clinical change was observed (Fig. 5A, 5B).

Case report No. 3, chemical trauma

Female, 39 years, suffered a 3rd degree chemical burn on 30% body surface from a mixture of acids and lyes in a car accident in 2013. On surgical examination, we found a full-thickness skin loss on her face and neck. These areas were treated by Integra® replacement. In the frontoparietal area, the wound reached even the skull on approx. 4x3 cm. Following several drills into lamina externa, the defect was also covered by Integra®. (Fig. 6A–6D; Fig. 7A, 7B; Fig. 8A–8F.)

Case report No. 4, high-voltage electric injury

A 14-year-old girl was burnt by high-voltage electric current when climbing train wagons in 2003. She suffered burn injuries of 2nd b–3rd degree on 43% body surface area. Areas on the left part of the face, neck and adjacent head parts were managed by the application of Integra®. (Fig. 9, Fig. 10.)

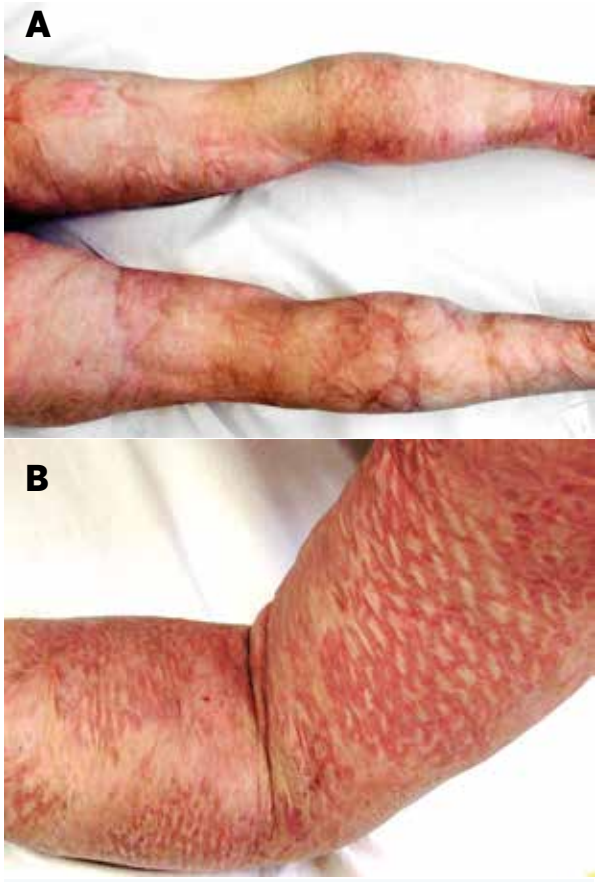

Fig. 4. Comparison of scars on lower limbs (Integra®) and upper limb (mixed transplantation of autografts and paternal allografts on wound bed without Integra®). Condition after 14 years
A. Scars on lower limbs after the application of replacement in 2002, **B.** The scar on the upper limb after the transplantation of DE grafts with a visible pattern of the original graft mesh

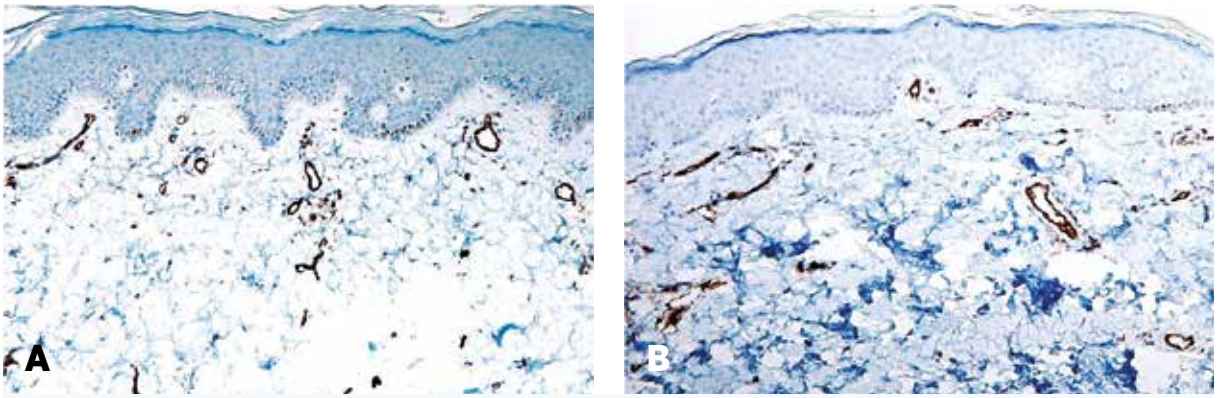

Fig. 5. The histological comparison of tissue revascularization after the application of Integra® and DE graft
A. Neodermis following Integra® application with a reconstituted superficial dermal plexus (of virtually normal quality), **B.** The restitution of superficial vascular plexus is imperfect in the scar without Integra®. Immunohistochemical staining with primary monoclonal antibody anti-CD31/PECAM-1 marking endothelium, original image scale 400x

DISCUSSION

Published papers have unanimously confirmed favourable functional and cosmetic results of Integra® in burn trauma.[7,8,9] The multicentre study conducted by Frame (2004) lists Integra® as an adequate equivalent to the use of full-thickness transplants in the management of scar

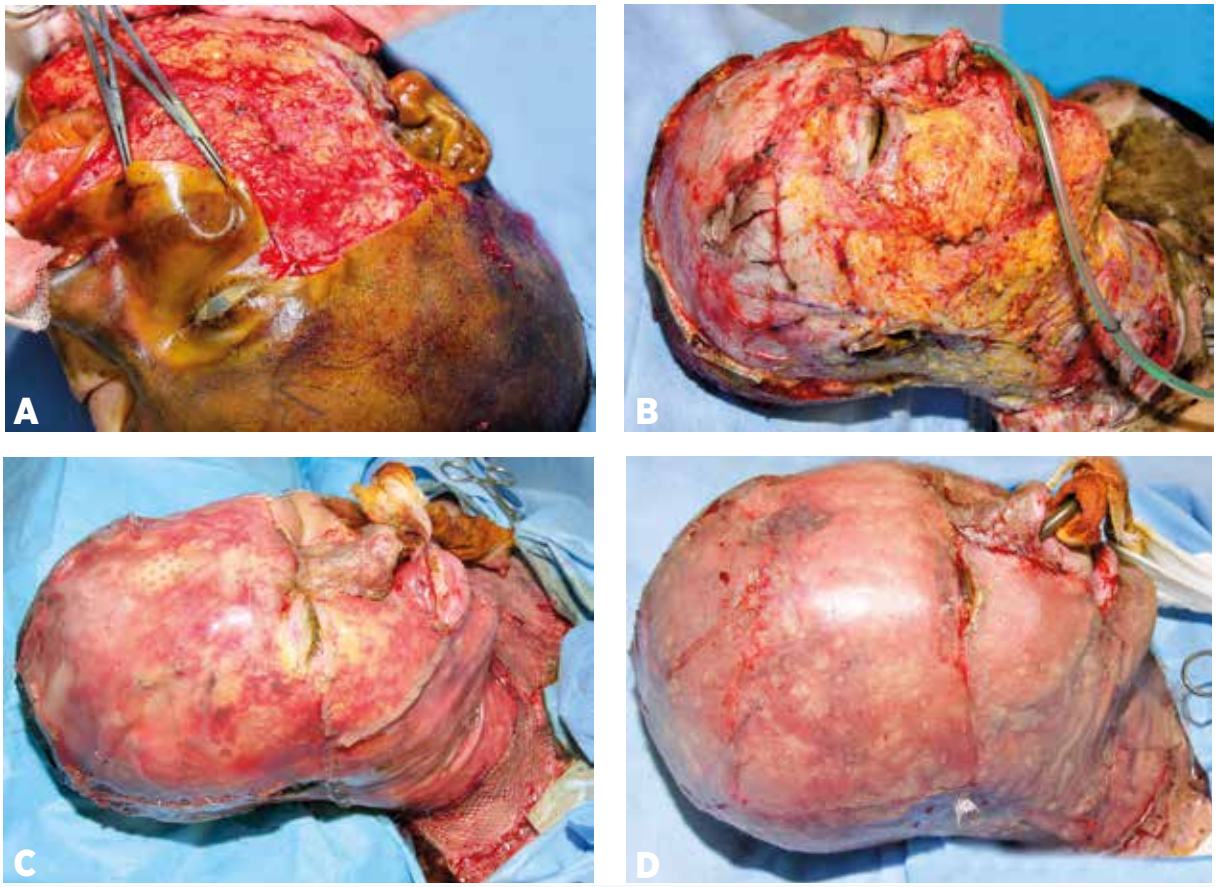

Fig. 6. The application of Integra® in the management of deep skin loss in face after a chemical burn by mixture of acids and lyes
A. A 39-year-old patient with chemical burns of 3rd degree on her face due to a leakage of mixed acids and lyes during a car accident. 48 hours after admission a fascial necrectomy of burnt facial and neck areas was performed, **B.** Condition after necrectomy in face, head and neck 48 hours from the injury, **C.** The wound bed was covered by Integra® (an arrow indicates the site of bone defect coverage), **D.** On day 25 since the application of Integra®, vascularized neodermis was covered by thin non-meshed dermoepidermal grafts

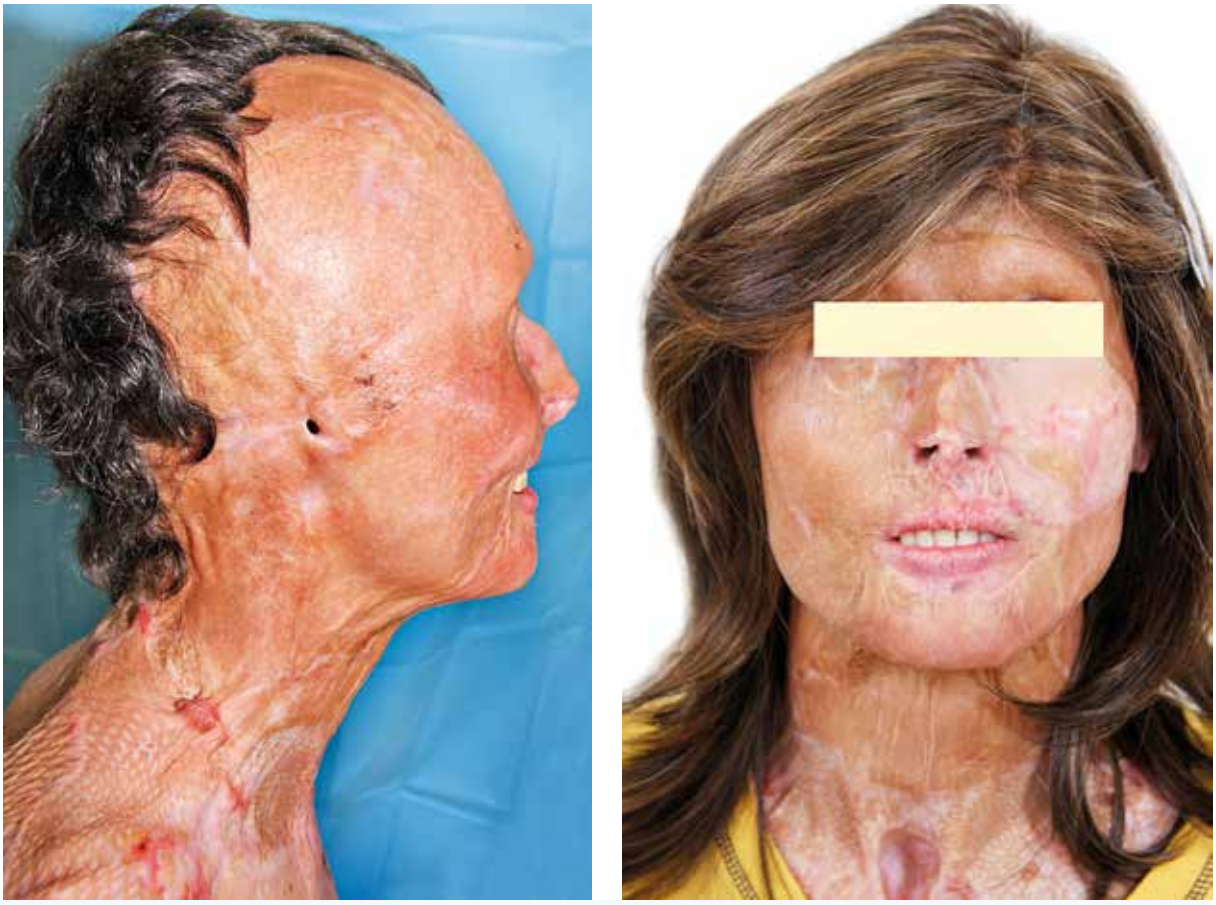

Fig. 7A, B. A cosmetic and functional result 3 years later

contractures due to burns.[10] One of the main disadvantages of full-thickness grafts mentioned is the resulting scar at a harvested site. Our experience at Clinic of Burns Medicine, Královské Vinohrady Teaching Hospital in Prague confirm that Integra® is very effective in the management of extensive burn injuries in childhood with a limited size of harvesting site. Integra® was used in our workplace to successfully treat 90% burn injuries of 3rd degree in a 9-year-old boy and to quickly cover 60% of his body surface. Only a few clinical case studies report on the application of Integra® on a wound bed after a chemical or electric trauma.[11] Despite the fact that the wound bed after a chemical trauma carries a high risk of deepening and subsequent excessive scarring, we applied Integra® even in such a case of the patient with deep chemical burns of face by the mixture of acids and lyes.

The study by Graham published in the Journal of Burn Care and Research presents successful usage of Integra® for definitive coverage of soft tissue defects with exposed deep structures such as bones or sinews.[12] Gonzales Alaña et al. confirm in their paper that usage of Integra® in combination with V.A.C. (Vacuum Assisted Closure) system on denuded skeleton after burns is an adequate alternative to a surgical approach with free flaps, namely in patients with a serious contraindication of free tissue transfer.[13] We have not gained a clinically relevant experience with the combination of negative pressure and Integra® at our workplace. Yet we applied Integra® to cover the exposed bone in the aforementioned patient.

Injuries by electric current are one of the most severe ones in burn medicine. A definitive wound closure is often delayed even up to 6 weeks after the trauma because of wound depth progression. This is due to the influence of electric current foremost on blood vessels.[14] In case of the electric trauma of the 14-year-old girl, we used Integra® to cover areas of face and neck. Healing proceeded without complications and after the take of a thin DE graft, an intensive multimodal rehabilitation started. No scar contracture requiring surgical treatment has developed in subsequent years.

Regeneration of skin adnexa was not found in any analysed histological samples. Some published papers even refute the presence of elastic fibres in scars after Integra® application. [15] Moiemen proved the presence of elastic fibres in all samples included in his group of biopsied patients. Elastic fibres however had abnormal morphology as our findings also confirm.[16,17] The presence of residue of the original bovine matrix was documented by Jeng 2 years after the application.[18] Remnants of the original matrix in the biopsy sample of the patient from our group were found 13 years after skin replacement. The presence of peripheral nerve fibres in assessed samples was confirmed by an immunohistochemical analysis. The fibres were localized in the reticular part of dermis and their uneven distribution

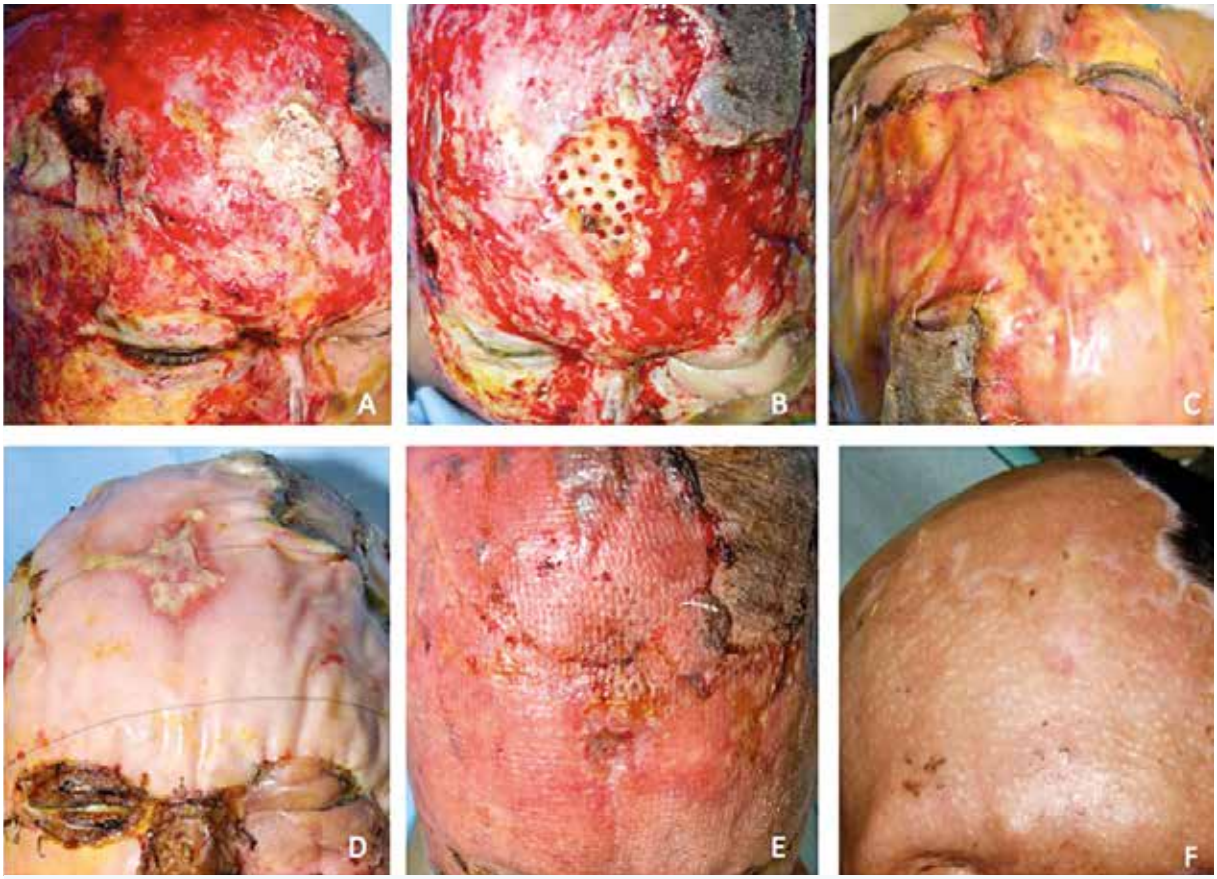

Fig. 8. The coverage of exposed skull by Integra® replacement
A. The wound in frontal area reached to the skull, **B.** Several drills of lamina externa were carried out, **C.** The wound was covered by Integra® after drilling, **D.** The bone defect was rebuilt in course of maturation, **E.** The same area after coverage by DE graft, **F.** The result 2 years since application – no visible deformity

is likely responsible for the difference in sensitivity of scars after dermal replacement in comparison with healthy skin.

CONCLUSION

Our clinical experience with the use of dermal replacement confirms the positive effect of Integra® coverage on the resulting functional and cosmetic effect on post-burn scars in comparison with the standard method of DE graft transplantation. The main indication of Integra® application are extensive burn injuries with limited harvesting sites. It is also advantageous to use Integra® to cover large skin defects after the release of scar contractures, namely in patients with limited possibility to harvest a full-thickness skin graft. It seems that the Integra® artificial skin is suitable even in case of deep skin losses caused by electric current or by chemical burns. From the long-term perspective, we prefer applicationof Integra® in facial injuries because of cosmetic reasons as we have not observed any occurrence of scar contractures. Our histological and immunohistochemical analyses confirm that the tissue after application of Integra® markedly differs from the scar after the transplantation of dermoepidermal graft. Deeper understanding of the clinical and histological processes involved in the rebuilding of the artificial dermal replacement like Integra® may play an important role in the development of a new generation of full-bodied dermoepidermal skin replacements.

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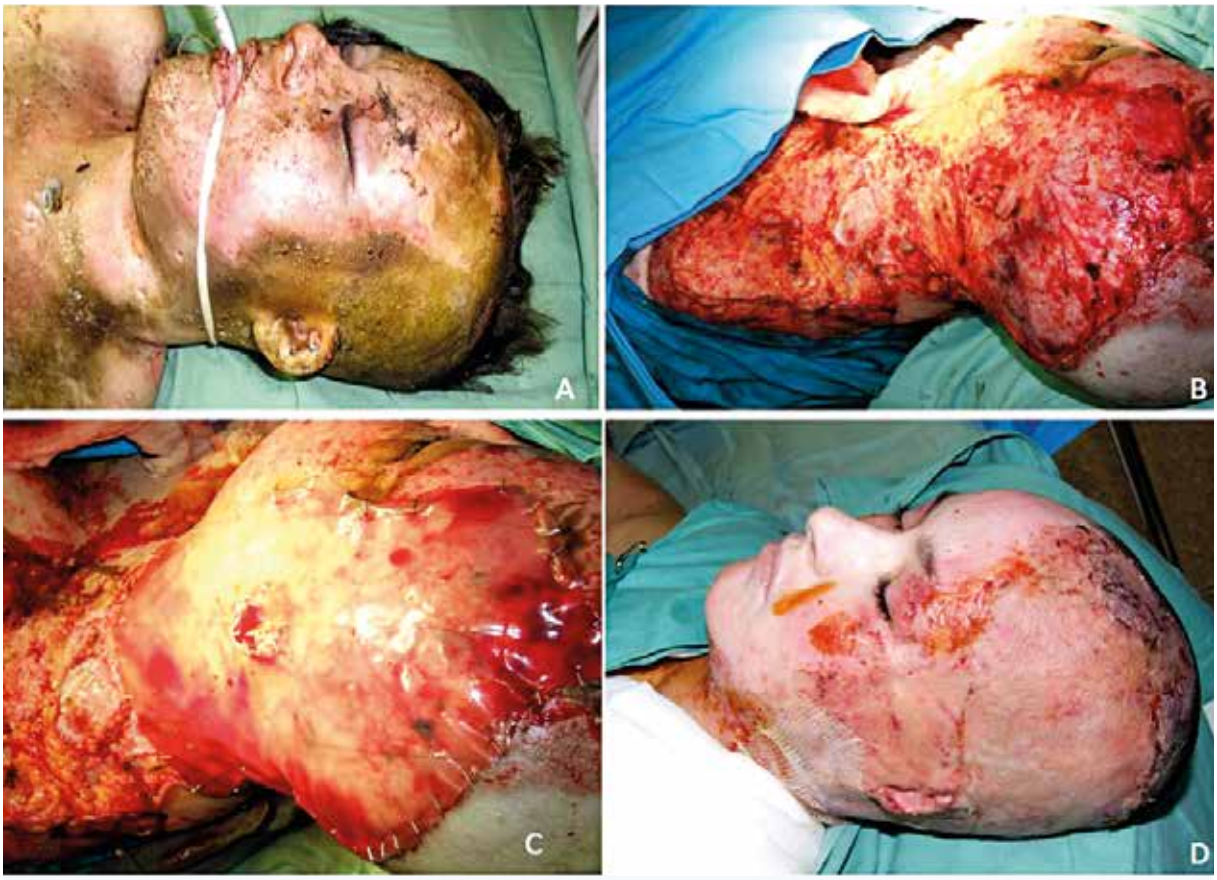

Fig. 9. A 14-year- old patient after an electric injury with 3rd degree burns on her face and head
A. Deep burns on the left half of face after the passage of high-voltage electric current, **B.** A condition after fascial necrectomy, **C.** A defect covered by Integra®, **D.** A successfully healed thin non-meshed DE graft 2 weeks after the application

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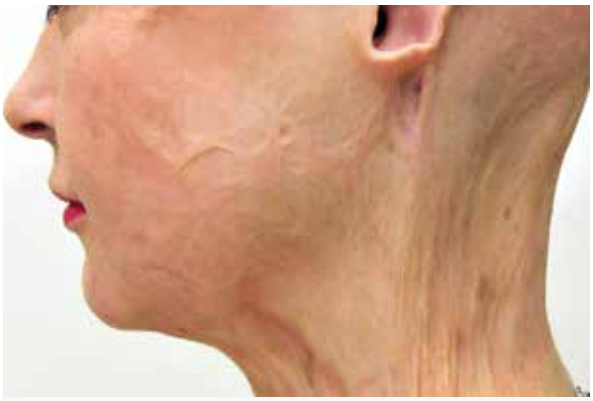

Fig. 10. A cosmetic and functional effect 10 years later

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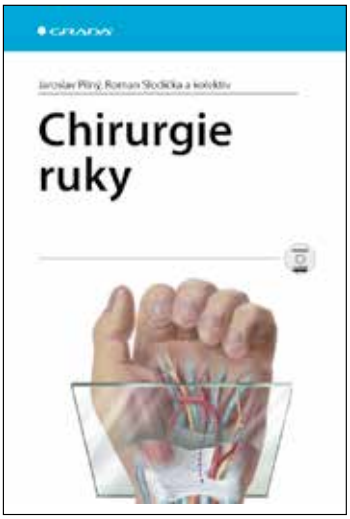
Chirurgie ruky

Pilný Jaroslav, Slodička Roman a kol.



Úrazy ruky jsou nejčastějšími poraněními, se kterými se lékař setkává nejen v úrazové ambulanci, ale jsou i častým steskem, se kterým se setkávají i lékaři jiných oborů. Špatně řešené úrazy mohou vést k následkům omezujícím pacienta v běžném životě. Mezinárodní kolektiv autorů, kteří se zabývají problematikou chirurgie ruky (traumatologové, ortopedi, plastičtí chirurgové, mikrochirurgové, neurologové, anesteziologové) připravil tyto praktické návody, kde lékaři setkávající se s touto problematikou najdou informace o vzniku postižení, způsobu diagnostiky a terapie. Svým rozsahem publikace zahrnuje problematiku traumatologie ruky, řešení poúrazových stavů a degenerativních postižení ruky. Zahrnuje i problematiku lokte a předloktí ve vztahu k ruce. Práce je základní publikací určenou nejen mladým lékařům, kteří se chtějí problematikou chirurgie ruky zabývat či se chystají ke specializační atestaci, ale oslovuje i lékaře zkušené a přináší jim nové informace o chirurgii ruky v širším kontextu. Protože problematika chirurgie ruky je multioborovou záležitostí, je i kniha koncipována tak, že oslovuje nejen chirurgy, traumatology, ortopedy, neurochirurgy, plastické chirurgy či mikrochirurgy, ale i neurology, radiology, anesteziology či rehabilitační pracovníky, pro které jsou zpracovány jednotlivé části kapitol. Kniha je bohatě obrazově dokumentována – čtenář v ní najde 349 často složených obrázků (celkový počet kreseb a fotografií je tedy 436). Publikace je dvojbarevná, kompletní obrazová dokumentace s barevnými fotografiemi je na přiloženém CD.

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MICROMYCETES INFECTION IN PATIENTS WITH THERMAL TRAUMA

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ABSTRACT

Goal: Determination of basic epidemiological parameters of burn patients with micromycetes infection. Identification of the most important micromycetes in burn patients.
Material and methods: Monocentre retrospective study enrolling all adult burn patients who were hospitalized between 2007 and 2015 and in whom micromycetes were isolated during hospitalization. ABSI index (Abbreviated Burn Severity Index) was used to evaluate severity of thermal trauma. Results were statistically analysed.
Results: There were 61 patients with thermal trauma identified in total during the period of observation, and there were yeast or fibrous fungi isolated. There were 37 males and 24 females (M:F ratio – 1.5:1) in this group. The average age of patients was 57.3 years (29 patients were aged up to 60 years, 32 patients were over the age of 60 years, inclusive). 6 patients died (lethality was 9.8%). The average extent of the burn area was 21.6% TBSA (median 14.0%). There were 90 strains of micromycetes cultured in total in these patients (79 yeasts, 11 fibrous fungi). Micromycetes were isolated from burn area in 30 patients, from the lower airways in 19 patients, from the urogenital area in 15 patients and from blood culture in 7 patients. Non-albicans Candida species were predominant among yeasts (60 strains); Candida albicans was isolated 16 times in total. Aspergillus fumigatus (4 isolations) and Fusarium species (2 isolations) were predominant species among fibrous fungi.
Conclusion: We successfully identified the basic epidemiological parameters in burn patients with micromycetes infection, similarly to the most important yeasts and fibrous fungi causing infection in these patients.

KEYWORDS

Burns, yeasts, fibrous fungi, infection

INTRODUCTION

Severely and critically burned patients are exposed every day to a wide range of potentially pathogenic microorganisms (PPM).[1] Infectious complications represent a predominant cause of mortality in these patients. This fact is mainly due to improved quality of care for these patients, when patients who would certainly die many years ago can survive an extensive thermal trauma today. Another reason is also increasing resistance of potentially pathogenic microorganisms.[2] Recently we also noticed change in the occurrence of each PPM in the patients with thermal trauma. Bacteria are still the predominant PPM in these patients, however especially micromycetes infections play an important role today as well.[3]

This is mainly due to extensive loss of skin cover, or compromised function of skin as a barrier and local immunologic function. An important factor is also the fact that severe and critical burns are associated with a decline of immunological performance with a character of immune paralysis to immunosuppression. Antibacterial strategies and also antibiotics lead to selection of resistant forms of bacteria and they also facilitate propagation of yeasts and fungi.[4]

MATERIAL AND METHODS

This is a retrospective monocentre study, which enrolled all burn patients over the age of 18 with a thermal trauma who were hospitalized at the Department for Burns and Reconstructive Surgery of the University Hospital Brno within the period from 01/01/2007 to 31/12/2015. Yeasts or fibrous fungi were demonstrated in cultures in all of the patients in the group during hospitalization. Basic epidemiological markers were evaluated in these patients. ABSI score (Abbreviated Burn Severity Index) was used to determine the degree of the thermal trauma.

Culture of yeasts and fungi

Biological material sent for culture examination is processed according to the sample character. Culture on blood agar and MacConkey agar is a standard examination for all types of biological material; they represent the basic media for culture examination. Other selective culture media with a higher content of sodium chloride are subsequently added according to the sample character to demonstrate Staphylococci, VL agar is added to demonstrate anaerobic bacteria, etc. Microscopic preparation belongs to a standard

		Sex		
		all patients	male	female
N		61 (100%)	37 (60.7%)	24 (39.3%)
Age (years)		57.3; 62.0 (16.0; 90.0)	54.9; 56.0 (19.0; 90.0)	60.9; 67.0 (16.0; 89.0)
	< 60	29 (47.5%)	19 (51.4%)	10 (41.7%)
	60+	32 (52.5%)	18 (48.6%)	14 (58.3%)
Exitus	yes	6 (9.8%)	2 (5.4%)	4 (16.7%)
	no	55 (90.2%)	35 (94.6%)	20 (83.3%)
Extent of burns (% TBSA - total body surface area)		21.6; 14.0 (0.3; 82.0)	22.2; 15.0 (0.5; 75.0)	20.6; 13.5 (0.3; 82.0)
	21%+	21 (34.4%)	14 (37.8%)	7 (29.2%)
	<= 20%	40 (65.6%)	23 (62.2%)	17 (70.8%)
	41%+	12 (19.7%)	7 (18.9%)	5 (20.8%)
	<= 40%	49 (80.3%)	30 (81.1%)	19 (79.2%)
ABSI (Abbreviated Burn Severity Index)		7.9; 8.0 (3.0; 14.0)	7.7; 7.0 (4.0; 13.0)	8.2; 8.0 (3.0; 14.0)
	3–4	4 (6.6%)	2 (5.4%)	2 (8.3%)
	5–8	39 (63.9%)	24 (64.9%)	15 (62.5%)
	9–12	14 (23.0%)	9 (24.3%)	5 (20.8%)
	13–14	4 (6.6%)	2 (5.4%)	2 (8.3%)

Table 1. Basic epidemiological parameters of patients in the group (Continuous parameters are described with mean, median, minimum and maximum)

for liquid materials; some of them are processed quantitatively (bronchoalveolar lavage, sputum, urine).

In case of a suspicious micromycetes infection, cultivation on standard media is supplemented with inoculation of material on mycological media: the most frequently used medium is Sabouraud agar. Biological material is inoculated on Sabouraud agar on Petri dishes and on several inclined Sabouraud agars in a tube intended for growth of fibrous fungi. Cultivation takes place for 7 days and under a temperature of 28–30°C for yeasts. Fibrous fungi are cultured in room temperature and simultaneously under thermostat temperature of 35–37°C. Growth on a chromogenic medium is used to determine the type of grown yeasts (colour change), production of chlamydospores during a growth on rice agar and weight spectrometry-MALDI-TOF. Fibrous fungi are classified into a genus and species based on their macroscopic appearance and microscopic preparation from the culture.

Statistical analysis

Continuous and ordinal parameters are described in tables with mean, median, minimum and maximum. Categorical variables are described as a number of patients and their relative count in given groups. The results of statistical evaluation are presented as p-values of statistical tests. Mann-Whitney test is used, when continuous or ordinal parameters are compared between two groups of patients. Fisher's exact test is used to examine the association between two categorical variables. Statistically significant results at significance level 0.05 (p-value <0.05) are provided in bold. For all statistical analysis IBM SPSS Statistics ver. 23 (IBM Corporation, 2015) was used.

RESULTS

There were 61 patients with thermal trauma in whom yeast or fibrous fungi were isolated during the period of observation. There were 37 males and 24 females (M:F ratio – 1.5:1) in the group. Average age of the patients was 57.3 years (29 patients below 60 years of age, 32 patients were over 60 years, inclusive). 6 patients died (mortality was 9.8%). The average extent of the burn area was 21.6% TBSA (median 14.0%). There were 21 patients with severe thermal trauma, i.e. with an extent of the burn over 20% TBSA; there were 12 patients with a critical burn (extent of the burn over 40% TBSA). Average value of ABSI was 7.9. The highest number of the patients in the group was 5-8 within the ABSI range (39 patients, 63.9%). The basic epidemiological data of the patients in the monitored group are provided in Table 1.

There were 90 strains of micromycetes obtained from cultures in total in these patients (79 yeasts, 11 fibrous fungi). Micromycetes were isolated from burn area in 30 patients, from the lower airways in 19 patients, from the urogenital area in 15 patients and from blood culture in 7 patients. Non-albicans Candida strains were predominant among yeasts (60 species), *Candida albicans* was isolated totally 16 times. *Aspergillus fumigatus* (4 isolations) and *Fusarium spe-*

cies (2 isolations) were predominant species among fibrous fungi. All of the isolated strains of yeasts and fibrous fungi are shown in the Table 2.

		N
yeasts	*Candida glabrata*	32
	Candida albicans	16
	Candida krusei	10
	Candida tropicalis	6
	Candida parapsilosis	5
	Saccharomyces cerevisiae	2
	Candida pararugosa	1
	Candida guilliermondii	1
	Candida lypotica	1
	Candida kefyr	1
	Candida norvegensis	1
	Sporobolomyces salmonicolor	1
	Candida non-albicans (without specification)	2
fibrous fungi	*Aspergillus fumigatus*	4
	Fusarium sp.	2
	Aspergillus sp.	1
	Absidia sp.	1
	Rhizomucor sp.	1
	Mucor sp.	1
	Mucor circinelloides	1

Table 2. List of all micromycetes isolated in patients in the group

Micromycetes were obtained from culture in 7 patients in total within the first 5 days of hospitalization (11.5%). The number of patients with micromycetes isolation increased during further course. Micromycetes were cultured in 15 patients during the 6th - 10th day of hospitalization (25.0%), in 8 patients during the 11th–5th day (14.0%) and in 33 patients (61.1%) after the 16th day of hospitalization. The evaluation of the extent of thermal trauma expressed by the ABSI value is also interesting including its influence on the risk of micromycetes infection development. Within the 10th day of hospitalization the patients with positive culture for yeasts or fungi have a lower ABSI value than patients without positive culture. Higher ABSI value contributes on the development of infection caused by micromycetes until the 11th day of hospitalization. The effect of ABSI on the risk of yeast or fungi infection development is shown in Table 3.

During the monitoring of the effect of particular risk factors on the development of multipathogenic micromycetes infection in the patients from our group, we could not identify any of the factors with a statistically significant effect. In spite of that is interesting the effect of gender, while infectious complications in females were more frequent (p=0.093) or the effect of burn area extent (p=0.244). The most important risk factors for multipathogenic micromycetes infection are shown in Table 4.

Other risk factors for the development of infectious complications in the specific localisation are shown in Tables 5 and 6.

A strong effect of mechanical ventilation or tracheostoma (p<0.001, and p<0.001 respectively) was demonstrated from the infection development point of view in the area of the lower airways, when micromycetes were also isolated from the material. However, it is also interesting that tracheostoma and artificial pulmonary ventilation represent a risk factor for the development of micromycetes infection only in patients over the age of 60. This risk is not statistically significant in younger patients. Verification of inhalation

	Cultivation of pathogen to the 5th day of hospitalization			Statistical evaluation
	all patients	yes	no	yes vs. no
N	61 (100%)	7 (11.5%)	54 (88.5%)	p-value
ABSI	7.9; 8.0 (3.0; 14.0)	5.4; 5.0 (3.0; 8.0)	8.2; 8.0 (3.0; 14.0)	0.003
	Cultivationof pathogen 6th - 10th day of hospitalization			
	60 (100%)	15 (25.0%)	45 (75.0%)	
ABSI	7.9; 8.0 (3.0; 14.0)	6.3; 6.0 (3.0; 9.0)	8.5; 8.0 (3.0; 14.0)	0.001
	Cultivation of pathogen 11th - 15th day of hospitalization			
	57 (100%)	8 (14.0%)	49 (86.0%)	
ABSI	8.1; 8.0 (3.0; 14.0)	9.3; 8.5 (6.0; 14.0)	7.9; 8.0 (3.0; 13.0)	0.175
	Cultivation of pathogen after the 16th day of hospitalization			
	54 (100%)	33 (61.1%)	21 (38.9%)	
ABSI	8.1; 8.0 (3.0; 14.0)	9.0; 8.0 (4.0; 14.0)	6.7; 6.0 (3.0; 12.0)	**0.001**

Table 3. The effect of ABSI and duration of hospitalization on the count of culture detection of micromycetes in patients in the group (ABSI is described with mean, median, minimum and maximum. Mann-Whitney test is used in statistical evaluation.)

		Multi-pathogenic infection			Statistical evaluation
		all patients	yes	no	yes vs. no
N		61 (100%)	11 (18.0%)	50 (82.0%)	p-value
Age (years)		57.3; 62.0 (16.0; 90.0)	56.6; 67.0 (18.0; 84.0)	57.4; 59.0 (16.0; 90.0)	0.910
	< 60	29 (100%)	4 (13.8%)	25 (86.2%)	0.514
	60+	32 (100%)	7 (21.9%)	25 (78.1%)	
Sex	male	37 (100%)	4 (10.8%)	33 (89.2%)	0.093
	female	24 (100%)	7 (29.2%)	17 (70.8%)	
Extent of burns (% TBSA)		21.6; 14.0 (0.3; 82.0)	25.9; 17.0 (1.0; 82.0)	20.6; 12.0 (0.3; 75.0)	0.244
	21%+	21 (100%)	4 (19.0%)	17 (81.0%)	1.000
	<= 20%	40 (100%)	7 (17.5%)	33 (82.5%)	
	41%+	12 (100%)	2 (16.7%)	10 (83.3%)	1.000
	<= 40%	49 (100%)	9 (18.4%)	40 (81.6%)	
ABSI		7.9; 8.0 (3.0; 14.0)	8.2; 8.0 (3.0; 14.0)	7.8; 7.5 (3.0; 13.0)	0.608

Table 4. The most important risk factors for multipathogenic micromycetes infection

		Lower respiratory tract infections (LRTI)			Statistical evaluation
		all patients	yes	no	yes vs. no
N		61 (100%)	19 (31.1%)	42 (68.9%)	p-value
Inhalation injury	yes	15 (24.6%)	8 (42.1%)	7 (16.7%)	0.053
	no	46 (75.4%)	11 (57.9%)	35 (83.3%)	
Tracheostomy	yes	23 (37.7%)	14 (73.7%)	9 (21.4%)	**<0.001**
	no	38 (62.3%)	5 (26.3%)	33 (78.6%)	
Mechanical ventilation	yes	27 (44.3%)	15 (78.9%)	12 (28.6%)	**<0.001**
	no	34 (55.7%)	4 (21.1%)	30 (71.4%)	
Duration of mech. ventilation	(N = 27)	24.9; 22.0 (1.0; 79.0)	25.2; 21.0 (5.0; 79.0)	24.6; 27.0 (1.0; 43.0)	0.581

Table 5. The most important risk factors for the development of infection and culture of micromycetes in the area of lower airways (Duration of mechanical ventilation is described with mean, median, minimum and maximum. Mann-Whitney test is used in statistical evaluation for duration of mechanical ventilation; Fisher's exact test is used for the rest of the parameters.)

trauma itself is close above the margin of statistical significance (p=0.053). On the contrary, the effect of mechanical ventilation duration was not shown as important for isolation of yeasts or fungi from the area of the lower airways (p=0.581).

Micromycetes was most frequently isolated from burn area. In spite of that, we could not demonstrate any significant effect on the development of infection in this localisation in any of the monitored parameters, even if the values were close to statistical significance in case of absence of a deep burn or extent of the burn over 40% TBSA (p=0.053, and 0.059, respectively).

DISCUSSION

Even today, infectious complications represent a predominant cause of mortality and morbidity of burn patients. Burns represent such type of trauma, in which development of opportune infections may be very common. Paradoxically, the increase of infectious complications caused by micromycetes is due to extensive therapeutic approach in local and also systemic control of bacterial infection. Especially topical antibacterial dressing started the rising incidence of mycotic infections, which continues until today.[6] Candida infections are predominant in burn patients. The incidence of non-Candida infectious complications is much lower, however this fact is observed also in other groups of critically ill patients. [7,8]

Infection of the burn area is the most common location with regards to the occurrence of infectious complications in burn patients, no matter whether this is a bacterial or non-bacterial aetiological agent. Fungi are not predominant pathogens in the development of burn area infection, how-

		Burn wound infection (BWI)			Statistical evaluation
		all patients	yes	no	yes vs. no
N		61 (100%)	30 (49.2%)	31 (50.8%)	p-value
Extent of burns (% TBSA)	21%+	21 (34.4%)	9 (30.0%)	12 (38.7%)	0.592
	<= 20%	40 (65.6%)	21 (70.0%)	19 (61.3%)	
	41%+	12 (19.7%)	9 (30.0%)	3 (9.7%)	0.059
	<= 40%	49 (80.3%)	21 (70.0%)	28 (90.3%)	
Full-thickness burn area (FTBA)	yes	57 (93.4%)	26 (86.7%)	31 (100%)	0.053
	no	4 (6.6%)	4 (13.3%)	0	

Table 6. The most important risk factors for the development of infection and cultivation of micromycetes in the burn area (Fisher's exact test is used in statistical evaluation.)

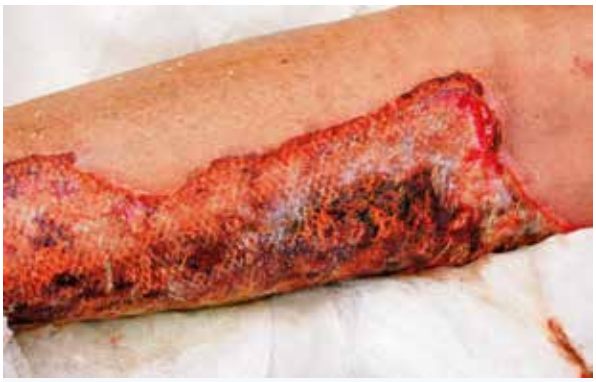

Fig. 1. Burn area with *Candida albicans* infection

ever their contribution gradually rises. Burn area infected with *Candida albicans* is shown on Figure 1.

According to a retrospective study of the American Burn Association (ABA), micromycetes were demonstrated as an aetiological agent in 6.3% of all infectious complications in the burn area.[9] Contribution of micromycetes in the aetiology of burn area infection reaches much higher values (20–40%) in most studies.[10,11] Questionable remains the real incidence. With regards to a common absence of specific clinical symptoms, omission of micromycetes role in burn patients or difficult laboratory diagnostics, the infectious complication may be missed in several patients. In relation to the incidence of infectious complications caused by fungi in burn patients, it is not possible to demonstrate whether there is a clear geographic prerequisite. This fact is due to worldwide presence of micromycetes.[12]

Isolation of *Candida albicans* within monitoring of each micromycetes is currently predominant in most of studies. Very surprising finding in our group of patients is that occurrence of non-albicans Candidas is much higher than the count of isolated *Candida albicans* strains. Count of the isolated *Candida krusei* and *Candida glabrata* strains is also alarming with regards to the sensitivity to the most commonly available antimycotic drug at present. Both these yeasts are virtually resistant to fluconazole (*Candida krusei* is naturally resistant, *Candida glabrata* acquires resistance very quickly). Another option for therapy of infection caused by these micromycetes is administration of echinocandins. Therefore occurrence of these yeasts means always a dramatic increase of economic costs of therapy. Most studies identify the basic risk factors for the development of candidemia, and possibly candidiasis. Greater extent of the burn area, prolongation of the period from trauma to admission, presence and extent of deep burns, number of surgical procedures, total parenteral nutrition or therapy with antibiotics (cotrimoxazole, amikacin, vancomycin and other) are such risk factors.[12] We focused on the two most common locations in our group with regards to the development of mycotic infection, i.e. on the burn area and lower airways. In case of burn area, no risk factor that would significantly contribute on the development of infection was demonstrated, although the extent of burn area and absence of a deep burn are on the margin of statistical significance. In case of infectious complication development in the area of the lower airways, the presence of a tracheostoma and requirement of mechanical ventilation were important risk factors, similarly to the presence of inhalation trauma.

The diagnostics and therapy of mycotic infections represent a great challenge. Culture of mycotic infections is quite lengthy. Since prompt diagnostics is currently greatly emphasized, the methods that demonstrate mycotic antigens are preferred more often, not only in burn patients. Mycotic antigens are actually parts of the body of the fungi, which can be demonstrated in various materials (blood, bronchoalveolar lavage and other). The most frequently used antigens today, which we encounter in common practice, include galactomannan for detection of aspergillum infection and also 1,3-β-D glucan as a so-called panfungal antigen in several fungi.[13]

Early diagnostics of zygomycetes infections is still problematic. Rising incidence has been observed recently also in these fibrous fungi. In relation with zygomycetes, *Absidia* species, *Mucor* species, *Rhizomucor* species and *Rhizopus* species occur in burn patients.[14] Area after necrectomy in left lower limb with isolation of *Absidia* species is shown on Figure 2.

CONCLUSION

Immune paralysis or immunosuppression can develop in patients with thermal trauma, especially in case the extent of the burn is over 20% TBSA. This fact together with compromised local skin barrier and presence of other risk factors (inhalation trauma, mechanical ventilation and other) cause

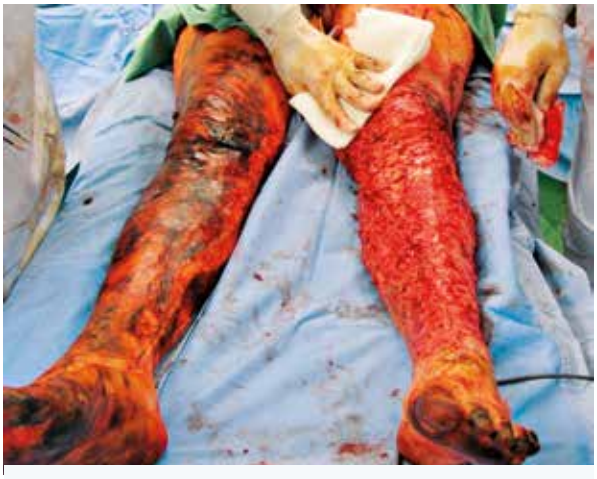

Fig. 2. Necrectomy of the lower limbs with isolation of *Absidia* species

that the burn patients are susceptible for development of infectious complications caused by micromycetes.

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MICRONEEDLING – A FORM OF COLLAGEN INDUCTION THERAPY – OUR FIRST EXPERIENCES

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ACTA CHIRURGIAE PLASTICAE, 59, 1, 2017, pp. 33–36

ABSTRACT

Introduction: Microneedling (percutaneous collagen induction therapy) is a new promising miniinvasive therapeutic method for the treatment of skin alterations of different aetiology, including burn scars. Since 2016, it is also available at our department. The microtraumatization of scars with the Dermaroller® leads to an activation of the healing cascade, activation of growth factors, which activate cell proliferation in the wound, increased synthesis and deposit of collagen – elastin complex with successive transformation of collagen III to collagen I, to neoangiogenesis and thus to accelerated scar remodelling.
Material and methods: In the pilot study conducted in 2016, the microneedling method with Dermaroller® with 2.5 mm needles was used in six patients (two males, four females; age 25–73 years) with stabilized scars after previous application of split thickness skin graft due to thermal injury. We repeated the microneedling procedure in three intervals approximately 6 to 8 weeks apart, with the use of topical anaesthesia.
Results: Preliminary results showed a subjective improvement of the scars. Objective evaluation with the Vancouver Scar Score showed an improvement of an average of two points before and after treatment.
Conclusion: Our first clinical experience show that microneedling appears to be a suitable microinvasive method for the improvement of scar quality after burn trauma.

KEYWORDS

Microneedling, Dermaroller®, collagen induction therapy, burn scar

INTRODUCTION

Innovation in the strategy of surgical therapy of severe burn trauma, together with considerable advances in intensive care, make the survival of patients with even critical body surface area burns possible. The goal of multidisciplinary care in burn centres is not only reduction of lethality of burn injuries, but also improvement of quality of life of burn patients through complex care for the resulting scars. Currently, a whole range of therapeutic approaches dedicated to improving function and appearance of the resulting scar is available (early wound closure, dermal substitutes, early rehabilitation, compression garments, splinting, silicone plates/gels, laser therapy, dermabrasion, corticotherapy, etc.).

Microneedling – a form of collagen induction therapy – is, due to its affordability, simplicity and a minimum of side effects, gradually gaining popularity in aesthetic surgery and corrective dermatology for the therapy of different skin lesions (hypertrophic scars, hypotrophic scars, scars after acne, wrinkles, stretch-marks, for rejuvenation therapy, pigmentation changes, telangiectasia, etc.).[1]

The research of the effects of microtraumatization on scars – dermaneedling – was underway from the mid 1990s and proceeded in two directions: transdermal delivery of pharmaceuticals and percutaneous induction of collagen.

Many studies from the era of 2001 to 2010 involving transdermal delivery of pharmaceuticals (insulin, photodynamic therapy, photo rejuvenation) to different skin layers with the help of a Dermaroller® confirmed an increased concentration of lipophilic and hydrophilic pharmaceuticals and of macromolecules in the layers under the stratum corneum.[2,3] An important factor was also the needle length of the Dermaroller®. With a needle penetrating into the depth of 0.15 mm there was an accumulation of the pharmaceutical in the stratum corneum and diffusion into the deeper layers of the epidermis. With a needle length of 0.5 mm the transdermal penetration of the pharmaceutical was facilitated, and with a needle length over 1.5 mm the pharmaceuticals penetrated into the receptor compartment of the dermis. A similar penetration of the pharmaceutical was confirmed also with the use of the Dermaroller® before the application of the drug (Dermaroller® pre-treatment). The microtraumatization of the dermis creates micropores, which cause increased transdermal water loss for a duration of approximately two hours with subsequent occlusive dressing in place (15 minutes without occlusive dressing); it is proven that the micropores also stay open for approximately 24 to 72 hours after application in case there is an occlusive dressing in place.

Fig. 1. Dermaroller® M925 (Dermaroller GmbH, Lindener Str. 15, Wolfenbüttel /Germany)

The other direction of research was percutaneous collagen inducing therapy. In 1995, Orentreig demonstrated improvement of the characteristics of a hypotrophic scar through repeated puncture ("subscission").[4] In 1997, Camirand and Doucet described the modification of scars by perforation with an empty tattoo gun.[5] Subsequently, in the timespan between 2000 to 2010, Schwartz and Laaff were using the Dermaroller® with a needle length of 1.5 mm in successful therapy of acne scars, posttraumatic scars and wrinkles.[6] In the year 2002, Fernando is publishing on the induction of neocollagenesis by the use of microneedling.[7] In 2010, Fabbrocini et al. confirmed the use of the Dermaroller® as a safe therapy of acne scars for all skin phototypes, with a minimum risk of inflammatory hyperpigmentation when compared to the use of dermabrasion, chemical peeling and ablative laser therapy.[8] With the use of microneedling, Aust et al. confirms in 2009 an 80% improvement of burn scars with a normalization of the extracellular collagen – elastin matrix, significantly increased collagen deposit, thickening of epidermis – stratum granulosum by 45%, with a clinical scar improvement – Vancouver scar scale (VSS) reduction by 1 to 6 points, reduction of scar thickness by 0.3 to 3.6 mm without observation of pigmentation changes like in ablative techniques.

Pathophysiology

The principle of microneedling/dermaneedling is the creation of numerous microtraumata to the epidermal or dermal part of the skin (by piercing the skin). These cause changes in the transepithelial electrical potential, and also minimal bleeding into the micropores with a subsequent minimal inflammatory reaction, where the healing cascade is being activated under participation of serum and blood cells (thrombocytes, neutrophils), which gradually release numerous growth factors into the area. They induce proliferation of fibroblasts with an increased synthesis and deposition of collagen and elastin, and neoangiogenesis. In the remodelling phase of healing the conversion of collagen III to collagen I ensues with the participation of monocytes/macrophages. The result is an induction of collagenogenesis (neocollagenogenesis), creation of the body's more inherent, more natural collagen type I and a gradual spatial remodelling of the parallel structure of scar collagen to the reticular (net-like) structure of the final collagen, and changes in the microvascularization of the scar.[1,9,10,11]

Microneedling technique

A special, disposable hand held device (Dermaroller®, Dermastamp®), which pierces/ microtraumatizes the skin layers with conical needles of a diameter of 0.1 mm and a length of 0.15 to 3 mm, is being used for microneedling. The needles are placed on a cylinder, which contains up to 192 needles (Dermaroller®) (Figure 1), or statically on a smaller area (Dermastamp®). The goal is to reach a density of approximately 200 to 250 punctures/cm^2. The needle length, the size and type of device are being chosen according to skin lesion and localization of the microneedling procedure. A needle length up to 0.25 mm enables safe use even in a home environment; the use by an experienced physician in a healthcare setting is required for a needle length of 0.5 mm and up. The indications for a microneedling therapy are skin alterations like hypo- or hypertrophic scars, stretch marks, wrinkles, cellulite, pigmentation changes, teleangiectasia, alopecia and further rejuvenation and photodynamic therapy. The contraindications are all local skin infections, solar dermatitis, active herpes simplex, keloids, healing disorders, coagulation disorders, collagen disorders and malignancy at the site of application.[1]

The procedure itself is being conducted approximately 45 minutes to 1 hour after application of topical anaesthesia (EMLA® cream, occlusive dressing), under sterile precautions. To reach the needed density of perforations, the rolling needs to be performed 6 times in 4–6 directions. The goal is to reach diffuse erythema (with the use of shorter needles) or diffuse pinpoint bleeding (with the use of longer needles) (Figure 2). The application on burn scars is accompanied by

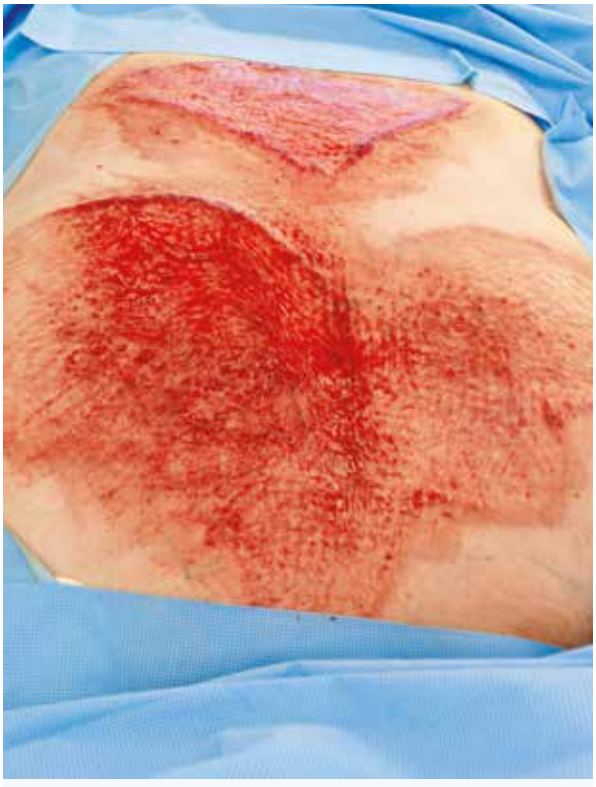

Fig. 2. Diffuse pinpoint bleeding – the endpoint of dermaneedling of scars

Fig. 3. Resulting oedema, redness and minimal diffuse bleeding post-procedure

a popping sound effect when the correct, deep scar layers are being pierced. Directly after the application a reddening of the area and a relatively obvious local oedema occurs, which can last for 24 to 48 hours (Figure 3), together with minimal diffuse short term bleeding. The wound should be appropriately covered with an occlusive dressing and an antiseptic/antibiotic ointment for approximately 24 to 48 hours. After the removal of dressings is sufficient routine hygiene and sun protection. The procedure is repeated in 4–10-week intervals with the use of 0.5–3 mm needles, in dermatocosmetic indications (needles up to 0.5 mm) even several times a week.

MATERIAL AND METHODS

In our pilot study, after obtaining informed consent, we used the Dermaroller® on six patients (2 males, 4 females; age 25–73 years) with stabilized scars (1–33 years after injury) after meshed split thickness skin grafting. The extent of the treated area was between 1–4.5% TBSA (Table 1). For topical anaesthesia we used EMLA® cream, and a customized pharmacy-made 10% lidocaine ointment in a combination with intramuscular application of analgesics. Post procedure the area was covered with a sterile occlusive dressing with Vaseline gauze and Chlorhexidine ointment. The procedure was repeated in each patient three times within an interval of 6–8 weeks. The results were documented photographically. The status of the scar was objectively evaluated with the VSS. With the subjective evaluation we focused on pain and tension within the scar.

RESULTS

In the perioperative process there were no bleeding or infectious complications noted; the postoperative pain was minimal, short, and easy to manage with common analgesics. All patients reported subjective improvement of the final quality of the scar. The subjective diminishing of tension in the scar was the most frequently appreciated feature by the patients. Objectively the scar surface and mainly the texture of the meshed graft were smoothed. Within the comparison of before and after the series of the procedures, there was an average improvement of two points (1–4 points) on the VSS scale. Change of pigmentation in terms of a more even distribution of pigment was also visible. Scar areas, which were hypertrophic and unstable, demonstrated signs of stabilization and slight flattening (Figures 4, 5).

DISCUSSION

Microneedling as a new method for modification of burn scars opens another possibility to improve the resulting scar and also to improve quality of life of the patients. In comparison with other readily available methods like laser therapy or dermabrasion, there is no extensive breach of epidermal integrity, no artificial necrotic tissue is created and there is no significant inflammatory reaction in the healing process, and the healing process is markedly shorter.[1,7,8] The limiting factor for the application of dermarolling in an ambulatory setting is the maximum dose of applicable topical anaesthesia (approximately an area of a letter-size paper). In case of a greater extent or a non-compliant patient, it is possible to use a combination of topical anaesthesia and some form

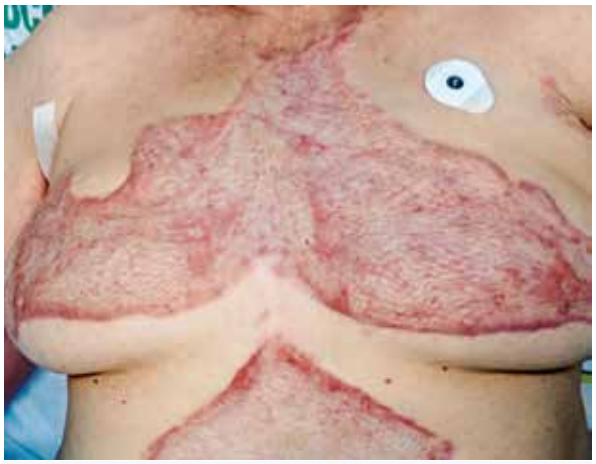

Fig. 4. Scars before dermaneedling (significantly visible MESH pattern)

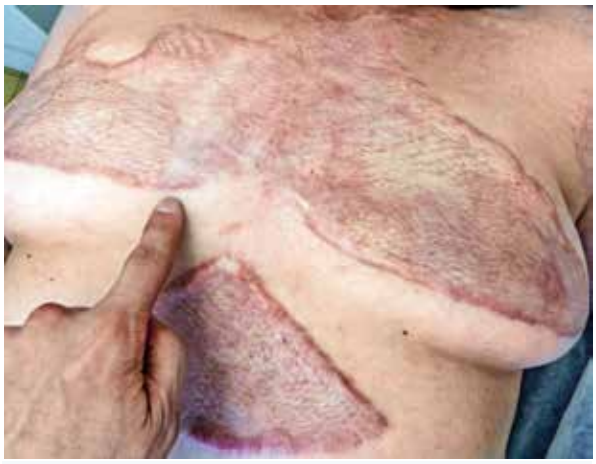

Fig. 5. Scars after dermaneedling, 4 weeks after the 3rd application (areas with smoothened surface visible)

Patient	gender	age	years postgraft	VSS before DR	VSS after DR	VSS improvement	DR BSA
1	female	42	9	5	2	-3	3.00%
2	female	40	33	3	2	-1	1.25%
3	male	27	3,5	6	4	-2	1.00%
4	female	73	1	5	4	-1	3.50%
5	female	28	2,5	4	2	-2	1.50%
6	male	25	5,5	9	7	-2	4.00%

Table 1. Results. DR- dermarolling, VSS – Vancouver scar score, BSA - body surface area

of analgosedation, or even general anaesthesia with short-term hospitalization.

Patients in our group evaluated pain as manageable. For more complicated anatomical localizations (interdigital space, perinasal area, band-like hypertrophic scars) it is necessary to use a narrower instrument (Dermaroller® with 4 rows of needles, Dermastamp®). The 9-row-cylinder used by us is not quite suitable in anatomically more complicated locations. The possible combination of Dermaroller® and the application of hyaluronic acid or corticoids seems to be advantageous.

We shall be able to clinically fully analyse the effects of this method on the maturation of scars only with a time interval of at least six months after the last procedure. The publications of Liebl and Aust [1,10,11] show unambiguously a positive influence of the method with at least six months time period after the last procedure – due to the slower maturation of burn scars. In terms of indication, it is not quite clear in what time interval it is possible to start with the method, starting from the fully healed burned tissue. In our set of patients we tried the method with patients at least one year from the application of split thickness skin graft and at the latest 33 years after the burn accident. With the next set we will focus on scars with a tendency to marked hypertrophy, especially in aesthetically and functionally important regions.

CONCLUSION

Based on our first clinical experiences with the microneedling method, it appears that this procedure is an appropriate and adjunctive miniinvasive method for possibly influencing the remodelling of collagen in burn scars.

Acknowledgment

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HISTORIE, SOUČASNOST A PERSPEKTIVY ČESKÉ POPÁLENINOVÉ MEDICÍNY

Brychta, P.

Klinika popálenin a rekonstrukční chirurgie FN Brno

ACTA CHIRURGIAE PLASTICAE, 59, 1, 2017, pp. 39–41

SUMMARY

History, Present State and Perspectives of Czech Burns Medicine. Care for burn patients is defined in most developed countries as an independent multidisciplinary specialty (burn medicine) and it is concentrated to specialized units, which are sufficiently staffed with appropriate space area and equipment. Since the 50s of the previous century in the former Czechoslovakia, there were five such units, three of which were in the Czech Republic (Prague, Ostrava, Brno). The specialty successfully developed and achieved prestige also abroad, mainly due to uninterrupted contacts with the foreign units.

Until approximately mid 90s of the previous century, an increasing trend of development accelerated (new technologies, better space area and equipment, acquisition of new knowledge from abroad, etc.). On the other hand, two negative tendencies occurred. These were negative economic balance of care for burn patients, which was due to the current system of financing healthcare, and a completely inappropriate system of postgraduate education for burn medicine specialty. These two factors cause that young doctors are not interested in the specialty and there is a risk of its stagnation in case that the units will not be at least in an even economical balance and will not be able to offer young doctors anything in terms of financial rewards and further professional growth.

KEYWORDS

Czech burn medicine, burn centres, negative economical balance, postgraduate education

ÚVOD

Péče o popálené je ve většině rozvinutých zemí definována jako samostatný multidisciplinární obor (popáleninová medicína) a je koncentrována na specializovaná pracoviště, která disponují dostatečným personálním, prostorovým a přístrojovým vybavením. To se ukázalo jako významný faktor zlepšení léčebných výsledků u těžce a kriticky popálených a vedlo to také ke zlepšení kvality jejich života po tomto závažném poranění.

V České republice (bývalém Československu) byla popáleninová medicína cílevědomě budována už od 50. let minulého století a zejména díky akademiku Burianovi vzniklo v Praze v roce 1953 jedno z prvních pracovišť specializovaných na léčbu popálenin v Evropě.[1] Současně byl vypracován plán regionálního zajištění republiky specializovanými popáleninovými centry a postupně zaveden koncept komplexní a kontinuální péče o popálené.[2,3] Předkládaný článek shrnuje v krátkosti historii české popáleninové medicíny, její současný stav a perspektivy dalšího rozvoje.

HISTORIE SPECIALIZOVANÉ PÉČE O POPÁLENÉ V ČR

Historie specializované péče o popálené v České republice začíná v první polovině 50. let dvacátého století vybudováním samostatného pracoviště v Praze v roce 1953. Krátce na to následovala podobná pracoviště v srdci českého a později i slovenského těžkého průmyslu (1954 Ostrava, 1971 Košice). Bratislavské centrum vzniklo v roce 1987. V Brně, kde bylo popáleninové pracoviště projektováno už v padesátých letech Karfíkem (4), došlo k jeho realizaci až v roce 1982. Hlavním podnětem byly dvě exploze v brněnské teplárně s desítkami kriticky a těžce popálených ve druhé polovině 70. let.

Zvláštní status si udržuje pracoviště v Hradci Králové (založené v roce 1985), zejména v souvislosti s napojením na armádu.

Díky několika vynikajícím osobnostem si získala česká popáleninová medicína rychle respekt v zahraničí a i v době normalizace probíhala poměrně živá výměna názorů a zkušeností s předními pracovišti v Evropě i USA. Zcela zásadní v tomto směru je přínos zakladatelky a dlouholeté přednostky Kliniky popáleninové medicíny v Praze, prof. MUDr. Radany Königové, CSc. – zakládající a dlouholeté aktivní členky Evropské popáleninové asociace (EBA) i Mezinárodní organizace pro popáleninové úrazy (ISBI). Především díky ní se mohl konat u nás kongres ISBI v roce 1981 a III. kongres EBA v roce 1989 v Praze, jako vyjádření respektu k české popáleninové medicíně.

Po roce 1990 je patrný postupný kvalitativní pokrok v péči o popálené s realizací zahraničních zkušeností. Dochází k rychlému přejímání či zavádění nových metod díky lepšímu materiálnímu zabezpečení, srovnatelnému s nejrozvinutějšími zeměmi, a také ke všeobecnému uznání popáleninové medicíny jako mezioborové a náročné lékařské disciplíny. Projevilo se to například vznikem samostatné Odborné společnosti popáleninové medicíny v rámci ČLS JEP v roce 1993 (předtím od 60. let jako Odborná sekce společnosti plastické chirurgie), vypracováním náplně specializační přípravy v oboru Popáleninová medicína a zavedením nástavbové

atestace (specializovaná funkční způsobilost) v tomto oboru v roce 2005 jako výraz osamostatnění od plastické chirurgie.

Jestliže až do tohoto bodu zaznamenával náš obor zřetelně pozitivní vývoj a růst, v dalším období nebyly už změny tak jednoznačné. Dále pokračovalo zlepšování výsledků léčby díky kumulujícím se zkušenostem a erudici personálu. I prostorové a technické vybavení přispělo k velmi dobré evropské úrovni našeho oboru (Ostrava – nové prostory, vybavení pracovišť přístroji z IOP – interních operačních programů) atd.

Na druhé straně se začaly objevovat i negativní tendence. Zejména ztráta samostatnosti v postgraduálním vzdělávání a přeřazení Popáleninové medicíny ze základních do nástavbových oborů (poslední atestace se konala v roce 2012). Dále trvale negativní hospodářské výsledky všech center s nutností saturace provozních nákladů ze strany nemocnic a postupně narůstající deficit kvalifikovaných specialistů s víceletou zkušeností s léčbou popálených.

SOUČASNÝ STAV POPÁLENINOVÉ MEDICÍNY V ČR

V současné době je komplexní a kontinuální péče o popálené všech věkových skupin a všech stupňů závažnosti poskytována na třech pracovištích:

– Klinika popáleninové medicíny, Fakultní nemocnice Královské Vinohrady, Praha

– Klinika popálenin a rekonstrukční chirurgie, Fakultní nemocnice Brno

– Popáleninové centrum Fakultní nemocnice Ostrava

Společnost popáleninové medicíny má v současné době 68 řádných členů, z toho 36 mužů a 32 žen. Šedesát sedm členů má titul MUDr. Věková struktura členské základny je ale alarmující (Tabulka 1).

Pro lepší ilustraci stárnutí populace specialistů v léčbě popálenin je uvedeno věkové složení lékařů aktivních v léčbě popálenin v Popáleninovém centru Brno (Tabulka 2).

Personální lékařské zajištění brněnského (ale i pražského) pracoviště je tedy poměrně hrozivé. Generace lékařů nad 50 let se pomalu blíží důchodovému věku a střední generace chybí. Největší problém spatřujeme v systému postgraduálního vzdělávání, kdy absolventům nemůžeme reálně mnoho nabídnout. Po absolvování chirurgického kmene a základního oboru má pro odbornost 602 (popáleninová medicína) jakožto nástavbového oboru následovat až tříletý certifikovaný kurz.

„Podmínkou pro zařazení do nástavbového oboru (certifikovaného kurzu) popáleninová medicína je získání specializované způsobilosti v oboru anesteziologie a intenzivní medicína nebo cévní chirurgie nebo dětská chirurgie nebo chirurgie nebo kardiochirurgie nebo neurochirurgie nebo plastická chirurgie.“ (Citace ze stávající vyhlášky MZ ČR[5].)

O nepraktičnosti tohoto systému svědčí např. fakt, že o něj za celou dobu (od roku 2012) nikdo neprojevil zájem. Plně erudovaný plastický chirurg, cévní chirurg, kardiochirurg, neurochirurg či intenzivista stěží přestoupí na náš úzce specializovaný obor s dalším několikaletým vzděláváním, částečně mimo pracoviště. (Tři roky je možno zkrátit o stáže identické v základním oboru.)

Na MZ ČR pracuje komise, která vypracovává nový systém postgraduálního vzdělávání, ale ani vysoké školy, které mají vzdělávání realizovat, ani odborné společnosti nemají zatím dostatek informací o charakteru plánovaných změn. Jisté se zdá být pouze to, že obor Popáleninová medicína se mezi základní obory nevrátí. Výbor Společnosti má vážnou obavu, aby současný, doslova likvidační systém pro popáleninovou medicínu nebyl nahrazen podobným. Proto bychom se rádi podíleli jako odborná společnost spolu s MZ ČR na přípravě nového systému s upozorněním na současný stav v oboru popáleninová medicína.

Druhým zásadním problémem je financování naší specializace. Systém DRG je pro náš obor značně nevýhodný. Nový systém připravovaný na MZ ČR, a to „restart DRG“, je ve fázi příprav a je malá naděje, že bude lepší. Zavedení tohoto systému se předpokládá asi za tři roky.

věk členů	počet členů
do 30 let	1
do 40 let	16
do 50 let	12
do 60 let	16
nad 60 let	23

Tabulka 1. Věková struktura členské základny Společnosti popáleninové medicíny ČLS JEP

věk	počet aktivních lékařů
25 – 35 let	5
35 – 45 let	1
45 – 55 let	1
55 – 65 let	5

Tabulka 2. Věkové složení lékařů aktivních v léčbě popálenin v Popáleninovém centru Brno

PERSPEKTIVY ČESKÉ POPÁLENINOVÉ MEDICÍNY

Výhledově lze na základě dosavadního vývoje předpokládat, že počet popálených a těžce popálených se v blízké budoucnosti nijak významně nesníží (přes 1000 těžkých popálenin a nejméně 10krát tolik ambulantně léčených). Koncentrace těchto pacientů do specializovaných center prokazatelně zlepšuje a bude zlepšovat výsledky jejich léčby a snížení nákladů. Tři pracoviště na 10 milionů obyvatel jsou jak podle evropských směrnic, tak podle naší dosavadní praxe právě dostačující.

Nejspíše se bude dále prohlubovat polarizace mezi resuscitací či intenzivní péčí o popálené (intenzivisté) a jejich chirurgickou léčbou (plastičtí chirurgové). Získání těchto specialistů pro obor Popáleninová medicína bude čím dál obtížnější. I tak by měla být všeobecná snaha udělat vše pro záchranu odbornosti Popáleninová medicína, protože úspěšnou resuscitací a krytím popálených ploch péče o popálené zdaleka nekončí, ba naopak právě začíná dlouhodobá a mnohdy celoživotní další fáze.

Je třeba vzít v úvahu speciální ošetřovatelskou péči, následnou péči o jizvy, rehabilitační a psychologickou podporu, řadu korekčních a rekonstrukčních operačních výkonů, dlouhodobou dispenzarizaci a podobně. Současně nelze v žádném případě opomenout stále aktuální možnost vzniku hromadných popáleninových katastrof při požárech hotelů, klubů, dopravních haváriích nebo průmyslových katastrofách, jak o tom svědčí realita celosvětové praxe.[6,7,8,9]

Víme, že jak vedení všech tří nemocnic, kde popáleninová centra jsou, tak i MZ ČR si jsou jejich významu vědoma. Proto také po stránce materiální (prostory, přístrojové vybavení) jsou na srovnatelné úrovni s centry v jiných rozvinutých zemích.

ZÁVĚR

Péče o popálené v České republice udělala za poslední více než půlstoletí obrovský kvalitativní skok kupředu a v současnosti se oprávněně řadí k evropské špičce. A to nejen po stránce léčebně-preventivní, materiální, výukové a vzdělávací, ale i vědecko-výzkumné, např. zapojením do mezinárodních studií, grantů, členství ve výkonných výborech mezinárodních společností apod. Výbor Společnosti je pevně přesvědčen, že tento trend se podaří udržet i v budoucích letech.

Co je však pro to nevyhnutelné a co stále chybí, jsou jasná, rozumná a dlouhodobě platná pravidla postgraduálního vzdělávání v oboru Popáleninová medicína a jasná, rozumná a dlouhodobě platná pravidla financování péče o popálené, která by dala našim pracovištím perspektivu budoucího rozvoje.

Práce byla přednesena jako úvodní sdělení na XX. výroční konferenci České společnosti popáleninové medicíny ČLS JEP, 14. – 16. října 2015.

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ERRATA

In the previous volume there was a print error in Figure 5 in the following article:

Hýža P., Veselý J., Streit L., Schwarz D., Kubek T., Catalano F., Lombardo G.A.G.

OUR PRELIMINARY EXPERIENCE WITH A NEW METHOD OF DIEAP FLAP DISSECTION.

Acta Chir. Plast. 2016;58(2): 64–69.

The correct Figure 5 is as follows:

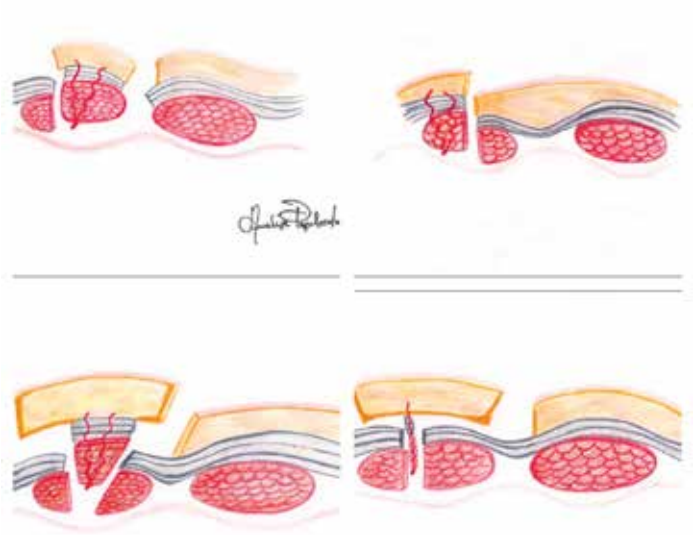

Fig. 5. A schematic representation of the various muscle sparing techniques. MS-1L (top left), MS-1M (top right), MS-2 (bottom left), Author's Variant (bottom right)

The editors apologize for the error.

REPORT ON THE OBSERVER TRAINING AT BROOKE ARMY MEDICAL CENTER IN SAN ANTONIO, TEXAS, USA

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ACTA CHIRURGIAE PLASTICAE, 59, 1, 2017, pp. 42–44

SUMMARY

A short report describing the unique experience of visiting the famous Brooke Army Medical Center (BAMC) in San Antonio, Texas, USA and its Burn Center and Plastic Surgery Department in the period between June 27 and August 26, 2016.

KEYWORDS

Observer Training, Brooke Army Medical Center, BAMC, IMET

In the period between June 27 and August 26, 2016, I had the opportunity to visit the well-known Brooke Army Medical Center (BAMC) situated in San Antonio, Texas, USA and its Burn Center and Plastic Surgery Department. During a two-month long observation, I was primarily interested in reconstructive surgery after disfiguring injuries and burns, and I was able to attend a five-day microvascular course. The rest of the time I observed interesting surgeries in plastic surgery operating rooms in order to compare techniques and methods of treatment in the U.S. and the Czech Republic.

I was able to participate in this Observer Training thanks to the International Military Education and Training (IMET) program. According to the United States State Department, the IMET program provides training and education to students from allied and friendly nations. The program is funded by the U.S. government, and its main goal is to improve reciprocal understanding and defense cooperation between the U.S. and foreign allied countries. IMET provides more than 4,000 courses focused on the enhancement of cooperation skills during collective military operations. These courses are taught at approximately 150 military schools, installations, and military hospitals, [1] including the BAMC.

BAMC is the largest U.S. military healthcare organization with approximately 8,500 staff members, including military personnel as well as civilian employees. At the heart of BAMC is the San Antonio Military Medical Center (SAMMC), which provides care for up to 425 military and civilian inpatients and more than 2,000 outpatients each day[2]. SAMMC is situated in Fort Sam Houston, a U.S. Military installation in San Antonio, Texas. From the World War II to the present days, the BAMC has had a long history of burn care and research development. The famous Brooke formula, the formula for initial 24-hour fluid resuscitation of the severely burned patient, was developed here. BAMC serves as the only U.S. military Burn Center and cares for combat burn casualties as well as civilian emergencies.

The Burn Center itself uses 40 beds including twelve ICU boxes heated to human body temperature and two operating rooms. It is the top-class burn center providing cutting-edge treatment. The system of care is based on physician assistants (PAs) and nurses. PAs are healthcare professionals who usually have master's degrees, and they help doctors with uncomplicated activities such as taking patient history, performing examinations, and prescribing medications. Some PAs run inpatient wards and some are allowed to attend surgical procedures in order to assist the surgeons. There are several types of nurses in the U.S. and some of them are authorized to work more independently than nurses in the Czech Republic. Compared to the number

Fig. 1. View of the San Antonio Military Center main building

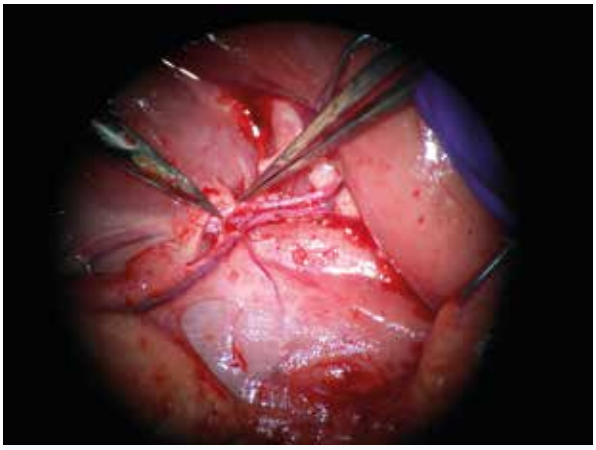

Fig. 2. Microscopic view of training the microanastomoses on a rat model during the Microvascular BAMC Course

of patients, there are more nurses in the U.S. than in the Czech Republic, and many of them are men. For example, at ICU the nurses are in charge of routine dressing changes without any supervision by the physicians. Besides the inpatient part of the center, there is also an outpatient department called the Burn Clinic, where long term follow up and dressing changes take place. Most of the follow-ups are carried out without direct physician presence by physician assistants only. The above mentioned differences are the main reasons why significantly fewer physicians are needed in the U.S. than in the Czech Republic.

For the majority of the time at SAMMC, I observed the work of Dr. Rodney K. Chan, the reconstructive plastic surgeon assigned to the Burn Center. The wide range of his work consisted of reconstructive surgery after serious burns, amputated extremities, and also of soft tissue defects after open fractures. At SAMMC I had a chance to see many burn patients with scar contractures, patients with abdominal wall defects after open abdominal surgery, or large reconstructive cases of defects with exposed bone/tendon/ligament, as well as a self-inflicted gunshot injury to the face following a suicide attempt. Dr. Chan is an internationally known reconstructive plastic surgeon and skilled microsurgeon. He has contributed to more than 50 publications on various plastic surgery topics, and he was also a member of Dr. Pomahač's team during the first full face transplantation in the U.S.

During my stay, I was happy to attend the BAMC Microvascular Course organized under the supervision of Dr. Peter Ch. Rhee, the Chief of Hand and Microvascular Surgery. The course focused on the training of microsurgical techniques on rats under microscope control in a live animal laboratory. The course was limited to only six residents, with four surgical microscopes to work with, providing each participant significant hands-on experience and staff guidance. During the five days in the live animal lab, we practiced not only end-to-end femoral artery and vein anastomoses, but also end-to-side femoral vein to artery anastomosis and even interposition of superficial epigastric vein graft into the femoral artery. These vessels, just 1mm in diameter or less, challenged the surgical skills of all participants. It was a rewarding experience because microsurgical skills are becoming more and more essential to the cutting-edge plastic surgeon.

Besides the time spent at the Burn Center and at the microvascular course, I also observed numerous interesting procedures in other operating rooms. I spent most of the time at Plastic Surgery Department, but several times I went to observe surgeries at the Ear, Nose, Throat operating room. I was surprised that their specialists did a lot of reconstructions after tumor resections by themselves without any assistance of plastic surgeons. For instance, twice I saw an impressive hemiglossectomy with immediate reconstruction utilizing a radial forearm free flap. In Plastic Surgery operating rooms (apart from the aesthetic procedures), I had the opportunity to follow cutting-edge breast reconstruction surgeries, fat grafting and multiple stage tissue expander procedures which were, little by little, supposed to remove a giant congenital pigmented nevus or a large skin grafted area. I also appreciated that I was able to become familiar with a wide range of modern technologies such as the Venous Coupler Doppler (a Doppler probe incorporated into a venous coupling device in order to monitor a free flap postoperatively), the ViOptix Tissue Oximeter (a system of near infrared spectroscopy for the monitoring of a free flap), and a fluorescence imaging system (SPY Elite) that enables surgeons to intraoperatively visualize microvascular blood flow and perfusion in tissue and therefore avoid ischemic complications. Although these technologies are currently too expensive to be used widely in plastic surgery departments in the Czech Republic, this will hopefully change over the course of the time.

Unfortunately, the U.S. law system does not recognize any foreign country university school of medicine, therefore I was not allowed to take part in a process of treating patients, and I could not even scrub into the surgeries. Nevertheless, I consider my observations a great experience, and I think I have learned a lot. During the time spent in and out of the operating rooms, I had the opportunity to discuss various topics of reconstructive and plastic surgery with Dr. Chan and other attending surgeons assigned to the Plastic Surgery department. With great interest, we discussed and compared procedures and methods used in the U.S. and the Czech Republic. I noted that the training of residents is much more systematic and sophisticated in the U.S.

Fig. 3. The author (in the middle) with the Burn Center assigned reconstructive plastic surgeon Dr. Rodney Chan (on the right) and his resident Dr. Daniel True (on the left)

and I personally consider it to be far better than the Czech style. The system motivates tutors to share their experience and knowledge with their residents. This is demonstrated especially in the operating rooms where residents actively participate in majority of the surgical procedures.

In conclusion, the entire observation took place in a very pleasant and friendly atmosphere, and I would like to thank Dr. Chan, his resident Dr. True, and the other staff from the Burn Center and Plastic Surgery Clinic for their interest and helpfulness which enabled me to gain considerable knowledge and experience. Last but not least, I would also like to thank all staff from the International Military Students Office at Fort Sam for their support and hospitality, without which none of this would have been possible.

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IN MEMORIAM: ASSOCIATE PROFESSOR KONSTANTIN G. TROSHEV, M.D., CSc.

In early February of this year, plastic surgeons in Bohemia, Moravia, and Slovakia were deeply saddened to receive news from Varna that our esteemed Bulgarian colleague, Associate Professor Konstantin Troshev, had passed away. A well-known surgeon and academic, his many years of participation at conferences and seminars in the fields of plastic surgery and burn medicine; his active involvement with the editorial board of this very journal; and numerous other academic, cultural, and international activities remain a lasting testament to his lifelong dedication to his chosen field. We would like to, at least briefly, recall the most important moments of his life and work.

Konstantin Georgiev Troshev was born on January 27, 1940 to a family of food chemists in Ruse, Bulgaria. After graduating high school, he enrolled at the Charles University, Faculty of General Medicine in Prague, from which he graduated in 1964. Having become well-acquainted with Czech history, Czech culture and our way of life during his studies, Dr. Troshev retained very close ties to his alma mater Charles University. Indeed, Prague was even the setting in which he first met Ludmila; the Czech classmate who would later become his wife, and a pediatrician in her own right. Following his graduation from medical school, Dr. Troshev had hoped to immediately continue his postgraduate research studies under Professor F. Burian, as the young physician was very interested in the fields of plastic and reconstructive surgery and burn treatments. However, he was summoned back to Bulgaria to perform his military service. Nevertheless, his interest in plastic surgery prevailed; he eventually specialized in the discipline as a student of Prof. Burian, and later became a pioneer of the field in his home country Bulgaria. In 1976, he successfully defended his medical doctorate thesis at the Charles University. In 1988, he became the founding director of the plastic surgery and burn center at Naval Hospital Varna, which was then part of the Bulgarian Military Medical Academy. During that same period, he also successfully defended his habilitation thesis. By the end of his career, he had published more than 200 scientific papers and authored 8 monographs and textbooks.

K. Troshev contributed admirably not only to the field of knowledge itself, but also to the mutual strengthening of historic and cultural ties between the Bulgarian, Czech, and Slovak nations. In 1973, he founded the Society for Bulgarian-Czech and Slovak Friendship in Varna, which organizes cultural and educational events throughout Bulgaria. It is also active in Prague, as well as in other Czech cities, presenting concerts, exhibitions of young Bulgarian artists, and showcasing young scientists at our professional events. With respect to collaboration at the academic level, Assoc. Prof. Troshev founded a branch of Prague's Carolinum Society in 1977, which serves the alumni and friends of Charles University who reside in Bulgaria. Konstantin Troshev had a great fondness for the study of Bulgarian-Czech relations within his chosen profession of medicine, and surgery in particular. He published numerous papers on the topic, the most significant monograph of which was entitled, *"Czech Physicians in Bulgaria during the Balkan Wars of 1912–1913."* The bilingual publication was presented in Bulgarian and Czech, and was printed in two editions (1984, 2003).

Assoc. Prof. Troshev was the recipient of numerous prestigious Bulgarian and Czech awards, including the *Order of Saints Cyril and Methodius*, and the *Memorial Medal* of Charles University, the latter of which was presented during the university's 650th anniversary ceremony. The award Konstantin held most dearly, however, was the *Gratias Agit* presented to him in 2003 by the Czech Republic Minister of Foreign Affairs for promoting the good name of the Czech Republic abroad. Assoc. Prof. Troshev maintained long-term personal and professional contacts with Czech and Slovak plastic surgeons,

as well as our burn medicine associations. He lectured at our symposiums and congresses. For many years, he served on the editorial board of *Acta Chirurgiae Plasticae* (1998–2014) and promoted the journal among his Bulgarian colleagues. Equally significant was his charitable contributions to the community, such as his assistance in organizing summer camps near the Black Sea (organized by the "Bolíto" civic association) for Czech pediatric burn survivors. Assoc. Prof. Troshev even continued to maintain his ties with us through these last few years despite having been seriously ill. He last visited Prague in October 2013, when he participated in a requiem mass for Professor R. Königová, whom he had respected enormously throughout his life. Konstantin Troshev passed away in Varna on February 3, 2017.

Our esteemed colleague, dear friend, and man of distinguished character, left this world with honor, having accomplished a tremendous career that contributed immensely to Bulgarian medicine, plastic surgery, and burn treatment; and having successfully broadened and strengthened the mutual friendships between Czechs, Slovaks, and Bulgarians. Finally, it must also be said that Konstantin Troshev was an exemplary husband, a doting father of two daughters, and a loving grandfather of four grandchildren; he was fully devoted to his family and cherished them above all else.

We shall preserve and honor his memory always!

Assoc. Prof. Leo Klein, M.D,. CSc.
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ČESKÉ SOUHRNY

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NAŠE ZKUŠENOSTI S VYUŽITÍM 40% KYSELINY BENZOOVÉ PŘI NEKREKTOMII U HLUBOKÝCH POPÁLENIN

Jelínková Z., Kaloudová Y., Řihová H., Suchánek I., Brychta P.

Východiska: Na Klinice popálenin a rekonstrukční chirurgie FN Brno je metoda chemické nekrektomie pomocí 40% kyseliny benzoové používána k léčbě hlubokých popálenin extenzivně od založení pracoviště v roce 1982 do současnosti. Přesto, že má klinicky metoda jasné výhody pro pacienta i ošetřovatelský tým, chyběla validní data o vstřebávání kyseliny přes nekrózu a tedy o bezpečnosti pro pacienta.

Materiál a metodika: Ve spolupráci s Oddělením klinické biochemie jsme se rozhodli vyšetřit u 22 pacientů hladiny kyseliny benzoové a kyseliny hippurové v séru a rovněž jsme stanovovali sérovou hladinu glycinu, který se při utilizaci kyseliny benzoové spotřebovává. Dále byl prováděn sběr moči, ve kterém se opět stanovovala kyselina hippurová a z odpadů do moči se dopočítalo celkové vstřebané resp. vyloučené množství kyseliny benzoové za 24 hodin.

Výsledky: Zjistili jsme, že konstantně dochází k rychlému a většinou krátkodobému nárůstu plasmatické koncentrace kyseliny benzoové (max. 1,3 mmol/l) což je asi 5x méně, než je hladina spojovaná s již toxickými projevy (6,5 mmol/l). Totéž se děje u hladiny kyseliny hippurové. Hladina glycinu mírně poklesá, ale nikoli mimo rámec normálních hodnot.

Diskuse: V diskusi jsou uvedeny některé typické a atypické průběhy hladin uvedených kyselin, korelace dynamiky resorpce a eliminace s rozsahem resorpční plochy a klinickým stavem pacienta. Je zhodnocena efektivita a bezpečnost metody.

Závěr: Závěr sumarizuje všechna pozorování a hodnotí chemickou nekrektomii 40% kyselinou benzoovou jako selektivní a srovnatelně efektivní s metodami ostré nekrektomie. Metoda je levná, snadno proveditelná a snižuje podstatně krevní ztráty. Přitom toxicita vstřebané kyseliny benzoové je klinicky bezvýznamná.

OPERAČNÍ LÉČBA HLUBOKÝCH POPÁLENIN METODOU MEEK MIKROGRFATINGU V POPÁLENINOVÉM CENTRU FN OSTRAVA

Klosová H., Němečková Crkvenjaš Z., Štětinský J.

Východiska: Předpokladem úspěšné léčby rozsáhlého popáleninového úrazu je časná nekrektomie a kožní autotransplantace, limitujícím faktorem je nedostatek odběrových ploch. Možným řešením se jeví metoda Meek mikrograftingu, kterou v roce 1958 publikoval americký lékař C. P. Meek. Kožní štěpy jsou prokrájeny na mikrografty a expandovány v poměru 1:3, 1:4, 1:6 nebo 1:9. I při malém rozsahu odběrových ploch je tak možné transplantovat rozsáhlé plochy po nekrektomii.

Materiál a metody: Meek mikrografting byl na Popáleninovém centru FN Ostrava poprvé použit v roce 2013. Dosud jsme takto provedli 14 operací u 4 pacientů s rozsáhlým popáleninovým traumatem. Pooperačně bylo sledováno přihojení mikrograftů, rychlost hojení a následné jizvení se zaměřením na vznik jizevnatých kontraktur.

Výsledky: Průměrná úspěšnost zhojení ploch transplantovaných mikrografty byla 86,5 %. Nejlépe se hojily plochy transplantované odloženě po nekrektomii. K rozvoji jizevnaté hypertrofie došlo na plochách transplantovaných mikrografty i meshovanými štěpy. V oblastech mikrograftingu nedošlo ke vzniku jizevnatých kontraktur s nutností operačního řešení. U jednoho pacienta bylo nutné operační uvolnění jizevnatých kontraktur v oblasti transplantace meshovanými štěpy.

Diskuse: Meek mikrografting osvědčil svoje výhody. K přípravě mikrograftů lze využít i velmi malé kožní štěpy, u nichž je meshování nemožné. Při expanzi meshovaných štěpů 1:3 a vyšší je tyto třeba krýt xenotransplantáty či allotransplantáty. U mikrograftů není sandwichové krytí dle našich zkušeností nutné ani při expanzi 1:6. V oblastech mikrograftingu nedošlo ke vzniku závažných jizevnatých kontraktur, lze spekulovat o možné menší rizikovosti Meek mikrograftů oproti meshovaným štěpům. Nevýhodou meek mikrograftingu je vyšší ekonomická náročnost.

Závěr: Meek mikrografting potvrdil svoji efektivitu pro operační léčbu hlubokých popálenin u rozsáhlých termických úrazů spojených s nedostatkem odběrových ploch.

INTEGRA® – ZKUŠENOSTI NA KLINICE POPÁLENINOVÉ MEDICÍNY FAKULTNÍ NEMOCNICE KRÁLOVSKÉ VINOHRADY 2002–2016

Zajíček R., Grossová I., Šuca H., Kubok R., Pafčuga I.

Východiska: Dermální náhrada Integra® má široké spektrum využití jak v popáleninové medicíně, tak v rekonstrukční, plastické chirurgii a traumatologii. Od roku 2002 je součástí chirurgické léčby pacientů na Klinice popáleninové medicíny Fakultní nemocnice Královské Vinohrady.

Soubor: Integra® byla v období 2002–2016 použita celkem u 47 pacientů. Z toho 28 pacientů byly děti, 19 pacientů bylo starších 18 let. Jedenáct dětí bylo operováno v rekonstrukčním období, 8 dětí v rámci akutního úrazu. U 11 dospělých byla Integra® aplikována v rámci traumatu, u 9 při rekonstrukci. V roce 2016 bylo vyšetřeno celkem 11 pacientů léčených Integrou® v odstupu nejméně 2 roky od aplikace. Průměrná doba od aplikace byla 9 let. U všech kontrolovaných pacientů byla Integra® primárně použita při řešení akutního úrazu.

Metodika: U jednotlivých pacientů byly porovnávány jizvy po aplikaci Integry® s jizvou řešenou dermoepidermálním štěpem (DE). Vyhodnocení proběhlo na základě subjektivního a objektivního vyšetření pomocí modifikované Vancouverské škály (VSS). Byly odebrány vzorky na histologické a imunohistochemické vyšetření.

Výsledky: Podle VSS dosahovala místa s Integrou® průměrně 1,4 bodu. Jizvy po dermoepidermální transplantaci vykazovaly 4 body škály. Subjektivně pacienti funkční a kosmetickou kvalitu jizev ve všech případech uvedli jako lepší

v porovnání s DE transplantací. Histologickým vyšetřením byly zjištěny rozdíly mezi jizvami po aplikaci Integry® a DE štěpu, a to zejména v uspořádání a kvalitě kolagenních a elastických vláken a v revaskularizaci tkáně.

Závěr: Arteficiální kožní náhrada Integra® je nedílnou součástí chirurgické strategie řešení rozsáhlých popáleninových traumat a má významné využití v rekonstrukční chirurgii. Výsledná kvalita jizvy se zdá být při použití Integry® objektivně i subjektivně lepší než u DE transplantace.

MIKROMYCETÁRNÍ INFEKCE U PACIENTŮ S TERMICKÝM TRAUMATEM

Lipový B., Holoubek J., Řihová H., Kaloudová Y., Hanslianová M., Cvanová M., Jarkovský J., Suchánek I., Brychta P.

Cíl: Stanovit základní epidemiologické ukazatele u popálených pacientů s mikromycetární infekcí. Identifikovat nejdůležitější mikromycety u popálených pacientů.

Materiál a metodika: Monocentrická, retrospektivní studie, do které byli zařazeni všichni dospělí popálení pacienti, kteří byli hospitalizováni v letech 2007–2015 a u kterých byla v průběhu hospitalizace izolována mikromyceta. Pro hodnocení závažnosti termického traumatu byl použit ABSI (Abbreviated burn severity index). Výsledky byly statisticky zpracovány.

Výsledky: Celkem bylo ve sledovaném období identifikováno 61 pacientů s termickým traumatem, u kterých byla izolována kvasinka či vláknitá houba. Z tohoto počtu bylo 37 mužů a 24 žen (M:F ratio 1,5:1). Průměrný věk pacientů v souboru byl 57,3 let (29 pacientů bylo ve věku do 60 let, 32 pacientů ve věku nad 60 let včetně). Šest pacientů zemřelo (letalita byla 9,8 %). Průměrný rozsah popálené plochy byl 21,6 % TBSA (medián 14,0 %). U těchto pacientů bylo vykultivováno celkem 90 kmenů mikromycet (79 kvasinek, 11 vláknitých hub). U 30 pacientů byla mikromyceta izolována z popálené plochy, u 19 pacientů z dolních dýchacích cest, u 15 pacientů z urogenitální oblasti a u 7 pacientů z hemokultury. Mezi kvasinkami dominovaly kmeny non-albicans kandid (60 kmenů), *Candida albicans* byla izolována celkem 16x. U vláknitých hub to byly kmeny *Aspergillus fumigatus* (4x izolace) a *Fusarium sp*. (2x izolace).

Závěr: Podařilo se nám identifikovat základní epidemiologické ukazatele u popálených pacientů s mikromycetární infekcí, podobně jako nejvýznamnější kvasinky a vláknité houby, které způsobují infekci u těchto pacientů.

MIKRONEEDLING – FORMA KOLAGEN INDUKČNÍ TERAPIE JIZEV – NAŠE PRVNÍ ZKUŠENOSTI

Šuca H.

Východiska: Mikroneedling (perkutánní kolagen indukční terapie) je nová perspektivní miniinvazivní metoda léčby alterací kůže různé etiologie včetně jizev po popálení. Od roku 2016 je dostupná i na našem pracovišti. Mikrotraumatizace jizev nástrojem Dermaroller® vede k aktivaci kaskády hojení, uvolňování růstových faktorů aktivujících buněčnou proliferaci v jizvě, zvýšenou tvorbu a depozici kolagen-elastinového komplexu s následnou přestavbou kolagenu III na kolagen I, neoangiogenezi a tím urychlení remodelace jizvy.

Soubor a metodika: V pilotní studii provedené v roce 2016 byla metoda mikroneedlingu za pomoci nástroje Dermaroller® s 2,5milimetrovými jehlami použita u 6 pacientů (2 muži, 4 ženy, věk 25–73 let) se stabilizovanými jizvami po dermoepidermální autotransplantaci z důvodu termického zranění. Proces mikroneedlingu jsme opakovali ve třech sezeních s odstupem 6–8 týdnů, za použití topické anestezie.

Výsledky: Předběžné výsledky ukazují subjektivní zlepšení stavu jizev. Při objektivním hodnocení pomocí Vancouver Scar Score byl zaznamenán rozdíl se zlepšením průměrně o 2 body před a po výkonech.

Závěr: Na základě našich prvních klinických zkušeností se mikroneedling zdá být vhodnou miniinvazivní metodou vedoucí ke zlepšení kvality jizev po popáleninovém traumatu.

HISTORIE, SOUČASNOST A PERSPEKTIVY ČESKÉ POPÁLENINOVÉ MEDICÍNY

Brychta P.

Péče o popálené je ve většině rozvinutých zemí definována jako samostatný multidisciplinární obor (popáleninová medicína) a je koncentrována na specializovaná pracoviště, která disponují dostatečným personálním, prostorovým a přístrojovým vybavením. V bývalém Československu se od 50. let minulého století vybudovalo pět takových pracovišť, z toho tři v České republice (Praha, Ostrava, Brno). Obor se velmi úspěšně rozvíjel a získal renomé i v zahraničí, zejména díky nepřerušeným zahraničním kontaktům.

Od zhruba poloviny 90. let minulého století se vzestupný trend na jednu stranu zrychlil (nové technologie, lepší prostorové a přístrojové vybavení, přejímání nových poznatků ze zahraničí, atd.), na druhou stranu se projevují negativně zejména dvě tendence, a to jednak negativní ekonomická bilance péče o popálené, daná současným systémem financování zdravotnictví, jednak naprosto nevyhovující systém postgraduálního vzdělávání pro obor popáleninová medicína.

Tyto dva faktory vedou k nezájmu mladých lékařů o obor a hrozí jeho stagnace v případě, že nebudou pracoviště trvale alespoň ve vyrovnané ekonomické bilanci a nebudou mít co nabídnout mladým lékařům po stránce odměňování a dalšího profesního růstu.

KLÍČOVÁ SLOVA: česká popáleninová medicína, popáleninová centra, negativní ekonomická bilance, postgraduální vzdělávání

ZPRÁVA O STÁŽI V BROOKE ARMY MEDICAL CENTER V SAN ANTONIU, TEXAS, USA

Bajus A.

Krátká zpráva popisuje unikátní zkušenost v podobě návštěvy známého Brooke Army Medical Center (BAMC) v San Antoniu (Texas, USA) a jeho Popáleninového centra a Oddělení plastické chirurgie ve dnech 27. června až 26. srpna 2016.

INSTRUCTIONS TO THE AUTHORS

ACTA CHIRURGIAE PLASTICAE, 59, 1, 2017, p. 49-52

The journal *Acta Chirurgiae Plasticae* is an international journal of plastic surgery. It is published in English with Czech/Slovak structured abstracts four times a year. There are articles dealing with problems of plastic, reconstructive and aesthetic surgery, craniofacial surgery, hand surgery, microsurgery, burns and allied and cooperating fields of medicine. The journal accepts the following types of articles for publication: original scientific papers including experimental studies, case reports, review articles, discussions, reviews of domestic and foreign publications, news (invitations to specialized meetings, reports from congresses and meetings, letters to the editors, etc.) and other important information from the specialty. All articles are subject to a peer review procedure, whereas bilateral anonymity is maintained. The editorial board accepts articles in English, or possibly after a previous agreement also in Czech and Slovak languages. Only articles that have not been previously published elsewhere can be accepted.

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Title page must contain brief and clear name of the article (maximum 10 words), in the case reports this should be included in the name.

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Use metric units and SI units. Use only established abbreviations, do not use any abbreviations in the header and summary, in case of the first use of the abbreviation in the text, provide expanded version in brackets. List of abbreviations in alphabet order with explanation may be provided before the list of used literature. In case of medication it is necessary to provide a generic name and producer in the product name.

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Examples:

Petitti DB, Crooks VC, Buckwalter JG, Chiu V. Blood pressure levels before dementia. *Arch Neurol.* 2005 Jan;62(1):112-6.

Chapter in a book:

In the authors write their full surname, initials of the name without a full stop, between the authors put comma, after the last name put full stop. The name of the book is separated with a comma, number of issue is terminated with a full stop. City of issue and in round bracket country of issue and colon, publisher, semi-colon, year of issue, full stop, name of chapter, semi-colon and pages terminated with a full stop.

Examples:

Riffenburgh RH. *Statistics in medicine*. 2nd ed. Amsterdam (Netherlands): Elsevier Academic Press; c2006. Chapter 24, Regression and correlation methods; p. 447-86.

Book, monograph:

In the authors put full surname, initials of the name without a full stop, between authors put comma, after the last name put full stop. Name of the book is terminated with a full stop and number of issue is terminated with a full stop. City, colon, publisher, semi-colon, year of issue, full stop and total number of pages terminated with a full stop.

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EXAMPLES OF OTHER CITATIONS:

Article in electronic serial publication:

Polgreen PM, Diekema DJ, Vandeberg J, Wiblin RT, Chen YY, David S, Rasmus D, Gerdts N, Ross A, Katz L, Herwaldt LA. Risk factors for groin wound infection after femoral artery catheterization: a case-control study. Infect Control Hosp Epidemiol [Internet]. 2006 Jan [cited 2007 Jan 5];27(1):34-7. Available from: http://www.journals.uchicago.edu/ICHE/journal/issues/v27n1/2004069/2004069.web.pdf

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Richardson ML. Approaches to differential diagnosis in musculoskeletal imaging [Internet]. Version 2.0. Seattle (WA): University of Washington School of Medicine; c2000 [revised 2001 Oct 1; cited 2006 Nov 1]. Available from: http://www.rad.washington.edu/mskbook/index.html

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