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CASE REPORT / ПРИКАЗ БОЛЕСНИКА

Challenges in surgery of deep burns

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SUMMARY

Introduction Full-thickness burns pose a significant challenge in terms of surgical management, particularly when concurrent trauma of other organs is involved. Traditional treatment of deep burns includes early excision or debridement of necrotic tissue, followed by skin grafting or flap reconstruction. There are numerous challenges such as poor overall general condition, polytrauma, questionable wound bed viability, limited donor sites. Thus, we have to consider skin substitutes. INTEGRA® is an acellular dermal substitute which creates a native dermis. The aim of this case was to share our experience of the treatment by skin substitutes in a polytraumatized burn patient.

Case outline We present a case report of a 46-year-old man with severe work-related contact burn wounds associated with multiple rib and vertebral fractures, as well as lungs contusion with localized bilateral hemothorax. Patient suffered from third-degree burns to the lower extremities, extending to scrotal and gluteal area, which included 15% of the total body surface area. The patient underwent early excision of necrotic tissues with subsequent skin autografting on the right leg; however, due to partial failure of autografts, we had to perform allografting followed by autografting because of limited local donor sites and poor general condition. Successive debridement and partial osteotomy resulted in the left knee defect with exposed patella. Therefore, in order to reconstruct the consequent defect and prevent joint contracture, the defect was finally covered by INTEGRA®.

Conclusion Our experience has highlighted that INTEGRA® prevents functional disability and furthermore, it leads to optimal aesthetic results.

Keywords: INTEGRA®; full-thickness burns; exposed bone; skin grafts; reconstruction

INTRODUCTION

Understanding of the pathophysiological abnormalities occurring not only locally but also systematically after burn injury is essential and leads to optimal treatment of burn patients [1]. Full-thickness burns pose a significant challenge in terms of surgical management in modern burn care [2]. Since burn illness may be greatly complicated by the persistence of an open wound due to malnutrition and bacterial invasion, the wound must be promptly closed. It would be of great importance to reduce the severity of hypertrophic scarring, postburn contractures, as well as promote faster rehabilitation [3]. Therefore, as soon as the overall status of the patient permits it, full-thickness burns should be prepared for debridement followed by autografting or flap reconstruction. However, these options may not be suitable for every patient. There are numerous challenges, which limit standard methods of repair, such as concurrent trauma of other organs, poor general condition, questionable underlying wound bed viability, limited donor sites; thus, we have to consider skin substitutes. Skin substitutes remain a fundamental part of the burn therapy system. They vary from skin allografts over xenografts to the dermal matrix [4]. Their common role is to overcome these challenges, with the greatest possible functional and aesthetic outcomes [5].

The aim of this report was to share our experience of the treatment by skin substitutes in the polytraumatized burn patient.

CASE REPORT

We present a case report of a 46-year-old man whose both legs, gluteal, and scrotal area were crushed by a glowing-hot metal construction at his work place.

Initially, the patient was referred to the Emergency Center under polytrauma alert, where he was examined by a neurosurgeon, an orthopedic surgeon, a thoracic surgeon, and an anesthesiologist. An X-ray of the thorax, ultrasound of abdomen, and multidetector computed tomography of the cervical spine revealed evidence of multiple rib and vertebral fractures, as well as lungs' contusion with localized bilateral hemothorax.

Due to the nature of the injuries, the patient was admitted and evaluated at our clinic 6.5 hours after the accident. The patient suffered third-degree contact burns with total burned body surface area of 15%, including the lower extremities, gluteal, and scrotal area (Figures 1A and 1B). At the fifth posttraumatic day, after bilateral thoracentesis, which had to be performed, patient underwent surgical debridement, followed by autografting on his right leg to the level of the fascia; the left thigh served as

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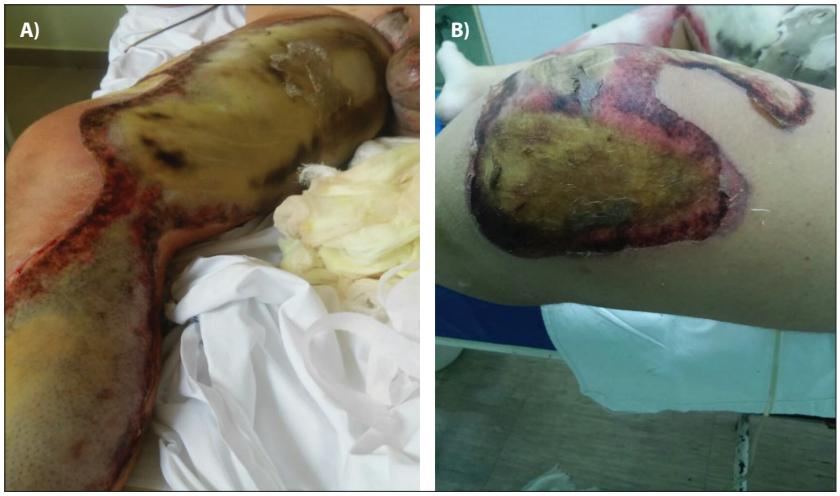

Figure 1. Local status on admission: third-degree burns to the lower extremities, scrotal, and gluteal area, which covered 15% of the total body surface area; patient on admission: A) right leg; B) left knee

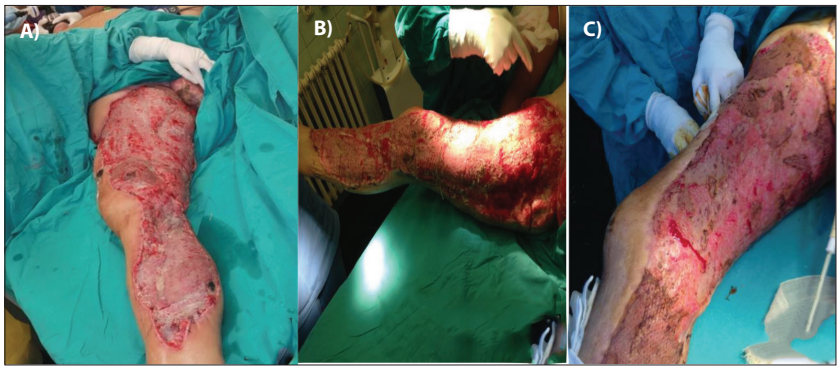

Figure 2. A: Fifth post-traumatic day – the right lower extremity after autografting; B: 12th day after autografting; partial failure of autografts; we performed allografting with fresh donor skin; C: status post allografting followed by autografting

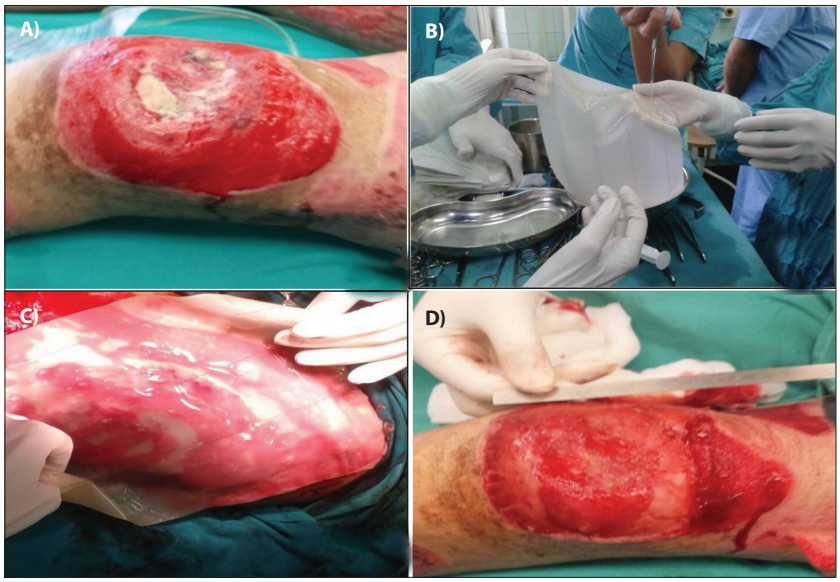

Figure 3. A: Radical debridements and partial ostectomy resulted in the left knee defect with exposed patella; B: in the preoperative planning, an INTEGRA patch of 20 × 15 cm in size was selected; C: placement of the INTEGRA matrix; the defect of the left knee that was managed with the INTEGRA matrix; D: status – post INTEGRA matrix placement; 18th day after initial INTEGRA matrix placement; the INTEGRA matrix had incorporated; treated area led to neodermis formation, which measured 22 × 18 cm

the donor site (Figure 2). Twelve days after autografting, due to partial failure of the autografts, we had to perform allografting, because of poor general condition and the limitation of the local donor site (Figure 2A). On the 23rd hospitalization day, autografting was performed again (Figure 2B), and the result was stable epithelium on the right lower extremity. Dressing changes were performed throughout treatment. Scrotal and gluteal areas were successfully reconstructed by autografting.

Furthermore, successive debridements and partial otectomy resulted in the left knee soft tissue defect with exposed patella (Figure 3A).

Our patient was not a candidate for flap reconstruction, because there were scars from previous donor sites. Therefore, we considered dermal replacement matrices in order to augment and improve the regeneration of the dermis. After 30 days, anterior part of the left knee after osteotomy was covered by the INTEGRA^{R} matrix (LifeSciences, Plainsboro, NJ, USA). An INTEGRA^{R} patch 20 × 15 cm in size (Figure 3B) was placed over the gap of 7 × 5 cm with exposed bone, thereafter affixed and covered with an antimicrobial dressing (Figure 3C). No vacuum therapy was performed. The wound was inspected five days after the placement of the INTEGRA^{R} matrix. On the 18th postoperative day, the outer silicon layer was removed and neodermis was formed, which measured 22 × 18 cm (Figure 3D). Ultrathin split-thickness skin 1:1.5 meshed autograft, harvested from the left calf, was applied over the neodermis. The wound was completely healed with stable coverage. Postoperative course was uneventful, and a six-month follow-up revealed resistant tissues on both sides, right and left. With no contracture, with normal skin pliability and normal range of movement, but also with superior quality of scars on the side treated by the INTEGRA^{R} matrix. We were more satisfied with the side covered by the INTEGRA^{R} matrix.

We confirm that we have read the journal's position on issues involving ethical publication and affirm that this work is consistent with those guidelines. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration

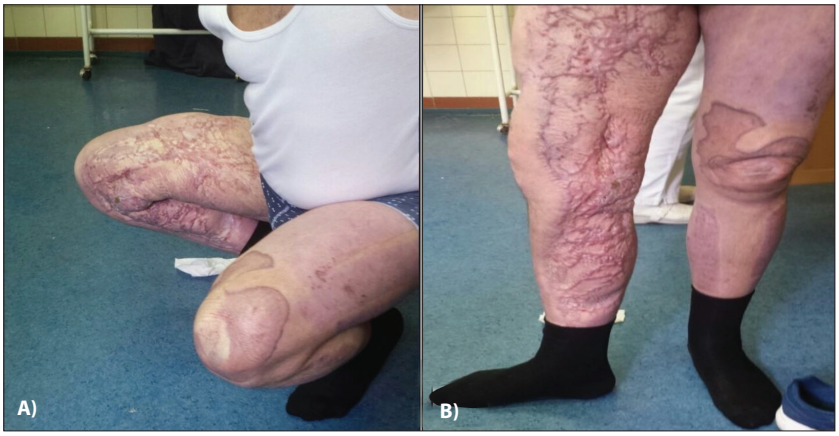

Figure 4. Ambulatory follow-up after six months; full range of motion of the left knee joint without contracture as well as satisfactory aesthetic result (A); comparing the quality of scars, skin texture, and pliability on the right and the left side show better results on the left side (B)

and its later amendments or comparable ethical standards. Written consent to publish all shown material was obtained from the patient.

DISCUSSION

Burn wound closure within the first five days is optimal, but this is often difficult to achieve in polytrauma patients, with concurrent traumatic injuries. Although debridement of full-thickness burns and autologous grafting remains the gold standard for treatment of third-degree burns, there are some challenging occasions, when we have to use skin substitutes with biological properties. Whenever the available skin donor sites are limited or the overall patient condition does not permit the coverage of excised burn wounds with autologous skin, there may still be a clinical demand for human allograft skin as a temporary biologic dressing [6]. As there is no skin bank in our country, we used skin allografts from living human donors.

Regarding the depth, reconstruction of soft tissue defects, resulting from the debridement of full-thickness burns, may extend deeper, to exposed bone, with denuded periosteum. These defects are not amenable to skin grafting; thus, a flap is needed, which is already standard care for lower-extremity injuries with exposed bone [7–10]. However, this option may be unavailable because of not only inadequate adjacent tissues but also due to poor overall condition or is technically difficult to perform [11]. Lee et al. [10] presented that INTEGRA^R matrix provides stable, long-term coverage for lower-limb burn injuries with exposed structures, with better aesthetic results compared to prolonged granulation followed by skin grafting or bulky tissue flaps, and allows the coverage of vital structures when flaps are unavailable or not a good option. Guerra et al. [11] have also noted an extraordinary capacity for INTEGRA^R to bridge avascular gaps in the wound bed in very deep burns to the extremities over small areas of bone and tendon. Interestingly, we highlighted the area with exposed bone without periosteum on the left knee, which was covered by INTEGRA^R, because our patient was not a candidate for flap reconstruction. Accordingly, as in our case, INTEGRA^R may be indicated to cover deep wounds, especially in weakened patients who are not eligible for flap rearrangement [12]. Regarding the anatomical site, the knee is largely a subcutaneous joint, which has to be promptly and properly covered with well-vascularized tissue. Various options have been used in the reconstruction of these defects: local muscle flaps, fasciocutaneous flaps, and free flaps [13, 14]. Products such as INTEGRA^R achieved optimal results, which "challenge the current gold-standard treatment" for lower-extremity defects with the anti-scarring effects – thus, they promote better aesthetic results with less resultant scarring [15].

INTEGRA^R artificial skin was developed by the cooperative work of the Massachusetts General Hospital and the Institute of Technology in the 1970s. Additionally, the first described use of INTEGRA^R was by Yannas and Burke [16]. INTEGRA^R dermal regeneration template is a dual-layer regeneration template composed of cross-linked bovine collagen and glycosaminoglycan from shark cartilage coated with an outer thin temporary epidermal substitute layer of a polysiloxane polymer (silicone) [16]. Its architecture provides ideal physicochemical conditions, leading to dead space elimination, control of bacterial invasion, prevention of water loss, while simultaneously ensuring cell migration with vascular growth, which are important for neodermis formation. Since its introduction in 1981, it has been successfully used for burn injuries [17]. Infection remains the most common complication of INTEGRA^R use, underlining the need for careful wound bed excision and meticulous hemostasis [18]. Despite, the main reason for its limited use in clinical practice is certainly its high cost [19]. However, since the introduction, several studies have been published from all over the world, proving its ability to vascularize over small areas of exposed bone and tendon [10, 11, 20, 21]. Ben-Nakhi and Eltayeb [21] concluded that INTEGRA^R was easy to use, safe, and effective when used over exposed underlying structures in the wound bed, including bones, tendons, and joints.

As in our case, many reports suggest that long-term results using INTEGRA^R lead to skin elasticity with no evidence of hypertrophic scar formation or clinical contracture [22]. There is some evidence which described combined application of negative pressure wound therapy (NPWT) and dermal substitutes [23]. NPWT is the application of a negative pressure across a wound to improve tissue repair and regeneration. The first commercially available NPWT device marketed in the United States was the Vacuum-Assisted Closure (VAC). Therefore, VAC uses

negative pressure to prepare the wound for spontaneous healing or for other reconstructive options.

Early surgical debridement was of great importance for patient survival. Unlike standard methods of repair, we used alternative methods such as skin substitutes as well. Further, our case showed that the INTEGRA^{R} matrix prevents functional disability and, furthermore, it leads to optimal aesthetic results.

Conflict of interest: None declared.

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Изазови у хирургији дубоких опекотина

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САЖЕТАК

Увод Опекотине пуне дебљине коже представљају значајан изазов у погледу хируршког лечења, посебно када истовремено постоје и повреде других органа. Традиционални третман дубоких опекотина укључује рану ексцизију или дебридман некротичног ткива, после чега следи пресађивање коже или реконструкција режњем. Постоје бројни изазови, као што су лоше опште стање пацијента, повреде других органа, упитна вијабилност подлоге ране, ограничене давајуће регије, када морамо узети у разматрање супституенте коже. ИНТЕГРА је ацелуларни дермални супституент која ствара нативни дермис.

Циљ овог рада је био да поделимо наше искуство лечења супституентима коже код политрауматизованог пацијента са опекотинама.

Приказ болесника Приказујемо 46-годишњег мушкарца са тешким контактним опекотинским ранама заједно са вишеструким преломима ребара и пршљенова, као и контузијом плућа са локализованим билатералним хемотораксом. Пацијент је задобио опекотине трећег степена доњих екстремитета, које су захватале скротални и глутеални део и обухватиле 15% укупне површине тела. Подвргнут је раној ексцизији некротичног ткива десне ноге са накнадном аутотрансплантацијом коже, међутим, због делимичног лизирања аутотрансплантата били смо принуђени да урадимо алотрансплантацију праћену каснијом аутотрансплантацијом због ограничених места давајуће регије и лошег општег стања пацијента. Сукцесивни дебридмани и парцијална остектомија довели су до дефекта левог колена са експонираном пателом. Дакле, у циљу реконструкције последичног дефекта и превенције контрактуре зглоба, дефект је финално покривен ИНТЕГРОМ.

Закључак Наше искуство је показало да ИНТЕГРА спречава функционалну онеспособљеност и, поред тога, доводи до оптималних естетских резултата.

Кључне речи: ИНТЕГРА; опекотине пуне дебљине коже; експонирана кост; кожни трансплантати; режњеви; реконструкција