**ABSTRACT**

**Introduction.** Skin and soft tissue defects in lower extremity are challenging clinical situations that have to be dealt with on an individual basis. Closure technique must be tailored to the wound size, location and etiology, and also to the patient’s characteristics (age, other comorbidities etc.). This paper aims at emphasizing the clinical particularities of lower extremity wound closure in children.

**Material and methods.** We review the clinical data, surgical strategy and operative staging, and also the postoperative outcome of three cases of children (aged between 4 and 9 years old) with skin and soft tissue defects caused by trauma and infection, operated in our department in 2017.

**Results.** The three patients presented with lower leg and anterior foot skin and soft tissue defects, ranging from 5 to 10 cm on the long axis, with deep involvement (including joint exposure in one of them). Etiology was traumatic in two cases, one complicated by infection due to inappropriate initial cure. In the third case, the skin defect was caused by foot cellulitis that was incised and debrided in another hospital, and was referred to us for closure of the remaining uncovered wound. The surgical approach was to use local flaps and skin grafts, alone or combined, after

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**RéSUMÉ**

**Introduction.** Les pertes cutanées et des tissus mous des membres inférieurs chez l’enfant – série des cas

**Introduction.** Les pertes cutanées et des tissus mous des membres inférieurs sont des situations cliniques difficiles qui doivent être traitées individuellement. La technique de fermeture doit être adaptée à la taille, à la localisation et à l’étiologie de la plaie, ainsi qu’aux caractéristiques du patient (âge, autres comorbidités etc.). Cet article vise à mettre en évidence les particularités cliniques de la fermeture de la plaie des membres inférieurs chez l’enfant.

**Matériel et méthodes.** Nous passons en revue les données cliniques, la stratégie chirurgicale et les étapes chirurgicales, ainsi que les résultats postopératoires de trois cas d’enfants (âgés de 4 à 9 ans) présentant une lésion de la jambe et des tissus mous causée par traumatisme et infection, opérés dans notre service en 2017.

**Résultats.** Les trois patients présentaient des pertes cutanées et des tissus mous de la jambe et du pied antérieur, allant de 5 à 10 cm sur le grand axe, avec une atteinte profonde (incluant une exposition articulaire chez l’un d’entre eux). L’étiologie était traumatique dans deux cas, l’un compliqué d’une infection due à
Surgical strategy for lower extremity skin and soft tissue defects in children – case series – TATAR et al

INTRODUCTION

Skin and soft tissue defects in lower extremity are challenging clinical situations that have to be dealt with on an individual basis. Reduced skin laxity and difficulty to mobilize the tissues are features forcing the surgeon to choose more complicated closing protocols or to combine various surgical methods. The closure technique must be tailored to the wound size, location and etiology, in order to obtain a good functional and aesthetic result for the patient and his/her family, as well as for the treating physician.

Keywords: lower extremity, trauma, children, soft tissue defects, reconstruction, coverage.

Conclusions. Surgical protocol for closing lower extremity skin and soft tissue defects raises technical problems, even in the young patient. However, a careful planning of closure steps and preparation of good quality underlying tissues may ensure fast and satisfactory results for the patient and his/her family, as well as for the treating physician.

Mots-clés: membre inférieur, traumatisme, enfant, pertes des tissus mous, reconstruction, champs d’application.

INTRODUCTION

Skin and soft tissue defects in lower extremity are challenging clinical situations that have to be dealt with on an individual basis. Reduced skin laxity and difficulty to mobilize the tissues are features forcing the surgeon to choose more complicated closing protocols or to combine various surgical methods. The closure technique must be tailored to the wound size, location and etiology, in order to obtain a good functional and aesthetic result in the shortest time, without any local complications. Other characteristics of the patient like age, other comorbidities etc. should also be taken into account.

Lower leg defects in children are most of the time a consequence of trauma (i.e. outdoor play accidents, sports accidents, car crushes etc), which makes the wound to be highly contaminated from the very beginning. Therefore, the potential infectious risk must be managed very carefully, especially because local soft tissue infection may lead to further skin loss and a greater defect to be covered subsequently. Moreover, traumatic injuries in children have their own particular elements to be considered, related to the developmental stage, further growth projection and functional impact of the scar. The reconstruction can be made immediately or after several days, as delayed primary closure, depending on the local conditions (tissue viability, microbiological status of the wound, anatomic elements involved that need to be covered). Wound healing and scar formation in children are favoured by the presence of many growth factors that enhance tissue regeneration process and also the recovery is better in this group of patients. On the other hand, in pediatric patients it is very important to ensure soft tissue and skin closure without wound tension. Otherwise, an initially convenient scar may turn, over the years, into a wide hypertrophic or keloid scar, generating in the long run a poor cosmetic outcome under the mechanical effects of the forces produced by body growth. Considering all these elements, this paper aims to emphasize the clinical particularities of lower extremity wound closure in children.

MATERIAL AND METHOD

We review the clinical data, surgical strategy and operative staging, and also the postoperative outcome of three cases of children (aged between 4 and 9 years old) with skin and soft tissue defect caused by trauma and infection, treated as inpatients in the Plastic Reconstructive Surgery and Burns Department from “Grigore Alexandrescu” Clinical Emergency Hospital for Children, Bucharest, in 2017.
RESULTS

Case 1

A 4-year-old girl, with no previous history of illness, victim of a car accident is transferred to our pediatric plastic surgery clinic with extensive skin and soft tissue defects of the anterior right foot, absence of extensor tendon of the first toe and fractures of phalanges and first metatarsal bone. The metatarsal-phalangeal joint was visible in the wound (Fig. 1). After repeated thorough debridement and reassessment, aimed at obtaining healthy granulation tissue, 11 days after the trauma (Fig. 2), the exposed bones are covered with local rotation flaps and the remaining defect is closed with intermediate split thickness skin graft harvested from the right thigh with the electrical dermatome (Fig. 3). Bone fracture healing was ensured by immobilizing the foot and leg with external splints. After 1 month we can see good healing, convenient graft retraction and also a good cosmetic aspect (Fig. 4), considering the starting point and missing structures (nail).

Case 2

A 9-year-old previously healthy boy is transferred to our service 8 days after the abscess he developed on his left anterior foot (supposedly after an insect
A bite or a minor metallic object prick was incised and drained in a regional hospital. After remission of infectious and inflammatory syndrome, he was referred to our department for coverage of the extensive skin defect that measured 10/17 cm (Fig. 5). The skin edges surrounding the defect still revealed signs of necrosis and were thoroughly debrided until healthy tissue was found. Wound culture performed on the day of admission in our clinic revealed no remaining bacterial infection. At 9 days after admission, under general anesthesia, after careful debridement, the skin defect is closed with intermediate split thickness skin graft harvested with the electrical dermatome from the left thigh (Fig. 6). He was discharged 8 days postoperatively, with good general state and good graft take.

**Case 3**

A 5-year-old boy, with no previous history of illness, is admitted to our service 7 days after he suffered a bicycle accident that lead to a loss of skin on the right lateral malleolus (Fig. 7), poorly treated at home (some hydrogen peroxide and iodine solution applied initially, with no dressing and no resting or horizontal positioning of the leg). Our first assessment revealed a circular necrotic area and moderate perilesional edema and pain, still persisting after one week, visible especially when compared with the healthy leg. Initial care included debridement and removal of necrotic tissues under local anesthesia, with a remaining skin and soft tissue defect of about 4 cm diameter and 2 cm depth. 3 days after admission, considering the surface and depth of the defect (Fig. 8), we ruled out the possibility of direct closure. At the same time, a skin graft would have left a depressed surface, so we also discarded this option. A single rotation flap was difficult to mobilize in that area without important tension in the suture line. Therefore, we finally chose the solution of two opposite rotation flaps sutured on the midline (O-to-Z plasty, Fig. 9). Later evolution showed good healing, with no vascular suffering on the distal part of the flaps, complete remission of the perilesional edema and good scar appearance 1 month postoperatively (Fig. 10).

All surgeries were performed under general anesthesia, considering the young age of the patients. At
the same time, in order to limit the operative bleeding, the interventions were all performed using the hemostatic tourniquet. For infection control we used systemic wide spectrum antibiotics (ceftriaxone) and we chose the delayed closure strategy, in order to prepare good underlying soft tissues to be covered with split thickness skin grafts and/or local flaps. The hospital staying ranged from 5 to 20 days, with faster discharge for the case without skin graft. At the time of discharge, all wounds were completely healed, we did not observe any operative or postoperative complications; there was no wound dehiscence after stitch and/or staple removal.

**DISCUSSION**

When facing a skin and soft tissue defect, the plastic surgeon always has to consider the reconstructive ladder, starting with the simplest solutions. For the lower extremity, direct suture and healing by secondary intention are often put aside because of the local characteristics of the skin. In the lower leg and foot, tissue extensibility is very limited when compared to other anatomical segments. Also, healing occurs more slowly because the lower extremity has to bear all body weight and because the skin in this area has a relatively poor circulation. Moreover, when the cause that led to the skin and soft tissue damage is an injury that sometimes associates microbial and particulate contamination, it becomes impossible to bring the wound edges together without tension. From the same reasons, immediate primary closure has to be discarded until the wound bed is completely clean microbiologically. Afterwards, a delayed primary closing technique has to be chosen.

Large defects can be covered conveniently with skin grafts, either split thickness (STSG) or full thickness (FTSG), when the underlying tissues are well prepared and do not include functional structures. For our second case we used STSG, since the surface of the defect was too large to allow harvesting of FTSG, this being a recognized indication for STSG in children, who present better healing aspects as compared to the adult patients. The disadvantages of this method are related to the donor site morbidity and to the fact that skin grafts in the lower leg show longer healing time. At the same time, STSG retract over time, they grow in a slower rate than normal skin and they need to be actively monitored until the child reaches the adult age. When the tendons, bones or joints are exposed, they have to be protected by local flaps in order to avoid fibrosis and functional impairment, as we did with the first patient, where we combined flaps and STSG.

Smaller defects can be solved with local rotational flaps. When local and technical issues interfere, such as insufficient skin elasticity, length of the incision needed to mobilize the flap or tension in the suture, we can combine two opposite flaps, as the O to Z plasty or the double helix flaps, in order to close the wound without tension and to avoid long-term complications like dehiscence, distal flap necrosis or scar enlargement. The O to Z plasty was the technical choice for our third patient. This particular solution also avoids the morbidity related to the donor site of the skin graft and local flaps in general lead to faster healing and early hospital discharge, which was noted in our case as well.

An important element, common for all situations of lower extremity traumatic injuries, is bed rest and splinting when bone fractures are present. Children may be less compliant with this measure that helps for resolution of perilesional edema, responsible for local discomfort and pain. If posttraumatic edema persists for a longer time, it may impair graft take or surgical wound healing.

After the complete wound healing and graft take, all our patients were instructed to start the scar prevention program using silicone sheets and pressure garments, in order to prevent retractions or hypertrophic scars, both on the initial defect and on the donor site, in the two cases where skin grafts were needed. The child and the parents usually show good compliance with these scar therapies. The risk of scar enlargement and excessive scar growing is a disadvantage when dealing with pediatric patients and close follow-up during childhood and teen years is necessary for preventing subsequent functional or cosmetic impairment.

Anesthesia is also an important issue when dealing with skin and soft tissue defects in children. In adults with similar conditions, the local or regional anesthesia, accompanied or not by sedation, may be a convenient alternative. However, in very young patients, as it was the situation with all our cases, the psychological stress and the anxiety keep them from relaxing and staying still for longer periods of time. Under these circumstances, general anesthesia remains the only reasonable option, especially when we also have to perform skin graft harvesting, which implies practically two operatory fields. This approach gives the operative team and also the patient a better comfort during surgery.

**CONCLUSIONS**

Surgical protocol for closing lower extremity skin and soft tissue defects raises technical problems, even in the young patient. The purpose for any
therapeutic intervention is to provide fast functional recovery and also a satisfactory esthetic appearance, while keeping in mind to minimize donor site morbidity, when necessary. The child’s fast healing capacity has to be considered against his/her further growing and body development, in order to avoid wound tension and subsequent scar enlargement and keloid formation. However, a careful assessment of patient’s individual features and characteristics of the defect, together with a thorough planning of the closure steps, preparation of good quality underlying tissues and long-term follow-up may ensure fast and satisfactory results for the patient and his/her family, as well as for the treating physician, both on short-term as well as in the long run.

Compliance with Ethics Requirements:

“The authors declare no conflict of interest regarding this article”

“The authors declare that all the procedures and experiments of this study respect the ethical standards in the Helsinki Declaration of 1975, as revised in 2008(5), as well as the national law. Informed consent was obtained from all the patients included in the study”

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