

CASE SERIES

SURGICAL STRATEGY FOR LOWER EXTREMITY SKIN AND SOFT TISSUE DEFECTS IN CHILDREN – CASE SERIES

Raluca T. TATAR^{1,2}✉, Doina I. NACEA¹

¹ Grigore Alexandrescu Clinical Emergency Hospital for Children, Bucharest, Romania

² Carol Davila University of Medicine and Pharmacy, Bucharest, Romania

Received 13 Apr 2019, Accepted 24 May 2019

<https://doi.org/10.31688/ABMU.2019.54.22>

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

RÉSUMÉ

Stratégie chirurgicale des 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 peau 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

✉ Address for correspondence:

Raluca TATAR
Grigore Alexandrescu Clinical Emergency Hospital for Children, Plastic
Reconstructive Surgery and Burns Clinic, Bucharest, Romania
Address: Bd. Iancu de Hunedoara, no. 30-32, Bucharest, Romania
Email: ralu.tatar@gmail.com; Phone 0744636709

thorough debridement and removal of all infected and devitalized tissue, combined with systemic antibiotics. Postoperative assessment at 1-2 months showed very good graft take and convenient scar appearance, with no functional impairments and no other complications.

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.

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

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 laxity¹ and difficulty to mobilize the tissues² 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

la cure initiale inappropriée. Dans le troisième cas, le défaut cutané était causé par une cellulite du pied incisée et débridée dans un autre hôpital, qui nous avait été adressé pour la fermeture de la plaie restante. L'approche chirurgicale consistait à utiliser des lambeaux locaux et des greffes de peau, seuls ou combinés, après un débridement complet et l'élimination de tous les tissus infectés et dévitalisés, associés à des antibiotiques systémiques. L'évaluation postopératoire à 1-2 mois a montré une très bonne prise de greffe et un aspect convenable de la cicatrice, sans altération fonctionnelle ni d'autres complications.

Conclusions. Le protocole chirurgical de fermeture des pertes cutanées et des tissus mous des membres inférieurs pose des problèmes techniques, même chez le jeune patient. Cependant, une planification minutieuse des étapes de fermeture et la préparation de tissus sous-jacents de bonne qualité peuvent garantir des résultats rapides et satisfaisants pour le patient et sa famille, ainsi que pour le médecin.

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

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 process³ 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 growth³. 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.



Figure 1. Admission day 1.



Figure 2. Admission day 11, preoperative aspect.



Figure 3. Immediate postoperative aspect, with local flaps covering the metatarsal-phalangeal joint and STSG for the remaining defects.



Figure 4. Final result – 1 month after the reconstruction.

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



Figure 5. Initial assessment, 8 days after an anterior foot abscess has been incised.



Figure 6. 5 days after surgery, graft take already visible.

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



Figure 7. At presentation, 7 days after the bike accident.



Figure 8. Admission day 3 – preoperative planning of the incisions for the O-to-Z plasty.



Figure 9. Postoperative aspect after flap mobilization and suture.



Figure 10. Final result, 1 month after the surgery

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^{4,5}. 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 segments¹. 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 circulation⁶. 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)⁵, 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 patients⁷. 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 time⁸. 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 age⁷. When the tendons, bones or joints are exposed, they have to be protected by local flaps⁹ 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^{1,3,10}, 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 plasty¹¹ or the double helix flaps^{2,8}, in order to close the wound without tension and to avoid long-term complications like dehiscence, distal flap necrosis or scar enlargement¹¹. 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 discharge¹⁰, 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 healing⁵.

After the complete wound healing and graft take, all our patients were instructed to start the scar prevention program using silicone sheets and pressure garments¹², 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 therapies¹³. 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 impairment³.

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^{14,15}. 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“

„No funding for this study“

REFERENCES

1. Rao K, Tillo O, Dalal M. Full thickness skin graft cover for lower limb defects following excision of cutaneous lesions. *Dermatology Online Journal* 2008;14(2):4.
2. Cecchi R, Bartoli L, Brunetti L. Double helix flaps for lower leg defects: report of 4 cases. *J Cutan Aesthet Surg.* 2013;6(3):164-165.
3. Sanchez J, Antonicelli F, Tuton D, Mazouz Dorval S, François C. Particularités de la cicatrisation de l'enfant. *Ann Chir Plast Esthet.* 2016;61(5):341-347.
4. Thorne Ch. Techniques and principles in plastic surgery, in Grabb and Smith's Plastic Surgery, 7th Edition, Lippincott Williams & Wilkins, Philadelphia, 2014, 1-1.
5. Blume PA. Skin grafts. In Lower Extremity Soft Tissue & Cutaneous Plastic Surgery 2nd edition, Dock Dockery G, Crawford ME Editors, Saunders Elsevier, 2012, 217-224
6. Bhandari PS, Bath AS, Sadhotra LP et al. Management of soft tissue defects of the ankle and foot. *Med J Armed Forces India.* 2005; 61(3): 253-255.
7. Depoortère C, François C, Belkhou A, Duquennoy-Martinot V, Guerreschi P. Particularités de la greffe cutanée en chirurgie plastique pédiatrique. *Ann Chir Plast Esthet.* 2016;61(5):722-731
8. Cecchi R, Bartoli L, Brunetti L, Troiano G. Reconstruction of a large leg defect with a combined hatchet flap technique. *Dermatology Online Journal.* 2017;23(4):3.
9. Brongo S, Pagliara D, Campitiello N, Rubino C. Reconstruction of traumatic defect of the lower third of the leg using a combined therapy. *Case Reports in Surgery.* 2014, article ID 783812.
10. Penington AJ, Mallucci P. Closure of elective skin defects in the leg with a fascio-cutaneous V-Y island flap. *Br J Plast Surg.* 1999;52(6):458-461/
11. Dock Dockery G. Excisional techniques and procedures. In Lower Extremity Soft Tissue & Cutaneous Plastic Surgery 2nd edition, Dock Dockery G, Crawford ME Editors, Saunders Elsevier, 2012, 113-126
12. Berman B, Viera MH, Amini S, Huo R, Jones IS. Prevention and management of hypertrophic scars and keloids after burns in children. *J Craniofac Surg.* 2008;19(4):989-1006.
13. Kerfant N, Lentini A, Le Nen D, Henry AS, Trimaille A, Hu W. Reconstruction des traumatismes complexes des membres inférieurs chez l'enfant. *Ann Chir Plast Esthet.* 2016;61(5):536-542.
14. Salazard B. La chirurgie plastique de l'enfant. *Ann Chir Plast Esthet.* 2010;55:461-470.
15. Chariker ME, Gerstle TL, Morrison CS. An algorithmic approach to the use of gauze-based negative-pressure wound therapy as a bridge to closure in pediatric extremity trauma. *Plast Reconstr Surg.* 2009;123(5):1510-20.