DOI: 10.17816/PTORS5139-44

FREE SKIN GRAFTING IN RECONSTRUCTIVE SURGERY OF BURNS IN CHILDREN

© *K.A. Afonichev, M.S. Nikitin, Ya.N. Proshchenko*

The Turner Scientific and Research Institute for Children's Orthopedics, Saint Petersburg, Russia

For citation: Pediatric Traumatology, Orthopaedics and Reconstructive Surgery, 2017;5(1):39-44

Received: 09.01.2017
Accepted: 15.02.2017

When performing reconstructive surgery in children suffering from extensive post-burn hypertrophic scars, the main problem is deficiency of donor intact skin.

Aim. This study aimed to determine the possibility of using the expander skin balloon expansion method for obtaining free, large area split-thickness skin autografts.

Materials and methods. A comparative analysis of treatment for 39 children with extensive post-burn hypertrophic scars was performed. In 16 children (experimental group), balloon skin expansion of a donor site for obtaining large area split-thickness skin grafts (more than 100 cm^2) was performed. In 23 children (control group), the large area grafts were cut off without prior balloon skin expansion of the donor site.

Results. In cases where it is necessary to close a wound defect over 100 cm^2, it is advisable to perform prior balloon skin expansion of the donor site. This technique enables attainment of an injury-resistant free implant full grafting material and also provides multiple uses of a donor site without disturbing the esthetics.

Keywords: thermal injury, hypertrophic scars, cicatricial deformities, balloon skin expander.

К ВОПРОСУ СВОБОДНОЙ КОЖНОЙ ПЛАСТИКИ В РЕКОНСТРУКТИВНОЙ ХИРУРГИИ ОЖОГОВ У ДЕТЕЙ

© *К.А. Афоничев, М.С. Никитин, Я.Н. Прощенко*

ФГБУ «НИДОИ им. Г.И. Турнера» Минздрава России, Санкт-Петербург

Статья поступила в редакцию: 09.01.2017

Статья принята к печати: 15.02.2017

При выполнении реконструктивных оперативных вмешательств у детей, страдающих от обширных послеожоговых гипертрофических рубцов, главной проблемой является дефицит донорских резервов — неизмененной кожи.

Цель: определить возможности использования метода экспандерной дермотензии при получении свободных толсто-расщепленных кожных аутотрансплантатов большой площади.

Материалы и методы. Проведен сравнительный анализ лечения 39 детей с обширными послеожоговыми гипертрофическими рубцами. У 16 детей (основная группа) первым этапом выполнена дермотензия донорской области для получения толсто-расщепленного кожного трансплантата большой площади (более 100 $см^2$). У 23 детей (контрольная группа) трансплантаты большой площади срезались без предварительной дермотензии донорской области.

Результаты исследования показали, что при необходимости закрытия раневого изъяна площадью более 100 $см^2$ целесообразно выполнять предварительную экспандерную дермотензию донорского места. Эта методика позволяет не только получить резистентный к травме свободной имплантации полноценный пластический материал, но и обеспечивает многократную эксплуатацию донорской области, не нарушая эстетику последней.

Ключевые слова: термическая травма, гипертрофические рубцы, рубцовые деформации, экспандерная дермотензия.

Despite the appearance and improvement of various options for the flap technique for the integumentary tissues, the almost common usage of grafting in microvascular anastomoses, the time-tested free cutaneous autografting technique remains the basic arsenal of surgical techniques for the reconstructive surgery of burns. Indications for the latter occur in those frequent cases of extensive scar degeneration in the skin in which the technique of grafting with local tissues (including the expander flap) is impossible and the implementation of flap grafting "from afar" is unreasonably difficult and risky. In this case, only the use of full-layered or split-thickness skin grafts meets the requirements for restoration of the skin, which qualities approach to the full repair of the skin [1]. In real clinical practice, the use of this surgical technique can often be very difficult. This is particularly true for reconstructive surgery in young patients. The main reason for this difficulty is the scarcity of donor reserves almost always found in convalescents after extensive burns: donor sites (areas of intact skin) are small and located far from the affected segment. Mostly, the areas of full-fledged skin alternate with inactive planar scar arrays or localize in areas important in the functional and/or aesthetic sense. Under these conditions, taking a free full-layer skin graft with an area of more than 100 cm^2 is an extremely difficult technical task. The surgeon who finds himself in such a difficult situation has two variants of the solution (if it is a traditional approach). First, after taking a full-layer skin graft, the wound can be sutured "toward oneself" with considerable tension in the suture line. In this approach, the formation of a hypertrophic scar at the site of the postoperative suture is inevitable [2, 3] or in the worst-case scenario, a partial or total inconsistency of the suture will occur. Second, without taking the risks described above, primary closure of the donor's wound with a split skin graft cut from the dermatome of another intact part of the body can be performed. The negative aspect of this technique is the appearance of a donor wound, after epithelization of which a scar-altered skin is formed, which is suitable as a full-fledged grafting material, as well as it becomes the object of an anti-scar therapy in most cases.

In the opinion of several Russian authors, it is possible to eliminate almost all the above difficulties if the full-layer skin autograft is cut off after expander dermatension of the donor site [4, 5]. In our practical work, we also concluded that it is always possible to obtain a full-fledged grafting material of the required area with a minimal risk of complications in the donor area using this method. In addition, a reserve of full-fledged skin is preserved for patients with extensive scar lesions.

It should be noted that the split-thickness graft (a skin graft with the thickness of 0.4 mm, cut within the reticular layer), in terms of its plastic properties, is almost equal to a full-layer graft, having a number of undeniable advantages to the latter. Firstly, after cutting off from the donor area, such a flap does not require laborious treatment by the Krasovitov method and is immediately ready for transplantation to the recipient site. Secondly, a thickly-split flap better drapes the bottom of the wound, providing a tight fit. Thirdly, a slightly thinned graft much better tolerates the trauma of free movement and hypoxia on the first day after transplantation.

Materials and methods

Our experience in eliminating post-burn scar deformities using split-thickness skin autografts obtained by expander dermatension includes 16 pediatric patients, who were burn convalescents aged 3 to 17 years. All patients in the study and control groups voluntarily signed the informed consent to participate in the study and to undergo surgical intervention.

The indication for the application of the described technique was the presence of post-burn hypertrophic scars causing segment deformity. Particularly, the indication in five cases included a common scar array circularly covering the thorax; the scars caused deformities of the upper extremities in five patients, 2 patients showed IV degree flexural contractures of the neck, and four cases showed IV degree contracture of the knee joint. In all cases, there was a need for plastic closure of a wound defect with an area of more than 100 cm^2. In all the patients of the described group, because of the generalized scar process, it was technically impossible to perform dermatension in a region adjacent to the deformity as well as to take a cutaneous autograft of a sufficient size from a remote donor site.

Technically, the method was performed in two stages of surgical treatment. At the first stage, a tissue expander was implanted into the area of the selected donor site. The dermatension was performed for 3–4 weeks until the growth of the skin was sufficient to close the defect at the recipient site and to suture the donor wound "toward oneself" without the risk of stretching the tissues along the suture line. During the second stage of the surgical treatment, the grafting dissection and/or excision of hypertrophic scars, determining the deformity of the segment, was performed. The tissue expander was removed from the area of the donor site. From the flap resulting from dermatension, a split-thickness skin autograft, which was sufficient in size for grafting closure of the wound defect at the recipient site, was cut and removed with a scalpel. The grafting of the donor wound was performed with the remaining skin flap. The edges of the flap and the wound were sutured by the application of an intracutaneous continuous suture. The resulting cutaneous graft was adapted and sutured to the edges of the wound defect at the recipient site. Depending on the situation, the sutures can be continuous intracutaneous or separate interrupted ones. The surgery was terminated with the application of an aseptic compression bandage to the graft, which was removed no earlier than 12 days after the surgery. The cutaneous sutures were removed no earlier than 14 days after the surgery.

To evaluate the results of treatment based on the method presented above, a comparison group consisting of 23 patients was included. The criteria for inclusion into this group were as follows: post-burn scar skin degeneration in a patient, which extends to all extremities and body; deficiency of intact skin; and free autografting performed for patients with a full-layer graft of an area of more than 100 cm^2 without preliminary expander stretching of the donor's skin. All pediatric patients underwent transplantation of full-layer skin graft technically in the same manner (according to the methods described above). The compression bandage was removed no earlier than 12 days after the surgery. The full-layer graft itself was cut (by a pattern from the wound defect) with a scalpel to the full depth of the skin and subcutaneous fat. The graft was processed using the Krasovitov method (the fatty tissue was completely removed). The edges of the donor wound were mobilized and sutured with two-row separate interrupted sutures after hemostasis. In all cases, the tension of the tissues along the suture line could not be avoided.

Results

During the comparative analysis of the applied surgery methods, indicators such as the degree of graft acceptance, the long-term quality of the transplanted graft, and the functional and cosmetic state of the donor area were compared. The functional and cosmetic results were evaluated using a five-point scale of assessment, considering the following: the severity of the scar process along the edges of the graft, the degree of graft retraction, the intensity of graft pigmentation, and the presence of scar deformity. Cases with thin atrophic scars, normal color of the graft, and no deformities scored 5 points. Cases with flat, somewhat compacted pale scars without itching, no deformities, and slightly pigmented and mobile grafts scored 4 points. Cases with raised, compacted, pink scars with itching, the presence of deformity in the area of their localization, and a graft partially soldered to the underlying tissues scored 3 points. Cases with rough purple-red scars with itching, which cause a pronounced deformity in the area of their localization as well as in contiguous areas and a depigmented graft tightly soldered to the underlying tissues scored 2 points.

It should be noted that the pediatric patients in the study and control groups are expected to have a long-term multi-stage surgical treatment; therefore, a comparative assessment of the state of the integument of donor areas was given special attention.

The graft acceptance in both groups was on average more than 95% of the transplanted skin. However, for accuracy, it should be noted that the acceptance of the grafts obtained by cutting from the expander flap almost always passed (no more than 5% complications) without transient trophic disorders, whereas partial exfoliation of the epidermis, point or local areas of paranecrosis or necrosis of the upper layers of the dermis, and local necrosis on the entire thickness of the graft were seen in the control group after the removal of compression bandages in 30% of cases. Although in most cases such complications were easily relieved and did not affect the timing of treatment, their development was undesirable.

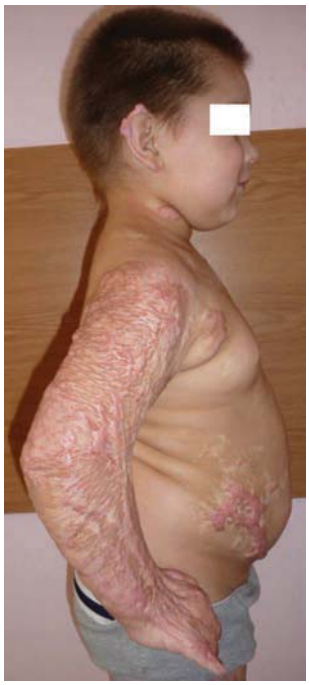

Fig. 1. Post-burn scar and total deformity of the right upper extremity

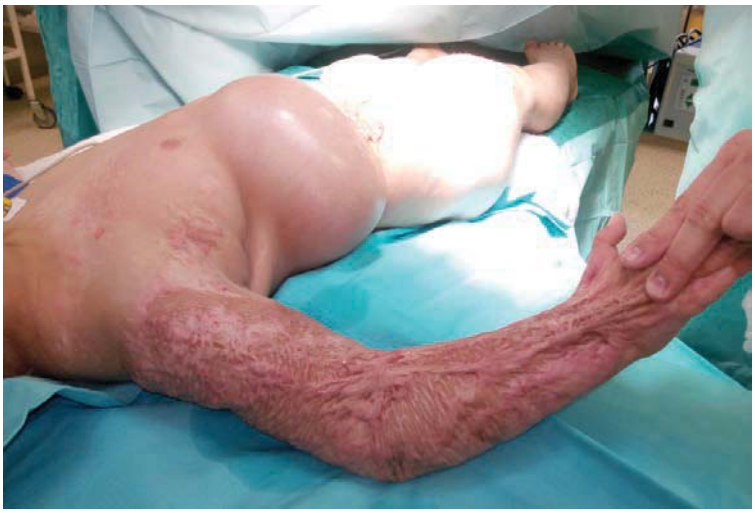

Fig. 2. The pediatric patient before the second stage of surgical treatment. The excess integumentary tissues formed as a result of expander dermatension of the donor area is visible

Unfortunately, in two patients in the control group, a serious complication, such as the partial dissolving of the graft, was observed, which led to the need for secondary skin grafting.

The state of the restored skin in the long-term period was clinically assessed in both groups in all the observations with a score of 4-5 points. However, the state of donor sites had significant differences. In the observations of the control group, the donor sites (after cutting the graft of more than 100 cm^2 and closing the wound "toward oneself") had scar changes and were estimated as no more than 3 points. There were raised, brightly colored, and dense hypertrophic scars causing deformities of the surrounding tissues. It was not possible to reuse this part of integument as a donor site. The donor site in the study group was an example of a good postoperative suture in 100% of cases. The scar changes were characterized as no less than 4 points. The surrounding tissues were unchanged. Secondary use of the donor area was not complicated.

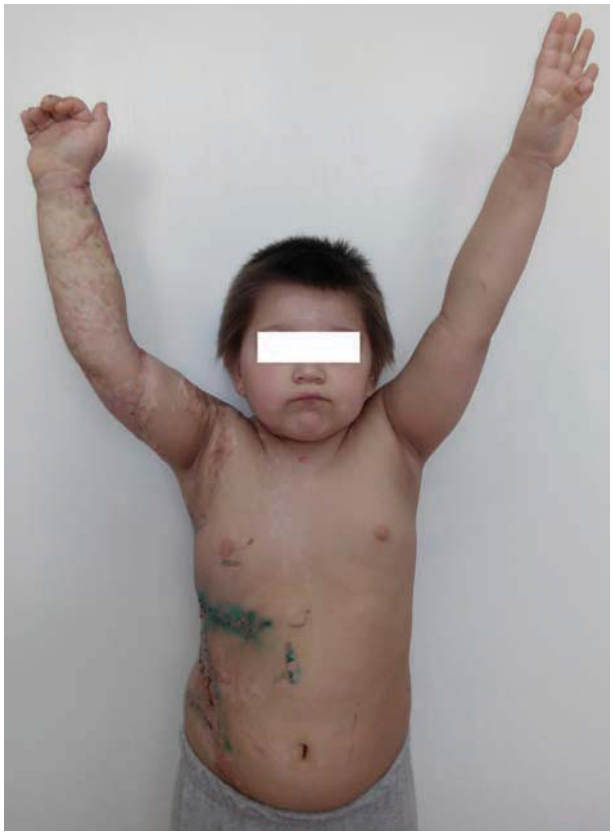

Fig. 3. The result of the surgical treatment

We performed our own clinical observations of the treatment of a child with post-burn scar deformities of the right upper extremity. From the anamnesis, it was known that the boy, born in 2008, got a 2-3AB degree thermal burn from spilling hot fluid on the right shoulder, forearm, and 25% of the body surface, at the age of 1 year. In the acute period, the patient underwent secondary free skin grafting of the body wounds and the right upper extremity in a primary care facility, whereas some of the wounds healed independently. The patient did not receive orthotic support.

The patient was admitted to the clinic of the institute at the age of 4 years with complaints of a

rough scar deformity on the right shoulder, forearm, and the elbow joint area, restriction of extension in the elbow joint to 110°, and expressed disorder of the function of the right upper extremity and self-service. Objectively, upon admission, a rough scar deformity of the lateral, flexural and part of the medial surface of the lower third of the right shoulder, the area of the elbow joint, and the forearm was noted. The extension in the elbow joint and rotation of the forearm was restricted due to rough deforming scars of the elbow joint area. The hand was in the position of dorsal flexion and was not brought to the middle position (due to scar deformities) (Fig. 1).

The patient underwent a step-wise surgical intervention. The first step was the implantation of a tissue expander in the soft tissues of the lateral surface of the body. During the period of tissue dermatension, the intact tissue (donor area) increased (Fig. 2). In the second step of the surgical treatment, the dissection and partial excision of the scar tissue of the lower third of the right shoulder, the elbow joint, and the upper third of the forearm as well as the scar-altered underlying tissues were performed to eliminate the flexural contracture of the elbow joint and the pathological position of the hand. As a result, the deformity was completely eliminated. The massive wound defect formed during the surgery was closed using the skin graft taken from the donor site (the site of implantation of the tissue expander). The graft was previously split and adapted to the relief of the wound with gauze bandages. The donor site was sutured "toward oneself."

The right upper extremity was fixed in the correction position using a plaster bandage. In the postoperative period, the patient was kept on a semi-strict bed rest for 14 days (the operated extremity was in an elevated position). On day 14, the gauze fixation of the skin graft was removed, and the skin graft was evaluated. Complete engraftment without any signs of necrosis of the graft was noted. Two weeks after the surgery, a step-wise splint was implemented in the position of full extension in the elbow joint and palmar flexion of the hand of 10°. As a result, a complete permanent deformity correction was achieved with no tendency of relapse within two years following surgery following surgery (Fig. 3). In the future, orthopedic support (wearing the splint at night for six months), anti-scar therapy, and rehabilitation courses (exercise therapy, physiotherapy) were recommended to the patient.

Therefore, the possibility of one-stage elimination of severe secondary post-burn deformities of the right upper extremity using a full-thickness skin autograft of a large area as a grafting material was demonstrated.

Conclusion

While performing reconstructive surgical interventions in pediatric patients suffering from extensive post-burn hypertrophic scars, the main problem is the scarcity of intact donor skin reserves. Involvement of the integument of the entire segment in the scar process makes it impossible to perform grafting with local tissues. In such circumstances, performing grafting with a full-layer or split-thickness graft is indicated. If it is necessary to close the wound defect with an area of more than 100 cm^2, it is advisable to perform the preliminary expander dermatension of the donor site. This technique enables to obtain a full-fledged grafting material resistant to the trauma of free implantation as well as provides for multiple operations of the donor area without violating the esthetics of the latter.

Information on funding and conflict of interest

The work was performed on the basis of and with the support of the Turner Scientific and Research Institute for Children's orthopedics, the Ministry of Health of Russia. The authors declare the absence of obvious and potential conflicts of interest related to the publication of this article.

References

1. Островский Н.В., Белянина И.Б., Якунин Г.С. Выбор сроков и методов устранения рубцовых деформаций у детей // Проблемы термической травмы у детей и подростков. – Екатеринбург, 2003. – С. 140. [Ostrovskii NV, Belyanina IB, Yakunin GS. Vybor srokov i metodov ustraneniya rubtsovykh deformatsii u detei. Problemy termicheskoi travmy u detei i podrostkov. Ekaterinburg; 2003. p. 140. (In Russ.)]
2. Белоусов А.Е. Пластическая реконструктивная и эстетическая хирургия. – СПб.: Гиппократ, 1998. – 743 с. [Belousov AE. Plasticheskaya rekonstruktivnaya i esteticheskaya khirurgiya. Saint Petersburg: Gippokrat; 1998. 743 p. (In Russ.)]

3. Парамонов Б.А. «Качество» послеоперационного шва: направления профилактики рубцовых изменений // Искусство профессионалов красоты. – 2013. – № 4. – С. 42–48. [Paramonov BA. "Kachestvo" posleoperatsionnogo shva: napravleniya profilaktiki rubtsovykh izmenenii. *Iskusstvo professionalov krasoty.* 2013;(4):42-48. (In Russ.)]

4. Патент РФ на изобретение № 2250080/20.04.2005. Бюл. № 11. Сидоренко Ю.С., Пржедецкий Ю.В., Бражникова Е.И., Барманова И.В. Способ пластического закрытия дефекта при хирургическом лечении меланомы кожи. [Patent RUS No 2250080/20.04.2005. Byul. No 11. Sidorenko YuS, Przhedetskii YuV, Brazhnikova EI, Barmanova IV. Sposob plasticheskogo zakrytiya defekta pri khirurgicheskom lechenii melanomy kozhi. (In Russ.)]

5. Патент РФ на изобретение № 2332179/27.08.2008. Бюл. № 24. Трусов А.В., Будкевич Л.И., Бурков И.В., и др. Способ получения полнослойного кожного трансплантата. [Patentn RUS No 2332179/27.08.2008. Byul. No 24. Trusov AV, Budkevich LI, Burkov IV, et al. Sposob polucheniya polnosloinogo kozhnogo transplantata. (In Russ.)]

Information about the authors

Konstantin A. Afonichev — MD, PhD, professor, head of the department of trauma effects and rheumatoid arthritis. The Turner Scientific and Research Institute for Children's Orthopedics. E-mail: afonichev@list.ru.

Maksim S. Nikitin — MD, orthopedic and trauma surgeon of the department of trauma effects and rheumatoid arthritis.The Turner Scientific and Research Institute for Children's Orthopedics.

Yaroslav N. Proshchenko — MD, PhD, research associate of the department of trauma effects and rheumatoid arthritis. The Turner Scientific and Research Institute for Children's Orthopedics. E-mail: Yar2011@list.ru.

Константин Александрович Афоничев — д-р мед. наук, руководитель отделения последствий травмы и ревматоидного артрита ФГБУ «НИДОИ им. Г.И. Турнера» Минздрава России. E-mail: afonichev@list.ru.

Максим Сергеевич Никитин — врач травматолог-ортопед отделения последствий травм и ревматоидного артрита ФГБУ «НИДОИ им. Г.И. Турнера» Минздрава России.

Ярослав Николаевич Прощенко — канд. мед. наук, старший научный сотрудник отделения последствий травм и ревматоидного артрита ФГБУ «НИДОИ им. Г.И. Турнера» Минздрава России. E-mail: Yar2011@list.ru.