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ANALYSIS OF COMPLICATED OUTCOMES IN BURNS IN CHILDREN

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This article analyzed the long-term results of the treatment of children who have undergone thermal injury and explored the main reasons for the unsatisfactory results of the treatment, which resulted in significant functional limitations that led to medical help for re-treatment. The investigation indicates the most important principles of surgical and conservative treatment and attempts to understand which factors led to the appearance, progression, or recurrence of a deformity.

Keywords: thermal injury, hypertrophic scars, scar deformity.

Introduction

Hypertrophic scars present a medical and surgical challenge, particularly in pediatric patients (1, 2). As a child's skeleton grows and develops, pathological scar tissue always lags behind, which often causes secondary deformities of the musculoskeletal system, such as persistent contractions, fibrous ankylosis, subluxations and dislocations of the joints, and curvatures of the long bones (3-5). The incidence of post-burn deformities remains considerable, making the discussion of this problem highly relevant and the need for standardized approaches to treatment urgent (6-8).

Aim. The objective of our study was to analyze the long-term results of treatment of thermal injury and its consequences as well as the main causes for poor functional and cosmetic results.

Patients and methods

During the period from 2010 to 2014, a total of 467 children with scar deformities on different locations of the body were treated at the Department of Plastic and Reconstructive Surgery of Turner Scientific and Research Institute for Children's Orthopedics, Russian Ministry of Health. The patients were referred from different regions of Russia. Collected data allowed us to identify the most common deformities and to divide patients into four main groups:

1) children with contractures of the fingers;

2) children with progressive contractures of large joints;

3) children with deformities of the mammary glands; and

4) children with secondary changes of the osteoarticular apparatus.

The authors analyzed medical histories, clinical presentations, and radiological and ultrasound data.

Results

Children with finger contractures constituted the most numerous group 1. The period since the thermal injury was between 5 and 18 months. The quantitative distribution of the deformities is presented in Table 1.

Table 1

Deformity	Incidence, %
Flexion contractures	66.6
Flexion-extension contractures	5.5
Scar syndactyly	5.5
Mixed deformities	22.2

Fig. 1. Grade 4 flexion contracture of fingers

Fig. 2. Outcome of the surgical treatment

Fig. 3. Hypertrophic ulcerated scar of the elbow

Fig. 4. Outcome of the surgical treatment

Fig. 5. Dystrophic changes in hypertrophic scars

Fig. 6. Grade 3–4 flexion contracture of the neck

Fig. 7. Scar dystopia of the breast

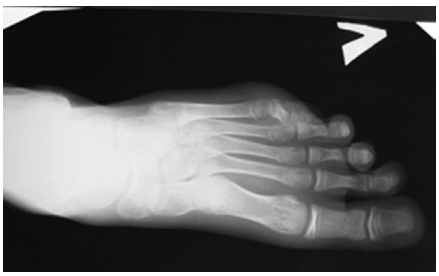

Fig. 8. Foot deformities

Table 2

Location	%
Neck	17.6
Shoulder joint	11.76
Elbow	17.78
Wrist	17.6
Ankle	23.5
Mixed deformity	11.76
Total	100

Table 3

Factor	%
Long-term self-healing of wounds	41.2
Incorrect or lack of immobilization	35.3
Use of mesh skin grafts in the joint area	17.6
Lack of follow-up care	23.5

The most frequently encountered flexion contractures of the fingers were observed in children who had suffered deep second and third degree burns of the palmar surface of the hand. In all cases, the palmar surface burns had been allowed to heal on their own with the formation of longitudinal pulling scars, leading to grade 2–3 flexion contractures during the first 6 months after the injury. In some cases, a grade 4 flexion contracture had developed 5–6 months after the injury (Fig. 1). In children who were admitted for treatment within 6–8 months after the contracture formation, those {2.2 [EN] Subject unclear} in most cases were dermatogenic in nature and removal of the pulling scar resulted in complete restoration of function (Fig. 2).

Flexion-extension contractures had developed after burns of the dorsal and palmar surfaces of the hand. In some cases, these contractures were combined with basal syndactyly, which limited the range of motion in the metacarpophalangeal joints and prevented thumb opposition. The interdigital skin membranes were often presented by adherent scar-altered split autografts {1.2 [EN] Meaning unclear. Please clarify}.

It should be noted that a large number of small joints, finely attuned muscle-tendon apparatus, relatively small amount of soft tissue, and surface position of the functionally important anatomical structures in the hand create the preconditions the deep impact of damaging agents {1.2 [EN] Meaning unclear. Please clarify} and the early development of secondary deformities.

The most severe deformities were neck contractures. Mixed deformities involved shoulder and wrist joints as well as elbow and wrist joints contractures.

Development of contractures has often been associated with the failure to execute free flap skin transplants during the treatment of a heat injury as well as long-term (2.5–4 months) self-healing, which resulted in the formation of rough hypertrophic scars and contractures (Fig. 3, 4). Upon examination, the surfaces of the scars were trophically altered and their ulcerations were observed in a number of cases (Fig. 5). Improper immobilization of the segments (in a position to counter any evolving contracture) also caused a decrease in the true size of the wound defect due to scar contractions, inadequate surface for skin grafting, and fixation of joints in the incorrect position. Of particular importance was the correct immobilization of the neck area during the treatment of burns, where we observed grade 3–4 flexion contractures in all cases (Fig. 6). Contractures are often formed as a result of using mesh skin grafts in the joint area, which cause more scar development and retraction than solid grafts.

Such tactics can be justified in cases with extensive lesions associated with a deficiency of donor resources, but in the described cases, the burn area was limited.

The main factors that contributed to poor treatment results are presented in Table 3.

In connection with the above factors, it is necessary to place an emphasis on the main principles of contracture prevention in functionally active areas:

1) completion of skin plastic surgery in a reasonably short time, according to the indications;

2) use of solid-split grafts, if there is no shortage of donor resources; and

3) immobilization of a limb in a position that counters retraction.

The third group included female patients under the age of 7 years who had suffered burns to the anterior surface of the chest. The time since the injury before entering the clinic for plastic and reconstructive surgery ranged from 2 to 10 years. In

addition to a significant deterioration in aesthetic appearance, there was breast displacement on the affected side in 50% of cases. Breast displacement was associated with the presence of extensive flat scarring, which caused the spreading, deformation, and fragmentation of the glandular tissue (Fig. 7). The continued existence of such scarring created conditions for the abnormal growth and malformation of the mammary gland and its ductal system. The development of extensive flat scarring could be also due to the prolonged existence of granulating wounds or a result of conservative treatment. In 25% of cases, there was a recurrence of the deformity after an attempt to correct it with a scar tissue excision in combination with an acute skin expansion. The outcome of such tactics was marginal necrosis of the graft flap and unsatisfactory results. The skin on the chest is normally taut and has a limited ability to shift; it is necessary to develop a sufficient amount of healthy tissue using skin expanders and to reduce the strain on the skin with layered suturing of the subcutaneous tissue.

The fourth group included patients with the most severe deformities, which in some cases required a multi-stage orthopedic surgery because of secondary deformations of the osteoarticular apparatus that had developed due to the presence of rough scars during the growth of the patient. Deformities developed from 1.5 to 5 years after thermal injuries and were evident through fibrous ankylosis, subluxation, and dislocation of the joints. Fibrous ankylosis was present in all hand and foot joint cases and was due to an unreasonably prolonged period of immobilization. Persistent organic contractures gradually developed in the absence of monitoring and functional rehabilitation. In association with the progressive secondary changes in the tendon and muscular systems (Fig. 8, 9), subluxation and dislocation of the joints have also been observed. In a number of cases, changes in vascular topography and reduced blood flow due to bending and scar adhesion around the vessel have been observed. This made the one-step correction of the deformity impossible. In addition, long-term abnormalities of the existing anatomical and topographical relationships of the joints and improper load distribution on the bones and joints resulted in malformation of the bones and partial hypoplasia. The leading factor in the development of such deformations in all cases was the lack of dynamic medical follow-up supervision for the convalescent child.

Conclusion

We have identified the most important causes of complications in children after burns. The development of severe contractures has often been associated with the failure to perform free skin plastic surgery during treatment after heat injury and long-term (2.5–4 months) wound self-healing with contracture formation and rough hypertrophic scars. The lack of proper positioning of the patient's limb also decreased the true size of the wound defect because of scar contractions, created an inadequate surface for skin grafting, and led to the fixation of joints in an incorrect position. Contractures were formed because of the use of mesh skin grafts in the joint area. Mesh skin grafts were more likely to cause excessive scarring and retraction than solid grafts. The delay of functional rehabilitation and lack of conservative anti-scar treatment also resulted in severe scar formation, even after appropriate and successful treatment of burn wounds.

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АНАЛИЗ ОСЛОЖНЕННЫХ ИСХОДОВ ОЖОГОВ У ДЕТЕЙ

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Статья посвящена анализу отдаленных результатов лечения детей, перенесших термическую травму, и основных причин неудовлетворительных результатов лечения, которые повлекли за собой значительные функциональные ограничения и привели к повторному обращению за медицинской помощью. Проведенное исследование обозначает наиболее важные звенья хирургического и консервативного лечения, отступление от которых ведет к возникновению, прогрессированию или рецидиву деформации.

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

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