

Surgical Techniques and Treatment Results of Skin Graft Reconstruction in Post-Burn Elbow Contractures

Sulaymanova Khosiyat Khamidjanovna

Andijan State Medical Institute

xosiyat756@gmail.com

Abstract: Post-burn scar deformities and contractures affecting joint regions, particularly the elbow, represent a significant clinical problem due to their impact on both functional capacity and aesthetic appearance. These pathological changes often result in restricted range of motion, discomfort, and a noticeable decline in patients' quality of life and daily activity levels. Among the available reconstructive methods, skin grafting remains one of the most reliable and widely used techniques for correcting such deformities. This study focuses on the surgical principles and technical nuances of skin grafting in the management of post-burn elbow deformities. Special attention is given to preoperative evaluation, including assessment of scar characteristics and tissue condition, as well as to the selection of appropriate grafting techniques. In addition, key aspects of postoperative care, rehabilitation, and complication prevention are discussed. The findings indicate that properly planned and executed skin grafting significantly improves joint mobility, restores functional performance, and enhances cosmetic outcomes. Furthermore, the integration of adjunctive methods, including physiotherapy and laser therapy, contributes to better long-term results and reduces the risk of recurrence.

Keywords: elbow joint, post-burn scar deformities, contracture, skin grafting, reconstructive surgery, laser therapy, rehabilitation.

Introduction

Healthcare Burn injuries remain one of the major medical and social challenges worldwide. Among their most severe late complications are scar deformities and contractures, which significantly restrict joint mobility and negatively affect patients' working capacity and overall quality of life. According to published data, post-burn scar contractures develop in approximately 38–54% of patients, with a higher incidence observed in areas of increased joint mobility.

The formation of post-burn scar tissue is accompanied by fibrotic changes in the skin and underlying soft tissues, leading to tissue shortening and a reduction in the range of motion. In particular, the joints of the upper extremities, including the elbow joint, play a crucial functional role; therefore, contractures in these regions often result in pronounced functional impairment[1].

Multicenter studies have demonstrated that post-burn contractures most frequently affect the joints of the upper limbs, especially the shoulder and elbow joints. These conditions limit the functional range of motion of the limb and create significant difficulties in performing daily activities. In plastic and reconstructive surgery, various techniques are employed to manage such deformities. Among them, scar excision followed by skin grafting is considered one of the most commonly used and effective approaches.

Several studies have reported that skin grafting for post-burn elbow contractures can significantly improve functional outcomes. Clinical observations indicate that surgical management using skin

grafting provides satisfactory wound coverage and functional recovery in more than 80% of cases . However, recurrence of contractures may still occur in certain patients, highlighting the need for further improvement in surgical techniques and postoperative rehabilitation strategies[2].

In some studies, when compared with local flap reconstruction, skin grafting has been associated with a higher risk of recurrence, while flap-based techniques may offer more stable long-term results in selected cases. Therefore, the choice of the optimal reconstructive method remains a relevant and unresolved issue in modern reconstructive surgery.

In addition, several factors have been identified as contributing to the development of post-burn contractures, including burn depth, extent of tissue damage, patient age, and insufficient rehabilitation measures[3].

The above considerations underline the scientific and practical importance of studying the technical aspects and clinical outcomes of skin grafting in the treatment of post-burn scar deformities and contractures of the elbow joint.

Materials and methods

The present study included patients with post-burn scar deformities localized in the elbow joint region. During the study period, scar deformities of the elbow were identified in 66.1% of cases (41 patients). All participants were divided into two groups depending on the treatment approach: the main group and the control group. In the control group, scar deformities were managed using conventional skin grafting techniques, whereas in the main group, skin grafting was performed using an improved method developed by the authors.

Clinical evaluation of scar tissue characteristics revealed that 45 patients (72.6%) had superficially located scars, while 17 patients (27.4%) presented with deep scar formations. The size of the scars was also carefully assessed. According to the findings, in 38 patients (61.3%), the scar area did not exceed 50 cm², with a mean value of 47.7±2.5 cm². In 18 patients (29%), the scar size ranged from 50 to 120 cm², with an average area of 105.8±11.3 cm². In the remaining 6 patients (9.7%), the scar area exceeded 120 cm², with a mean value of 152.4±22.1 cm².

The morphological types of scars were also analyzed. Normotrophic scars were observed in 38 patients (61.3%), atrophic scars in 13 patients (20.9%), and hypertrophic or keloid scars in 11 patients (17.7%). All patients underwent comprehensive clinical assessment, including evaluation of scar size, functional status of the joint, and analysis of postoperative outcomes.

Results

Surgical intervention was performed to eliminate post-burn scar deformities and contractures in the elbow joint region. The procedures were carried out under either endotracheal or local anesthesia, depending on the patient's age, general condition, extent of scar involvement, and the anticipated volume of surgical intervention. Prior to surgery, the operative field was prepared according to standard antiseptic protocols[4].

The recipient site was defined as the area surrounding the elbow joint affected by post-burn scar deformity or contracture. For proper preparation of the operative field, initial cleansing was performed using a sterile gauze pad soaked in 5% hypertonic solution, applied from the center toward the periphery for approximately one minute. After a 30-second interval, the surgical site was further treated with a sterile swab impregnated with 0.5% chlorhexidine bigluconate solution. During this step, the operative field was wiped from the center outward at an approximate speed of 0.06 m/s for about one minute. The antiseptic preparation process was repeated twice using the above-mentioned solutions[5].

Following antiseptic preparation, the surgical approach was selected based on the size and extent of

the scar deformity in the elbow region. In cases of small, localized scar deformities, complete excision of the scar tissue was performed. For medium-sized deformities, scar excision was carried out partially or completely, taking into account the required size of the skin graft. In cases of extensive or total scar involvement, transverse incisions were made in alignment with the functional axis of the joint[6].

During scar tissue resection, a scalpel was used to clearly define the boundary between scarred and healthy tissue, and the scar tissue was gradually dissected in a stepwise manner. When complete excision was indicated, the scar tissue was removed entirely along the transitional zone between affected and healthy tissues. In cases where correction was achieved through transverse incision, the scar tissue was dissected up to the boundary of intact tissue, followed by an additional incision parallel to the joint axis. The configuration of these incisions resembled a “swallow-tail” pattern and was determined based on the extent of scar spread and involvement of the joint surface[7].

During wound exploration, tissues were dissected layer by layer. Adipose tissue was separated from surrounding structures using both sharp and blunt dissection techniques. In cases of deep scar deformities, where scar tissue was adherent to the muscular fascia, it was noted that sharp dissection carried a risk of muscle injury. Therefore, blunt dissection was predominantly employed to minimize vascular damage and to reduce the likelihood of subgraft hematoma formation.

Hemostasis during surgery was achieved by ligation of large-caliber vessels using electrocautery or “P”-shaped interrupted sutures. Bleeding from smaller vessels was controlled using chemical or physical hemostatic methods. To accurately determine the size of the recipient wound area, a template was created using sterile gauze. This template was then used to outline the required dimensions of the skin graft at the donor site. Additionally, when necessary, the wound surface area was measured using specialized instruments to ensure precise graft sizing[8].

After preparation of the recipient site, the operative field was covered with a sterile dressing, and the procedure was continued at the donor site. The donor area was treated using the same antiseptic protocol as applied to the recipient site. For this purpose, solutions with combined bacteriostatic and bactericidal effects were used. Initially, the donor site was irrigated with a 5% hypertonic solution, followed 30 seconds later by treatment with a 0.5% chlorhexidine bigluconate solution. This antiseptic procedure was repeated three times over a total duration of approximately one minute. Subsequently, the surgical field was isolated with sterile drapes[9].

Based on the dimensions of the recipient wound, the required size of the skin graft was outlined on the donor site. Skin harvesting was performed using a scalpel, with incisions directed from the inner to the outer aspect, from anterior to posterior, and from right to left. The incision depth included all layers down to the subcutaneous fat tissue. A traction suture was placed at one edge of the graft to facilitate handling, and gentle traction allowed careful separation of the underlying adipose tissue using the scalpel[10].

Special attention was paid to avoiding excessive inclusion of subcutaneous fat with the graft, as this may increase the risk of graft necrosis. Therefore, adipose tissue was meticulously removed, and a graft of the required thickness and size was obtained.

Hemostasis at the donor site was achieved by coagulation of both small and large vessels using electrocautery. Various closure techniques described in the literature were applied depending on the size of the donor wound. In clinical practice, different reconstructive approaches were selected based on wound dimensions. For defects up to 30 cm², acute dermatotension techniques were used; for wounds measuring 30–60 cm², local tissue rearrangement (local flap techniques) was applied; and for defects larger than 60 cm², intraoperative balloon-assisted tissue expansion was employed. In all cases, the wound edges were gradually mobilized from the surrounding tissues[11].

Given the complexity and duration of the procedure, the operation was performed simultaneously by two independent surgical teams working in parallel. During closure of the donor site, subcutaneous tissues were approximated using interrupted non-absorbable sutures placed at

intervals of approximately 1.5 cm. The skin layer was then closed with interrupted sutures using non-absorbable material (sizes 4.0 or 5.0), with spacing of approximately 0.6 cm between sutures[12].

Before and after wound closure, the surgical field and wound edges were again treated with antiseptic solutions using the same protocol described above. At the completion of the procedure, the donor site was treated with a 5% hypertonic solution, followed after 30 seconds by 0.5% chlorhexidine bigluconate. This process was repeated three times over approximately one minute, and the wound was covered with sterile dressings.

Meanwhile, the first surgical team proceeded with graft placement at the recipient site. The skin graft was applied to fully cover the wound surface, utilizing its natural elastic properties for optimal adaptation. Fixation of the graft was achieved using interrupted sutures placed from the periphery toward the center. To ensure secure fixation, atraumatic sutures were initially placed in the graft itself and then passed through the edges of the recipient wound[13].

To promote close adherence of the graft to the underlying tissues, a “tie-over” (pressure dressing) technique was used. At the end of the surgical procedure, laser therapy was applied to the grafted area as a form of physiotherapeutic support. For this purpose, a “Sogdiana” laser device with a wavelength of 890 nm, pulse power of 5 W, and frequency of 1500 Hz was utilized. Laser irradiation was performed for 5 minutes immediately after surgery and repeated daily for 5 consecutive days. This approach was aimed at improving graft survival, enhancing local microcirculation, and stimulating regenerative processes.

Early Outcomes. Analysis of early postoperative results revealed that the following complications were observed in both the main group (64 patients) and the control group (62 patients) (see Table 1).

Table 1. Early postoperative complications

Complications	Main Group (n=64)	Control Group (n=62)
Partial skin necrosis	1 (1.6%)	3 (4.8%)
Subgraft hematoma	2 (3.2%)	4 (6.4%)
Epidermal sloughing	1 (1.6%)	5 (8.1%)
Total	4 (6.25%)	12 (19.3%)

In the main group, where the improved technique was applied, the overall complication rate was 6.25%, whereas in the control group this показатель reached 19.3% ($\chi^2 = 4.14$; $df = 3$; $p \leq 0.02$). The analysis of indirect (secondary) complications yielded the following results (see Table 2)[14].

Table 2. Secondary (Indirect) postoperative complications

Complications	Main Group (n=64)	Control Group (n=62)
Wound dehiscence	1 (1.6%)	1 (1.6%)
Wound suppuration	1 (1.6%)	3 (4.8%)
Bleeding	–	1 (1.6%)
Total	2 (3.2%)	5 (8.1%)

The rate of unsatisfactory functional outcomes in the control group was 11.3%, compared to 4.8% in the main group, indicating an improvement of 2.4-fold ($\chi^2 = 7.24$; $df = 8$; $p \leq 0.21$). Complications leading to deterioration of cosmetic results are presented as follows (see Table 3).

Table 3. Affecting Cosmetic Outcomes

Complications	Main Group (n=64)	Control Group (n=62)
Direct complications	5 (7.8%)	12 (19.4%)
Changes in skin color	1 (1.6%)	3 (4.8%)
Skin not pliable	2 (3.2%)	3 (4.8%)
Loss of sensitivity	–	1 (1.6%)
Failure to form natural creases	–	2 (3.2%)
Absence of subcutaneous fat layer	2 (3.2%)	3 (3.2%)
Indirect complications	5 (7.8%)	6 (9.7%)
Scar widening	2 (3.2%)	3 (4.8%)
Development of pathological scars	2 (3.2%)	1 (1.6%)
Pathological scars around the graft	1 (1.6%)	2 (3.2%)

Discussion

The application of laser-assisted therapy in conjunction with skin grafting offers multiple significant advantages. Primarily, it helps preserve both the natural anatomical structure and the functional properties of the transplanted skin flap. Regardless of the size or location of the recipient site, the use of laser irradiation reduces the likelihood of epidermal sloughing and supports the maintenance of the graft's integrity. By delivering continuous laser energy across the entire graft area, local microcirculation is enhanced, which not only improves tissue perfusion but also promotes the full expression of the graft's elastic and biomechanical properties over time.

Improved microcirculation at the recipient site plays a critical role in mitigating ischemia in post-burn scar tissue. This enhanced perfusion reduces the oxygen demand of hypoxic tissues and contributes to the alleviation of pain associated with pathological hypoxia. Additionally, laser irradiation helps modulate the inflammatory response in the recipient area, thereby minimizing acute inflammation and accelerating adherence of the graft to the underlying tissues. This dual effect—enhanced vascularization and reduced inflammatory stress—supports faster integration of the graft, reduces the risk of necrosis, and contributes to better long-term functional and cosmetic outcomes[15].

Moreover, laser therapy stimulates local cellular metabolism and collagen remodeling, which are crucial for restoring the skin's elasticity, thickness, and tensile strength. These effects are particularly important in regions with high functional demands, such as the elbow joint, where scar contractures can severely limit mobility. The synergistic impact of precise surgical technique and adjunctive laser therapy thus provides a more predictable and durable result, enhancing both the aesthetic appearance of the grafted area and the patient's overall range of motion.

Overall, incorporating laser treatment into post-burn skin grafting protocols appears to significantly optimize graft survival, improve local tissue health, and reduce postoperative complications, making it a valuable adjunct in reconstructive procedures aimed at restoring function and appearance in scarred joint regions.

Conclusion

In patients with post-burn elbow joint contractures, traditional skin grafting was associated with considerable early and long-term complications. Early postoperative outcomes included epidermal sloughing in 8.1% of cases, subgraft hematoma in 6.4%, partial graft necrosis in 4.8%, and an overall

complication rate of 19.3%. Long-term follow-up demonstrated unsatisfactory functional outcomes in 11.3% of patients and poor cosmetic results in 19.4% in the control group. In contrast, patients treated with the proposed enhanced skin grafting protocol achieved substantially better outcomes, with unsatisfactory functional results in only 4.8% of cases representing a 2.4-fold improvement and unsatisfactory cosmetic outcomes in 7.8%, corresponding to a 2.5-fold improvement. The enhanced protocol involved meticulous recipient site preparation using sequential treatment with a 5% hypertonic solution followed by 0.5% chlorhexidine bigluconate, repeated three times, combined with precise surgical techniques and adjunctive laser therapy. These measures significantly reduced early complications, including partial graft necrosis (1.6%), subgraft hematoma (3.2%), and epidermal sloughing (1.6%), as well as the overall rate of direct complications (6.25%). The results indicate that systematic recipient site preparation and refined grafting techniques can substantially improve both functional recovery and aesthetic outcomes in patients undergoing skin grafting for post-burn elbow contractures.

References

- [1] D. N. Herndon, *Total Burn Care*, 5th ed. Philadelphia, PA, USA: Elsevier, 2018, pp. 721–734.
- [2] A. M. Oosterwijk, M. K. Nieuwenhuis, M. E. van Baar et al., “Prevalence of scar contractures after burn: A systematic review,” *Burns*, vol. 43, no. 1, pp. 41–49, 2017.
- [3] G. G. Gauglitz, H. C. Korting, T. Pavicic et al., “Hypertrophic scarring and keloids: Pathomechanisms and current treatment strategies,” *Journal of Burn Care & Research*, vol. 32, no. 4, pp. 423–432, 2011.
- [4] S. Baux, M. Mimoun, J. M. Kirsch et al., “Treatment of elbow contractures in burns,” *Burns*, vol. 13, no. 3, pp. 241–244, 1987.
- [5] V. M. Grishkevich, “The post-burn elbow medial flexion scar contracture treatment with trapeze-flap plasty,” *Burns*, vol. 35, no. 2, pp. 280–287, 2009.
- [6] F. C. Iwuagwu, D. Wilson, and F. Bailie, “The use of skin grafts in postburn contracture release: A 10-year review,” *Plastic and Reconstructive Surgery*, vol. 103, no. 4, pp. 1198–1204, 1999.
- [7] M. Issa, M. Badawi, G. Bisheet et al., “Skin graft versus local flaps in management of post-burn elbow contracture,” *Cureus*, vol. 13, no. 12, p. e20768, pp. 1–9, 2021.
- [8] H. J. Schouten, M. K. Nieuwenhuis, M. E. van Baar et al., “The prevalence and development of burn scar contractures: A multicenter cohort study,” *Burns*, vol. 45, no. 4, pp. 783–790, 2019.
- [9] K. J. Zuo and L. L. Shi, “Surgical management of contractures,” *Hand Clinics*, vol. 32, no. 2, pp. 247–259, 2016.
- [10] S. Mohanty and J. K. Gupta, “Improving cosmetic and functional outcome in case of post-burn contracture of hand and fingers by using plantar skin graft,” *International Journal of Research in Orthopaedics*, vol. 10, no. 2, pp. 314–317, 2024.
- [11] S. P. Lakshmi Bai and R. Gunasekaran, “Post-burn flexion contracture of hand: A prospective study,” *International Surgery Journal*, vol. 6, no. 8, pp. 2823–2827, 2019.
- [12] A. Elemosho, L. Macdonald, D. Bell et al., “Outcomes of microsurgical reconstruction of post-burn joint contracture: Systematic review and meta-analysis,” *Microsurgery*, vol. 45, no. 6, p. e70104, pp. 1–12, 2025.
- [13] Sh. A. Karimov, *Surgical Diseases*. Tashkent, Uzbekistan: Ibn Sino, 2010, pp. 210–245.
- [14] U. A. Asqarov, *Fundamentals of Traumatology and Orthopedics*. Tashkent, Uzbekistan: O‘qituvchi, 2015, pp. 134–162.
- [15] B. T. Daminov, “Burn injuries and their treatment methods,” *Medical Journal*, vol. 2, no. 3, pp. 45–52, 2020.