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Starplasty for reconstruction of the post burn contractures

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Abstract

Background and objective: Around 180,000 people die from burn injuries annually, which can result from heat, radiation, electricity, friction, or chemicals. Axillary and web post-burn contractures are prevalent and significantly limit the range of motion and quality of life, traditional contracture release procedures can result in donor site morbidity and low functional outcome. Range of motion after Starplasty flap for contractures in different part of the body

Methods: A longitudinal study that includes 20 cases selected to undergo Starplasty operation, and then were followed for three months. The study was conducted in three main hospitals in Erbil city (Rizgary Teaching Hospital, Western Emergency Hospital and Emergency Hospital), The investigation started in November 2020 and continued until June 2022.

Results: A total of 20 patients, including both children and adults, underwent contracture release surgery using Starplasty. The mean preoperative ROM (range of motion) was 30.5% of the normal value, which was increased to 56.6%, 66.0%, 75.3%, and 88.2% of the normal value, postoperatively (after one week, one month, and three months, respectively). On all follow-up occasions, the mean ROM increased significantly (P <0.001).

Conclusion: Starplasty was a successful and safe procedure in treating both Axillary and web space contractures. In the absence of significant complications and graft failure, a response exceeding 50% of the normal range of motion can start as early as one week postoperatively.

Keywords: Starplasty; Burn; Contractures.

Introduction

Burns, caused by direct heat, radiation, electricity, friction, or chemical contact are common injuries resulting from skin and organ damage. They cause around 180,000 deaths annually and can cause different morbidities. The majority of burn cases occur in middle-income countries, with one-third occurring in the WHO regions of Africa and South-East Asia.[(1)]

Contractures defined as any restriction of movement in a joint or other part of the body can result from different factors such as limb positioning, prolonged immobilization, and pathologies affecting muscles, soft tissues, and bones. Recent studies highlight that burns remain a predominant cause of contractures. Patients with severe burns often endure extended periods of immobility due to their injuries, pain management and necessary splinting and positioning. [(2)]

Contractures often occur due to inadequate burn care or improper scar management; they can also result from split-thickness skin grafting applied to the burn area, burned skin tissues typically transform into scars. The slow growth of scar tissue compared to surrounding tissues leads to skin distortion in the

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affected area resulting in contractures. Recent studies showed that combining conventional techniques with advanced therapies such as acellular dermal matrix ADM and platelet-rich plasma PRP therapies can improve functional outcomes in the repair of burn contractures.[3] The Starplasty procedure is a highly effective technique for treating contractures in different body sites, dorsal and volar neosyndactyly and the reconstruction of web spaces following burns. Starplasty is regarded as a safe method for anterior and posterior axillary fold.[4] The aim of the study was evaluating the effectiveness of Starplasty procedure in treating patients with post burn contracture.

Methods

Study design

A longitudinal study that includes 20 human subjects selected to undergo Starplasty operation, and then were followed for three months.

Study Setting

The study conducted in the three main hospitals in Erbil city (Rizgari Teaching Hospital, Western Emergency Hospital and Emergency Hospital). The study started in November 2020 and concluded in June 2022.

Inclusion criteria

Burn complicated by contracture.

Exclusion criteria

Contractures due to any cause other than burns.
Patients with comorbidities.
Patients with psychiatric problems.
Patients who are lost to follow-up.

Ethical Considerations

Permission was taken regarding the initiation of the research in the committee for approval of the protocol in Hawler Medical University, and also from the hospital administrators from which the samples will be selected for operational procedure.
Consent forms were filled for each participant in this study, and it includes informing them that this information will be kept confidential and used solely for data analysis without disclosing any private information. The purpose of this study should be clear to each participant, and they are informed that there is no harm to them and they can withdraw from the study at any time.

Surgical technique for Starplasty

Before starting the procedure, the patient should undergo general anesthesia, the affected area should be exposed and prepared with an antiseptic solution following standard aseptic techniques, the Starplasty incision site is marked using a surgical marker, the incision is made parallel to the contracture using a scalpel, the vertical and oblique incisions are made to ensure that the flap will inset without tension. It was ideal to retain a thin layer of adipose tissue on the flaps, since this facilitates tissue glide and movement while minimizing the risk of harm to the dermal plexus.
The vascularity of the flaps is best preserved by using fine scissors to dissect parallel to the perforating vessels. Once bleeding is controlled, the flaps are inset. It's important to outline the incision lines on the skin for marking, the vertical incision runs perpendicular to the contracture line, the oblique incisions are angled to create triangular flaps, these flaps are later repositioned to release the contracture and allow better movement.
The type of suture depends on the thickness of the flap, if it is of sufficient thickness, It is recommended to use simple, interrupted deep dermal 3-0 or 4-0 monoaryl (polyglecaprone 23) or vicryl (polyglactine910) sutures, followed by a layer of 3-0 or 4-0 nylon for skin closure. But if the flap was thin in layer we can typically alternated between simple, interrupted 3-0 nylon sutures and vertical or horizontal mattress sutures using the same material, in order to get good skin eversion.[5]

Statistical analysis

All analyses performed using SPSS version 24.0 (USA, Chicago). For

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continuous variables, mean and standard deviation (SD) were calculated to present the variables (normally distributed), while frequencies and percentages were used to present categorical variables. Paired t-test was used to analyze the difference between consecutive variables. A *P*-value of <0.05 was considered statistically significant.

Results

A total of 20 patients both children and adults underwent contracture release surgery using Starplasty, the mean age of the patients was 21.25 ± 10.29 years, (ranging from 7 – 40 years), and patients underwent surgery after 3.8 years after the primary surgery, as illustrated in Table 1.
The most common etiology was hot water (60%), web space was the most common location (75%), in term of hand digits thumb was the most common location (25%), for type of contractures type IV was the most common type, as illustrated in Table 2.

Table 1 Demographic and clinical characteristics of patients with Starplasty for postburn contractures

Variables	Value
Total patients	20
Age (y), mean ± SD	21.25 ± 10.29
Gender, n (%)	
Female	13 (65%)
Male	7 (35%)
Time after injury (y), mean ± SD	3.8 ± 2.2

Y: year, SD: standard deviation

Table 2 Etiology and type of scar contractures in patients with Starplasty

Variables	Number (%)
Etiology, n (%)	
Hot water	12 (60%)
Flame	3 (15%)
Electrical burn	5 (25%)
Location	
Upper extremity	20 (100%)
Axilla	5 (25%)
Web space	15 (75%)
Hand digits (n = 15)	
Thumb	5 (33.3%)
Digit II	2 (13.3%)
Digit III	2 (13.3%)
Digit IV	4 (26.7%)
Digit V	2 (13.3%)
Type of contractures	
Type I: superficial	0 (0%)
Type II: linear	6 (30%)
Type III: diffuse	5 (25%)
Type IV: broadband	9 (45%)

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Few minor complications occurred (surgical site infection 15%), and mean operation time was 63.6 minutes, as illustrated in Table 3.

The mean preoperative ROM (range of motion) was 30.5% of the normal value, which was increased to 56.6%, 66.0%, 75.3%, and 88.2% of the normal value (postoperatively, after one week, one month, and three months respectively). On all follow-up occasions, the mean ROM increased statistically significantly (*P* <0.001), as illustrated in Table 4, Figure 1.

This line graph illustrates the improvement in ROM over time, the graph shows a significant increase in ROM from 30% preoperatively to nearly 90% at the three month mark, each point on the graph includes error bars indicating variability and *P*-values <0.0001 indicate statistically significant differences between the stages.

Table 3 Surgical characteristics of patients receiving Starplasty

Variables	Value
Operation time (minutes), mean ± SD	63.6 ± 15.0
Total complications, n (%)	
Major complications	0 (0%)
Minor complications	3 (15%)
Surgical site infection	3 (15%)

Table 4 Analysis of range of motion over time in patients with Starplasty

Time	ROM
Preoperative	30.5 ± 5.9
Postoperative	56.6 ± 6.4
One week PO	66.0 ± 8.5
One month PO	75.3 ± 8.9
Three months PO	88.2 ± 4.1

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Table 5 Analysis of angle of Motion over Time

Time	Angle of movement	
	Mean ± SD	Median (range)
Preoperative	49.5 ± 37.6	30.5 (23.0 – 93.0)
Postoperative	54.1 ± 39.0	34.5 (26.3 – 101.0)
One week PO	59.3 ± 41.3	39.5 (29.3 – 109.5)
One month PO	63.5 ± 42.6	44.5 (32.0 – 114.5)
Three months PO	68.8 ± 45.0	50.0 (34.3 – 121.5)

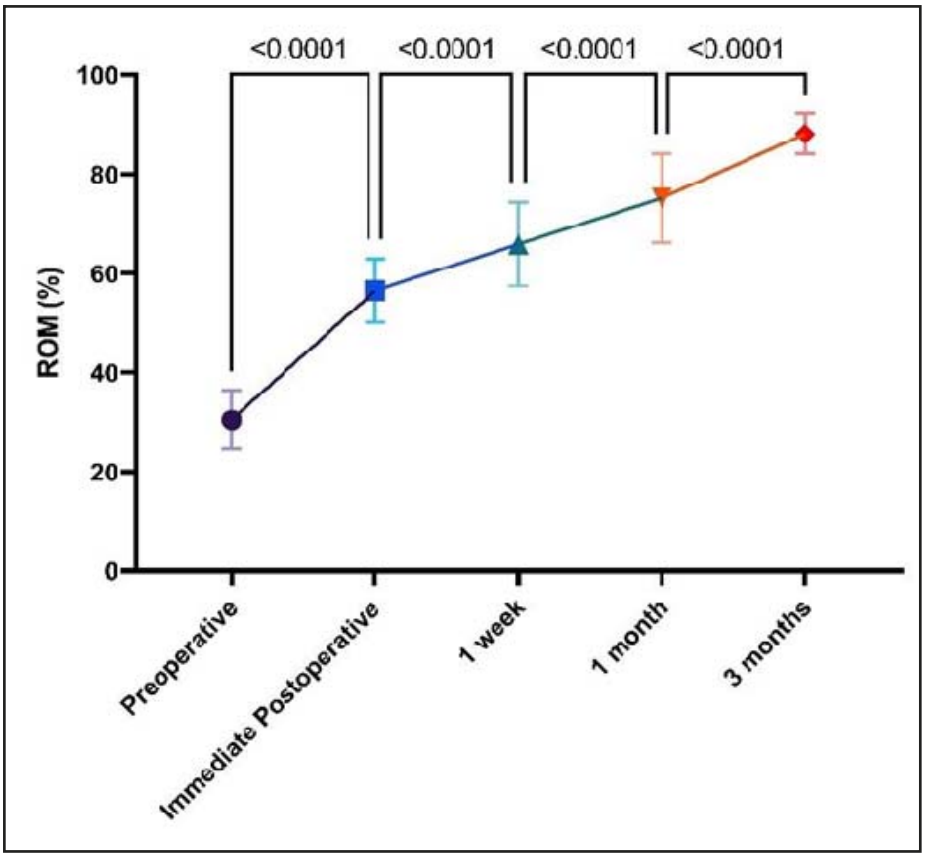

Figure 1 Assessment of ROM thought-out the study

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A 14 year old male presented with 23% body surface area burns after 5 years the patient suffered from contracture was managed using the Starplasty procedure (Figure 2). The patient's condition was visually compared before and after the Starplasty procedure with photographs A and C show the patient's condition before surgery and B and D one month postoperatively.

Figure 2 A) Before surgery, B) One month after surgery, C) Before surgery, D) One month post operative

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A 12 year old female presented with 13% body surface area burn that involved the anterior right axilla (Figure 3).

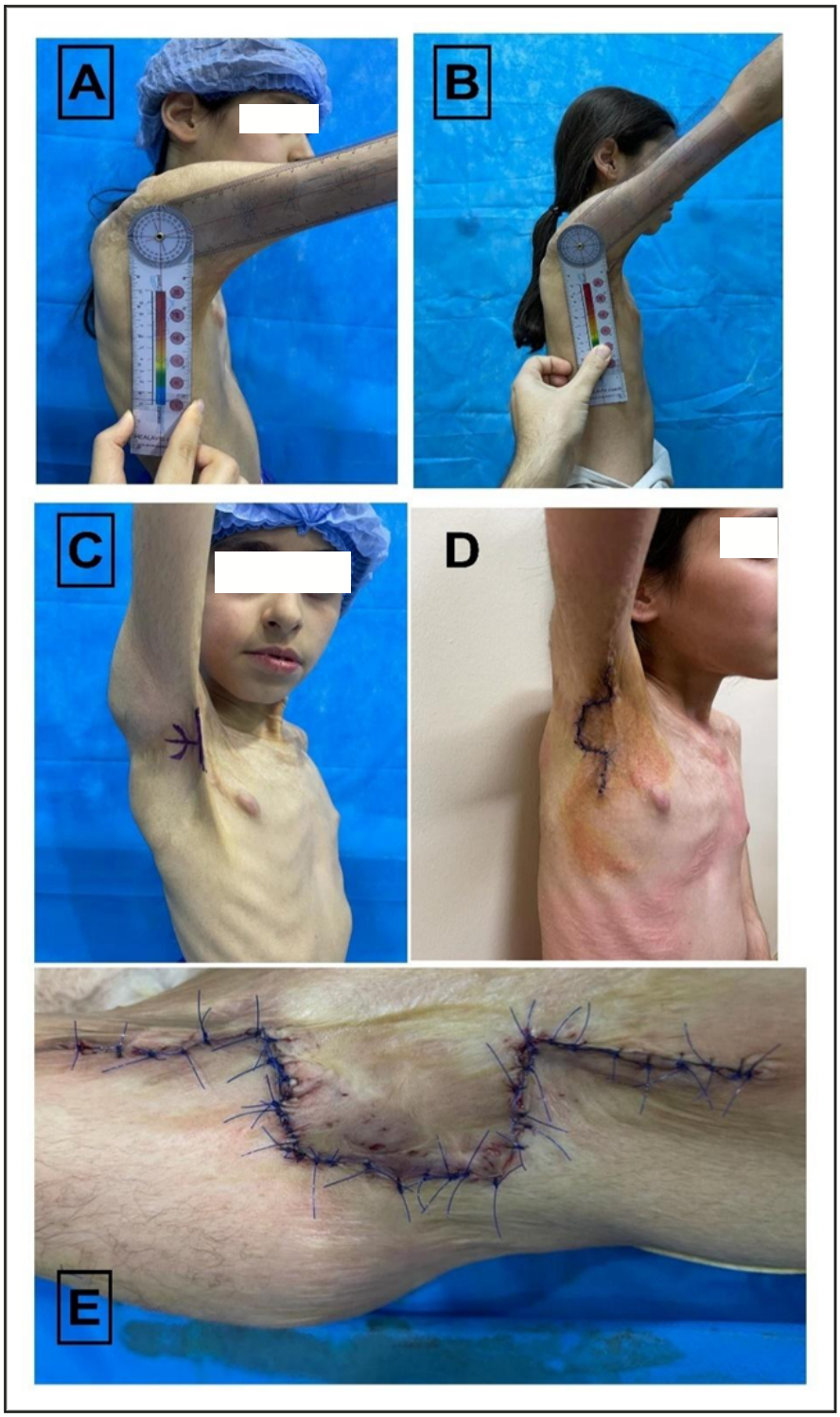

Figure 3 A) Preoperative (105°), B) one month postoperative (improved to 130°), C) preoperative Starplasty marking, D) one week Postoperative, and E) immediately postoperative

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A 24-year-old male, presented with left hand contracture (1st web space) caused by third degree electrical burn (23%) (Figure 4).

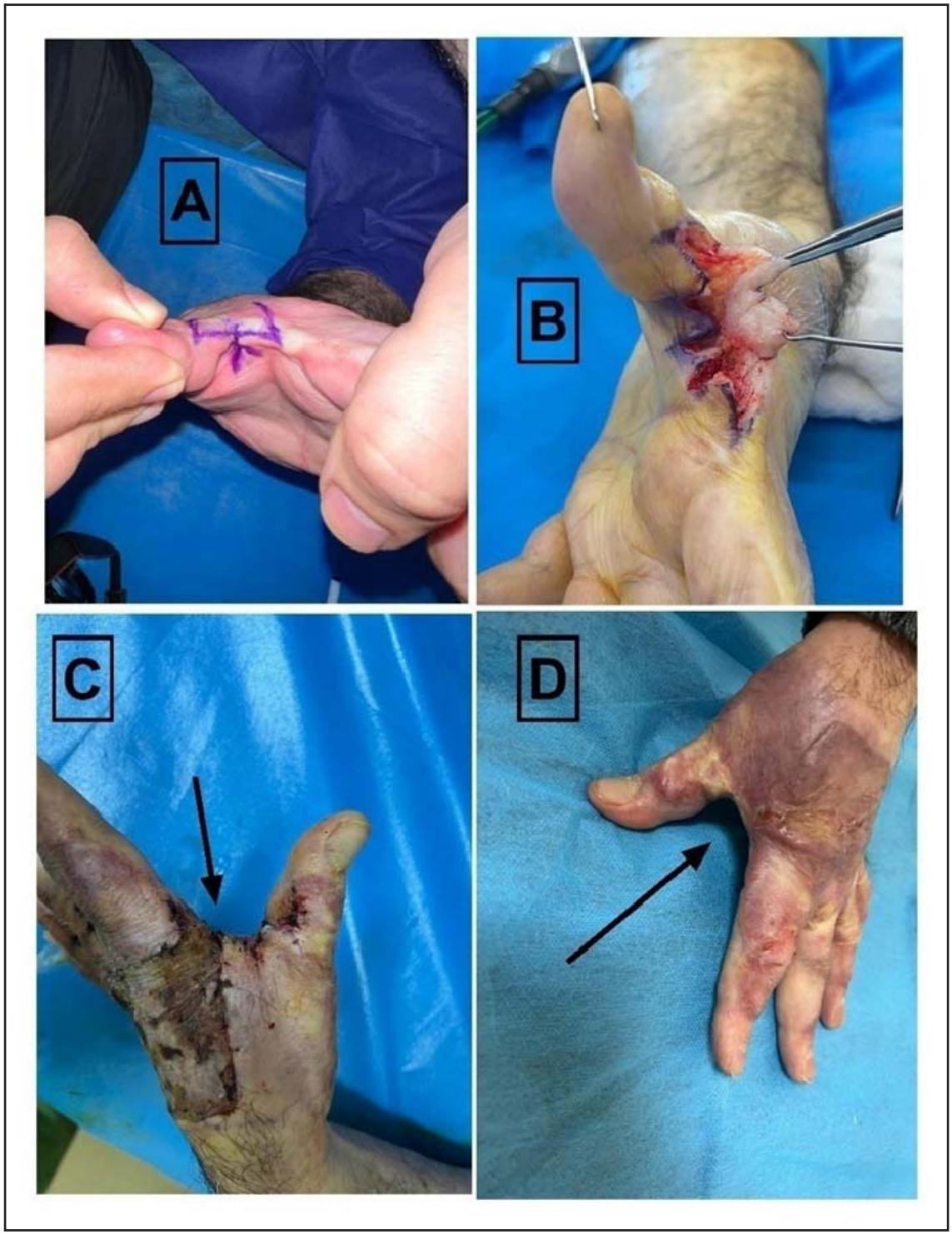

Figure 4 A) Preoperative, B) Intraoperative, C) One week postoperative, and D) Three months postoperative

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Discussion

This is the first longitudinal study that assessed the effectiveness of contracture release surgery (using Starplast flap), utilizing ROM as a principal outcome measure accompanied by a definitive statistical analysis.

Our results demonstrate that Starplasty surgery could be performed safely and was effective in the vast majority of cases, resulting in significant improvement in ROM. And in up to 3 months of follow up there was significant improvement of ROM 88.2 ± 4.1% of the normal movement value.

The study by Cauley et al. 2017 involved a retrospective review of patients who received web space reconstructions using Starplasty. Their results included twelve patients (mean age: 51 years; range: 38-63 years) who underwent a total of 16 Starplasty procedure an average of 11.1 months after burn injury. No complications occurred in the Starplasty group, including infection, flap loss, dehiscence, nerve injury, or recurrent contracture. All patients had improved function (mean follow-up: 30 days). These findings are in agreement with the current study.[6]

Aretrospective study by Liu et al. in 2024 involved the axilla of 27 patients with upper extremity burns who received 30 primary Starplasties for the treatment of axillary contractures. Three patients underwent simultaneous bilateral procedure, majority of the primary procedures were used to address contractures of the anterior axillary fold. The mean patient age was 36.8 years, the average time from first injury to primary reconstruction was 10.3 months.

One patient required revision for persistent contracture, another experienced wound dehiscence that ultimately required split thickness skin grafting, no other significant complications were noted, all remaining patients had closed wounds and full range of motion by 30 days post procedure. These findings are also in agreement with the current study.[7]

The dorsal portion of the digital web space is most commonly affected by neosyndactyly from hand burns. Tissue reorganizations involving the afflicted dorsal skin are frequently insufficient since the dorsum of the hand is often affected. To treat post-burn neosyndactyly when there is insufficient dorsal laxity, the Starplasty a unique local tissue rearrangement was developed to advance unaffected palmar skin. The Starplastyis a broad-based local advancement flap effective for treating wide contracture bands particularly when only one side of the band has slack tissue.[7]

In the ideal scenario, a multidisciplinary team and a progressive procedure would be used to treat the burned axilla. Axillary contractures may be less severe with physical therapy, long-term splinting, tissue -sparing tangential excision techniques,[8,9] and early skin grafting, it has been demonstrated.[10] The shoulder is still the most often affected joint, with contracture frequency ranging from 23% to 38%, despite current preventative efforts.[11] Therefore, appropriate subsequent surgical reconstruction is frequently required. [12]

The best surgical course of action for each contracture is determined by (I) the type of contracture, (II) the degree of the contracture, and (III) the patient's tolerance for surgical intervention, and should ideally follow the conventional reconstructive ladder. Any contracture with sufficient subcutaneous fat can be treated with simple release in combination with STSG, although this requires a donor site, demands immobilization, and may not produce the best functional results due to the high risk of recurrence.[13]

This procedure's simplicity and low surgical risk are advantages. A release and grafting technique may be the best option for patients who have severe medical comorbidities or who have no surrounding skin laxity. Although, unlike an STSG, the complete thickness defect will be restored with full thickness skin, in

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many circumstances a local tissue rearrangement or loco-regional flap should be used.[6]

Incorporating as much healthy tissue as you can into the reconstructed axillary fold is desirable if the contracture is large and the skin is spared unilaterally. By rearranging local tissue, the Hyakusoku and Fumiiri square flap approach may make it easier for healthy tissue to move into the line of contracture. Some writers contend that it offers an axilla that is more like the stereometric shape and function than the typical z-plasty. The flap, however, may theoretically be more susceptible to ischemia and subsequent dehiscence because the square flap approach calls for more flap rotation than the Starplasty. Since the Starplasty does not call for rotating the center advancement flap, we think it can advance a larger band of tissue than a square flap.[14]

Despite the fact that regional flaps from the back, flank, or posterior arm can be employed to treat severe contractures, they may be accompanied by significant donor site morbidity and a protracted recovery period. Many people need STSG or secondary flaps to close the secondary defect. These flaps frequently need laborious dissection, which may prolong the wait time in the operating room. Regional flaps are only advised when local flaps would not yield sufficient functional gains due to the more involved nature of the procedure in these situations.

Conclusion

Starplasty was successful and safe procedure in treating both Axillary and web space contractures. With no major complication and failure of flap, with response starting to exceed 50% of normal range of movement start as early as one week post operative.

Competing interests

The authors declare that they have no competing interests.

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