A PROSPECTIVE STUDY OF THE CLINICAL AND HISTOLOGICAL CHANGES AFTER FAT TRANSFER IN TREATMENT OF HYPERTROPHIC BURN SCARS.

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Abstract

Introduction Managing burn scars using conventional surgical methods poses difficulties because of the frequent recurrence of contractures. Although fat grafting has been explored in limited clinical trials, these findings are often influenced by a lack of rigorous scientific validation. Typically, fat grafting is assessed for its ability to fill spaces rather than being thoroughly validated for its potential in regenerating dermal tissue. Animal research has demonstrated dermal regeneration through the formation of new collagen fibres and their reorientation. Our study seeks to bridge the gap between in vitro research validity and its application in real-world clinical scenarios.

Methods: Our study conducted a prospective assessment of outcomes in 24 patients who underwent Fat Grafting for contracted burn scars that severely limited range of motion. Evaluation of results was carried out clinically using the Vancouver scale and by measuring range of motion at intervals of 1, 3, 6, and 12 months. Dermal regeneration was assessed by observing thickening of the dermis through high-definition ultrasound and examining scar remodelling by analysing the reorientation and new deposition of collagen fibres using haematoxylin-eosin histology and monoclonal antibodies targeting collagen type 1 and 3.

ResultsWe observed statistically significant clinical enhancements in the range of motion of the affected joints ($P<0.05$). On average, there was a 41.8% reabsorption of fat. Additionally, we observed thickening of the dermis and redistribution, as well as reorientation of collagen fibres within the dermis. Histological examination revealed patterns of new collagen deposition, local hypervascularity, and dermal hyperplasia within the context of newly formed tissue, closely resembling the original tissue structure.

ConclusionsOur findings represent the initial clinical scientific proof of dermal regeneration in fat grafting. Through the utilization of monoclonal antibodies and high-definition ultrasound, we showcase the inaugural evidence of dermis regeneration in a clinical context. The preliminary results indicate that lipofilling enhances scar quality and propose a process that enhances tissue regeneration.

Keywords: Burn Scars, Fat Grafting, Dermal Regeneration, Clinical Assessment, Tissue Remodeling.

INTRODUCTION

Reconstructive surgery for burn injuries presents significant challenges, including compromised functionality, cosmetic disfigurements, and often a shortage of suitable autologous tissue. In many developed countries, the standard approach involves primary excision and grafting of deep second-degree and full-thickness burns. This method aims to promote healing and reduce the formation of hypertrophic scars, which commonly occur through contraction and subsequent tension.[1,2]

Although fat grafting has shown promise in burn treatment, clinical studies have typically involved small patient groups and lack robust scientific validation. However, experiments on murine models have demonstrated promising outcomes such as improved revascularization, reduced scarring and fibrosis, and increased dermis thickness, accompanied by rearrangement of collagen fibres.[3] Our study seeks to bridge the gap between these in vitro findings and their practical application in clinical settings.

MATERIALS AND METHOD

Our study, approved by the Institutional Review Board (IRB), prospectively examined 24 patients who underwent treatment utilizing the Fat Grafting technique.

Inclusion criteria encompassed patients presenting with contracted scar bands in flexion creases, including regions such as the face and neck (n=6), upper extremity and axilla (n=3), lower extremities (n=2), and perineum (n=1).

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All assessed scars restricted the range of motion of the affected joints and had previously undergone treatment such as scar release, skin grafts, or Z-plasties, performed at least one year following the initial injury.
Clinical evaluation of scars utilized the Vancouver scale, while joint range of motion was measured using a goniometer at intervals of 1, 3, 6, and 12 months post-treatment. Histological analysis was conducted in three patients to assess dermal regeneration, employing hematoxylin-eosin and rabbit monoclonal antibodies staining for collagen type I and III before and after treatment. Additionally, the survival of fat grafts and changes in skin were evaluated through high-frequency 18MHz ultrasound imaging.[4]Both ultrasound and biopsy procedures were conducted at predetermined anatomical landmarks to minimize bias. Statistical significance was determined using the Student's t-test.

Procedure:
The technique involved positioning scar bands under tension on the operative table to aid in their release. Fat harvesting was conducted from the abdomen in all patients, utilizing 60 cc syringes under negative pressure. The harvested fat was initially washed with ringer lactate and processed on non-adherent gauze pads. Subcision of scar cords was performed using 18G needles, employing the "Rigottomy" technique, as described by Gino Rigotti. This technique involved creating multiple small (2 mm) cavities to release and stretch-expand contracted scars. Fat grafting was then performed using 2.5 mm lipofilling cannulas, injecting 0.3 ml of fat in a three-dimensional pattern at each pass.

Special considerations were made for specific anatomical areas. For instance, on the face, injections were mainly targeted at the jawline to minimize potential postoperative disfiguration in case of weight gain. On the hands, subcision was performed between the dermis and extensor tendons, followed by fat grafting into the released space.

The postoperative protocol included oral antibiotics for three days and suture removal at one week. Stretching exercises commenced on postoperative day 5. Between surgical sessions, a 2–3 month interval was observed to allow for graft take and remodeling. A maximum of three sessions were utilized.

RESULTS

The mean operative time was recorded at 70 minutes, with an average tumescent fluid infiltration of 100 cc, and a mean injection of fat grafts measuring 45 cc.All patients demonstrated statistically significant improvements in scar contractures according to the Vancouver scale, as well as enhancements in the range of motion for various anatomical regions including the head, neck, hands, lower extremities, and perineum (P<0.05) (Refer to Table 1 and Figure 1). High-frequency ultrasound assessments revealed an average fat reabsorption rate of 41.8%, alongside an increase in dermal thickness (Table 1). Histological staining using rabbit monoclonal antibodies displayed heightened deposition of collagen I following fat grafting, with the fibers demonstrating regular orientation akin to that of mature healing dermis. One patient experienced skin breakdown but healed without complications. Notably, no instances of donor site morbidity were observed.

Table 1.

	Pre-operative	**Post-operative**	***P*-value (T-test)**
Vancouver scale	10 (18–24)	4 (6–14)	0.0025
Range of motion neck (Rotation)	82 (50–100)	123.9 (90–160)	0.0165
		[41.8]	
Range of motion neck (flexion/extension)	36.3 (20–45)	61.2 (45–70)	0.0452
		[24.9]	
18 MHz US dermal thickness	0.23 mm	0.37 mm	0.0007
Fat resorption		41.8% (25–60)	

DISCUSSION

Non-surgical methods for scar release often yield unsatisfactory results. Surgical interventions, such as excision and reconstruction using local tissue rearrangement techniques like Z-plasties, flaps, tissue expansion, and skin grafting, are commonly employed. However, these surgical approaches may present challenges such as tissue scarcity, potential for creating new contractures, and the need for complex tissue borrowing. Hence, subcision and fat grafting offer a promising alternative for managing contracted scars. By remodeling the scar internally, the risk of developing new contractures is minimized.

Although this study has limitations such as a small sample size and the potential for information bias due to measurement errors during scar and range of motion evaluations, it presents encouraging findings for treating contracted scars. Our clinical outcomes, supported by scientific validation through high-definition ultrasound

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and histological examination, demonstrate the regenerative effects of fat grafting. Notably, histological changes within the dermis and the rearrangement of collagen type I fibres further underscore the efficacy of this approach. We recommend that future research should involve larger sample sizes and randomized clinical trial designs to further investigate the potential of this technique.

CONCLUSION

In conclusion, it's important to acknowledge that the *fat transfer*technique may not achieve complete effectiveness in all cases, particularly when dealing with thick scars that severely restrict range of motion. Moving forward, our study aims to incorporate patients in the early stages of burns to potentially alter the natural course of scar retraction.Our findings mark the first validation of grafting outcomes previously only demonstrated in vitro studies. The observed improvements in range of motion, dermal thickening, and fat graft survival provide compelling evidence for the novelty and validity of this technique in clinical practice.

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