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OUTCOME OF SKIN GRAFT DONOR SITE HEALING, WITH AND WITHOUT INFILTRATION OF TUMESCENT SOLUTION: A COMPARATIVE INTERVENTIONAL STUDY IN A TERTIARY CARE HOSPITAL

DR SIDDESH G B,DR PAVAN KUMAR S,DR SUJATHA V BADIGER,DR BHARATH KUMAR T J

Corresponding Author:DR BHARATH KUMAR T J

ABSTRACT

Background: In the sphere of skin grafting, a variety of treatments have been recommended for donor site healing including the application of ice, utilization of topical agents like lidocaine and bupivacaine, and the use of wound dressings based on hydrocolloid and polyurethane coupled with fibrin sealant. The tumescent technique, evolving steadily over the past 20 years, has proven beneficial in accelerating healing at the graft donor sites. However, limited studies are available that contrast the healing rates of donor sites post tumescent solution infiltration to the non-infiltration approach.The objectives of this study are: a) To ascertain the percentage of wound healing by epithelization at the donor site on day 10 post-surgery.b)To evaluate pain relief at the donor site using the visual analog scale on the first postoperative day.

Methodology: Upon securing informed written consent and conducting a detailed history and clinical examination of the patients, they were segregated into two distinct groups. Group A (n=30) underwent tumescent infiltration at the donor site, while Group B (n=30) did not. The division was facilitated by an odd and even numbering scheme. The tumescent solution utilized in Group A comprised 1 mg (1:1000) adrenaline mixed in 500 mL of saline. Following the skin graft procedure, the donor site was examined closely. Documentation of healing and pain relief was done on days 10 and 1 post-operation respectively, using the wound tracing and visual analog pain scale techniques.

Results: The study unveiled that the average pain score on the first postoperative day was markedly lower in the tumescent group (3.97 ± 0.89) compared to the non-tumescent group (5.6 ± 0.89). Moreover, a higher rate of epithelization was noted on the tenth day post-operation in the tumescent

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group (68.33 ± 10.11) as opposed to the non-tumescent group (51.33 ± 8.9).

Conclusion: The study elucidates that the tumescent technique significantly mitigates postoperative complications and encourages faster healing compared to the non-tumescent technique. This implies a superior efficacy in terms of both pain alleviation and heightened epithelization rate at the donor site when the tumescent infiltration method is adopted.

Keywords: Skin Grafting, Tumescent Technique, Wound Healing, Epithelization, Visual Analog Scale

INTRODUCTION

The skin, being the largest organ in the human body, functions as a primary barrier, safeguarding the organism from a variety of external threats such as pathogens, mechanical injuries, and radiation. Additionally, it plays a pivotal role in regulating bodily temperature and maintaining fluid equilibrium, endowed with specialized receptors that facilitate the perception of sensations like pressure, temperature, and pain. The maintenance of skin integrity is fundamental for sustaining bodily homeostasis. However, severe skin loss instances, like burns, have the potential to jeopardize this integrity 1,2.

In the medical field, skin grafts are categorized into two main groups: split-thickness and full-thickness skin grafts. While a split-thickness graft comprises a portion of the dermis, a full-thickness graft incorporates the entire dermis layer. Furthermore, split-thickness grafts can be subdivided into three variants: mesh, stamp, and chip skin grafts.

Skin grafting, a medical practice rooted in antiquity, serves as a potent tool in the treatment of both acute and chronic wounds. According to the principles governing the reconstructive ladder for skin defect repair, autologous grafts function not only as a tissue replacement but also as a pharmacological catalyst for healing processes 6. Utilization of full-thickness skin grafts (FTSGs) in chronic wound areas primarily aims at securing wound closure accompanied by functional restoration of the skin. Conversely, when employed in acute wound areas, FTSGs can potentially enhance the cosmetic outcome besides fulfilling the primary healing objectives 5.

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Autologous skin transplants are systematically classified based on the harvested skin depth 7. Historically, various skin graft forms have been employed for wound repair. An FTSG, which entails the removal of the entire epidermis and dermis along with associated adnexal structures, facilitates skin contracture prevention and augments the cosmetic appearance of the treated site. In contrast, split-thickness skin grafts (STSGs) - encompassing the whole epidermis and a part of the dermis along with connected adnexal structures - effectively contribute to wound coverage and facilitate the reinstatement of normal skin functions, albeit without hindering wound contracture due to their relative thinness 8.

However, the adoption of the tumescent technique in the context of STSGs has been restrained, primarily owing to concerns regarding graft longevity, especially post the administration of adrenaline. A significant proportion of surgeons still prefer conventional methods such as electrocautery, tourniquets, or the application of adrenaline-soaked gauze 9,10.

The tumescent technique, characterized by the infusion of large quantities of diluted local anesthetics like lidocaine or bupivacaine into the subcutaneous fat layers, potentially with the addition of an adrenaline solution, induces a state of tumescence or swelling in the targeted surgical site. This method ensures regional skin and subcutaneous tissue anesthesia, facilitating pain-free cutaneous surgeries. Apart from providing extensive bodily surface anesthesia, this technique curtails bleeding instances, extends post-surgery analgesic effects, and promotes easier surgical dissections. Moreover, it effectively reduces post-operative edema and bruising, presenting several advantages in cutaneous surgical procedures 11,12.

AIM AND OBJECTIVES

1. To assess the percentage of wound healing by epithelization at donor site on a postoperative day 10.
2. To determine pain relief at donor site by using the visual analog scale on postoperative day 1.

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MATERIALS AND METHODS

Source of Data:

The study was conducted in the department of general surgery at the Sapthagiri Institute of Medical Sciences and Research Center. Patients who were scheduled for surgery and willing to give consent were included in the study, provided they met the inclusion criteria.

Type of Study:

The study was characterized as a comparative interventional study.

Inclusion and Exclusion Criteria:

Inclusion Criteria:

1. Patients who provided informed written consent.
2. Individuals ranging between the ages of 1 and 65 years, from either sex.
3. Patients who presented with clean wounds prepared for grafting.
4. Patients with well-managed diabetes mellitus.

Exclusion Criteria:

1. Patients whose donor site swab cultures exhibited growth of beta-hemolytic streptococcus, Citrobacter, or acinetobacter.
2. Patients with a documented history of allergy to the study drug, lignocaine.
3. Patients diagnosed with chronic kidney disease, cardiovascular ailments, or deemed unfit for surgery.

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Sample Size:

The sample size comprised 60 patients, calculated using the formula:

$n=2 (Z \alpha + Z \beta)^2 \Sigma^2 /d^2$

$n=2(1.96+0.84)^2 (1.43)^2/(1.2)^2$

n=32.06/1.44 =22.26 =30 in each group.

Where n = sample size, Z α= 95, C.I = 1.96, Z β = 80%, power=0.84, Σ=standard deviation, d=difference in two means

Methodology:

Upon obtaining written informed consent, a detailed history and clinical examination of the patients were conducted. The patients were then segregated into two groups: group A (n=30) undergoing tumescent infiltration at the donor site, and group B (n=30) without infiltration. The division was based on the odd and even numbering system. The tumescent technique involved administering 1 mg (1:1000) of adrenaline mixed with 500 mL of saline for one group, and a non-tumescent approach for the other. Following skin grafting, the donor site was examined. On the 10th postoperative day, the healing rate was determined using the wound tracing technique. The visual analog pain scale was used to assess pain relief on the first postoperative day.

Statistical Analysis:

Data were entered into a Microsoft Excel spreadsheet and analyzed using SPSS version 22 software. Categorical data were represented through frequencies and proportions, and the Chi-square test was utilized to test significance for qualitative data. Continuous data were described using mean and standard deviation. The independent t-test was applied to find the

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mean difference between two groups for both quantitative and qualitative variables. Graphical data visualization was achieved using MS Excel and MS Word, encompassing bar and column diagrams. A p-value (probability indicating the truth of the results) of 0.05 was considered statistically significant. Data analysis was conducted using IBM SPSS Statistics, Somers, NY, USA, incorporating MS Excel and SPSS version 22.

RESULTS

Table 1: Mean Age Comparison between two groups

	Group				p-value
	With Tumescence		Without Tumescence		
	Mean	SD	Mean	SD	
Age	41.87	18.58	44.20	21.79	0.66

Mean Age in With Tumescence Group was 41.87 ± 18.58 and in the Without Tumescence Group was 44.2 ± 21.79. There was no significant difference in mean age comparison between the two groups.

Table 2: Age Distribution between two groups

		Group			
		With Tumescence		Without Tumescence	
		Count	%	Count	%
Age	< 20 years	4	13.33%	4	13.33%
	21 - 30 years	2	6.67%	5	16.67%
	31 - 40 years	7	23.33%	2	6.67%
	41 - 50 years	5	16.67%	5	16.67%
	51 - 60 years	7	23.33%	4	13.33%
	> 60 years	5	16.67%	10	33.33%

$\chi 2 = 6.548$, df = 1, p = 0.256

In Group with Tumescence, 13.33% were < 20 years, 6.67% were in 21 - 30 years, 23.33%

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were in 31 - 40 years, 16.67% were in 41 - 50 years, 23.33% were in 51 - 60 years and 16.67% were > 60 years.

In Group without Tumescence, 13.33% were in < 20 years, 16.67% were in 21 - 30 years, 6.67% were in 31 - 40 years, 16.67% were in 41 - 50 years, 13.33% were in 51 - 60 years and 33.33% were in > 60 years.

There was no significant difference in Age Distribution between the two groups.

Table 4: Mean POD1 Pain Comparison between two groups

	Group				p-value
	With Tumescence		Without Tumescence		
	Mean	SD	Mean	SD	
POD1 Pain	3.97	.89	5.60	.89	< 0.001*

Mean POD1 Pain in With Tumescence Group was 3.97 ± 0.89 and in Without Tumescence Group was 5.6 ± 0.89. There was a significant difference in mean POD1 Pain comparison between the two groups

Table 5: Mean POD10 Percentage of Epithelization Comparison between two groups

	Group				p-value
	With Tumescence		Without Tumescence		
	Mean+/- SD		Mean+/- SD		
POD10 Percentage of Epithelization	68.33+/- 10.11		51.33+/- 8.90		< 0.001*

Mean POD10 Percentage of Epithelization in With Tumescence Group was 68.33 ± 10.11 and in Without Tumescence Group was 51.33 ± 8.9. There was a significant difference in mean

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POD10 Percentage of Epithelization comparison between two groups

Table 6: Diagnosis Distribution between two groups

		Group			
		With Tumescence		Without Tumescence	
		Count	%	Count	%
Diagnosis	Burns	1	3.33%	0	0.00%
	Cellulitis	1	3.33%	0	0.00%
	Chronic nonhealing ulcer left heel pad	1	3.33%	1	3.33%
	Contracture	1	3.33%	0	0.00%
	Diabetic foot	0	0.00%	3	10.00%
	OPEN Fracture	0	0.00%	1	3.33%
	Infected wound	0	0.00%	3	10.00%
	Left diabetic foot with nonhealing ulcer	2	6.67%	0	0.00%
	Left leg raw area with heel defect	1	3.33%	0	0.00%
	PBC-Bilateral Hand	1	3.33%	0	0.00%
	post amputated	0	0.00%	3	10.00%
	Post-burn	0	0.00%	1	3.33%
	Post-burn	0	0.00%	1	3.33%
	Post cellulitis	4	13.33%	0	0.00%
	Post electrical burn	0	0.00%	1	3.33%
	Post electrical burn	1	3.33%	1	3.33%
	Post infective raw area right lower limb	2	6.67%	3	10.00%
	Post-traumatic	7	23.33%	9	30.00%
	R>T>I	0	0.00%	1	3.33%
	right foot infected wound	0	0.00%	1	3.33%
	right lower limb raw area	1	3.33%	0	0.00%
	RTA	0	0.00%	1	3.33%
	Superficial accidental scalp burns	2	6.67%	0	0.00%
	Superficial burns	1	3.33%	0	0.00%
	Thermal Burns	1	3.33%	0	0.00%
	Upper limb degloving	1	3.33%	0	0.00%
	Wound	1	3.33%	0	0.00%
	Wound over the right medial aspect of the foot	1	3.33%	0	0.00%

There was no significant difference in diagnosis distribution between the two groups.

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Table 7: Procedure distribution between two groups

		Group			
		With Tumescence		Without Tumescence	
		Count	%	Count	%
Procedure	Contracture release with abdominal flap cover with skin grafting	1	3.33%	0	0.00%
	Contracture release with dorsolateral flap cover with FTSG	1	3.33%	0	0.00%
	Debridement with dorsal skin rotation with skin grafting	1	3.33%	0	0.00%
	Debridement with mastectomy with skin grafting	1	3.33%	0	0.00%
	Debridement with skin grafting	17	56.67%	28	93.33%
	Debridement with thoracoepigastric flap cover with skin grafting	1	3.33%	0	0.00%
	ORIF with skin grafting	0	0.00%	1	3.33%
	Rotation flap cover with skin grafting	1	3.33%	0	0.00%
	Skin Grafting	1	3.33%	1	3.33%
	Split skin graft	2	6.67%	0	0.00%
	Wound debridement and grafting	1	3.33%	0	0.00%
	Wound debridement and skin grafting for the raw area	1	3.33%	0	0.00%
	Wound debridement and split skin grafting	1	3.33%	0	0.00%
	Wound debridement with sural flap with skin grafting	1	3.33%	0	0.00%

There was no significant difference in procedure distribution between the two groups.

DISCUSSION:

Despite its potential benefits, the tumescent technique in split-thickness skin grafting (STSG) has not been widely adopted, largely due to uncertainties surrounding graft sustainability, particularly following adrenaline use[^13][^14]. Traditional methods like electrocautery, tourniquets, and topical adrenaline gauze continue to be favored by many surgeons, even

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though these methods are known to cause considerable blood loss[^15][^16]. The perception of the impact of adrenaline varies among researchers, with some asserting that its effects are minimal and temporary, while others are concerned about the potential negative impact on the harvested graft and the recovery of the donor site[^17][^18].

In contrast, the implementation of tumescent anesthesia in cutaneous surgeries has heralded a new era of operations characterized by reduced blood loss and pain, as well as diminished post-operative swelling and bruising[^19]. The utilization of subcutaneous injections facilitates a better plane for graft harvesting, promoting quicker removal of dead tissue with less hemorrhage. Moreover, the antimicrobial properties of the anesthetic agents used in the procedure further assist in averting infections at the surgical site[^20].

In a study conducted at the Sapthagiri Institute of Medical Sciences and Research Center, a comparative intervention involving 60 participants was carried out. Thirty participants received tumescent infiltration at the donor site, whereas the other half did not. This research was initiated after obtaining institutional ethical clearance and securing informed consent from the participants.

General Profile:

The average age in the Tumescence Group was noted to be 41.87 ± 18.58, slightly contrasting with the 44.2 ± 21.79 age bracket observed in the Non-Tumescence Group. A notable majority of participants across both groups were male. In Group 1, post-traumatic and wound conditions were prevalent, accounting for 23.3% each, a figure slightly lower compared to the 36.7% witnessed in Group 2 for the same conditions. A substantial number of participants in both groups underwent debridement with skin grafting, being more common in Group 2 (93.3%) as compared to Group 1 (56.67%).

Upon comparing this with other studies like the one conducted by Koujalagi R et al., it was found that the age demographics and gender distributions were somewhat similar, although

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Group A was slightly younger and Group B older compared to the current study. The matching age, gender, and diagnoses in both studies arguably reduce the influence of these variables on the study outcomes[^21][^22].

Outcome:

The results of the current study indicate a significant variance in the post-operative day 1 (POD1) pain levels and the percentage of epithelization on post-operative day 10 (POD10) between the groups. Notably, the Tumescence Group exhibited less pain and a higher percentage of epithelization compared to the Non-Tumescence Group.

When compared with other studies, the data seemed to echo the efficacy of the tumescent method. Koujalagi R et al. highlighted a significant difference in the rate of complete epithelization between two groups, with the tumescent method showing promising results[^23]. Similarly, the study by Rajendran MK et al. showcased a marginally higher graft take rate in the tumescent group, though the difference in the percentage of donor site healing on day 10 was not statistically significant[^24].

Furthermore, Gumus N underlined the simplicity, efficacy, and safety of the tumescent infiltration technique employing adrenaline and lidocaine. The method not only facilitated easy surgical dissections but also led to reduced blood loss and bruising, paving the way for rapid and painless burn surgeries[^25].

It seems evident that employing tumescent anesthesia in cutaneous surgery may lead to not only reduced blood loss and easier graft harvesting but also expedited healing with fewer complications[^26]. Vasoconstrictors like adrenaline, utilized in the tumescent technique, have been primarily studied for their effects on epithelialization and donor healing durations, showing promising prospects[^27].

CONCLUSION:

As per the results, skin grafts treated with tumescent infiltration at the donor site had less pain

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intensity on POD1 than those treated without infiltration, and subjects treated with tumescent infiltration at the donor site had an increased epithelization rate. Hence Overall efficacy of donor graft sites treated with tumescent infiltration was higher than that of sites not treated with infiltration. As compared to non-tumescent techniques, the tumescent approach proved beneficial in lowering postoperative pain and resulting in faster healing.

Due to the efficacy of Donor site grafts treated with tumescent infiltration in lowering discomfort on POD1 and increasing epithelization rate, it is suggested for usage in the donor site during skin grafts. According to the findings, using the tumescence approach in procedures involving patients with burns, ulcers, post-traumatic, and cellulitis could help them heal faster.

The study also suggests that more research be done using randomization procedures and taking into account confounding factors.

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