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Comparative Study of Split Skin Graft Take After Harvesting with Tumescent and Non-Tumescent Technique

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Abstract: ***Background: Split thickness skin grafting is a widely employed reconstructive procedure for coverage of raw areas following trauma, burns, and surgical debridement. The success of skin grafting depends on multiple factors, including donor site characteristics, recipient bed condition, and perioperative technique. The tumescent technique, commonly practiced in liposuction, involves the infiltration of a dilute solution containing crystalloid, lignocaine, adrenaline, and sodium bicarbonate. While this technique is known to reduce blood loss and provide local anesthesia, its role in split thickness skin graft harvesting has not been widely explored. Objectives: To compare graft take and donor site healing following split thickness skin graft harvesting using tumescent and non-tumescent techniques. Methodology: This prospective observational study was conducted at Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai, over a one-year period from July 2017 to June 2018. A total of 50 patients aged 18–65 years with clean wounds prepared for grafting were included. In each patient, split thickness skin grafts were harvested using both tumescent and non-tumescent techniques, allowing direct comparison while minimizing confounding variables. Graft take was assessed on postoperative day 5, donor site healing was evaluated on day 10, and final outcomes were recorded after a follow-up period of three weeks. Results: The mean percentage graft take on day 5 was significantly higher in the tumescent technique compared to the non-tumescent technique. Donor site healing on day 10 was also superior in the tumescent group. Statistical analysis demonstrated a significant difference between the two techniques for graft take and donor site healing in the early postoperative period. However, by the end of three weeks, both techniques showed comparable final outcomes. Conclusion: Harvesting split thickness skin grafts using the tumescent technique results in improved early graft take and faster donor site healing compared to the non-tumescent technique. The benefits are likely attributable to reduced blood loss, decreased hematoma or seroma formation, and the bacteriostatic properties of lignocaine. The tumescent technique represents a simple and effective modification that can enhance early outcomes in split thickness skin grafting.***

Keywords: Split thickness skin graft; Tumescent technique; Non-tumescent technique; Graft take; Donor site healing; Adrenaline; Lignocaine

1. Introduction

Split thickness skin grafting remains a cornerstone reconstructive procedure for the management of raw areas following wound debridement in conditions such as cellulitis, necrotizing fasciitis, burns, and traumatic injuries. Once a healthy granulation tissue bed is achieved, coverage with a split thickness skin graft harvested from a suitable donor site most commonly the thigh provides effective wound closure and promotes healing. The overall success of skin grafting is determined by three principal factors: the condition of the donor site, the quality of the recipient bed, and the general physiological status of the patient [1,2].

Graft uptake is a dynamic biological process that depends on initial plasmatic imbibition, subsequent inosculation, and eventual vascular ingrowth from the recipient bed. Adequate postoperative immobilization is also essential to allow uninterrupted neovascularization [3]. Several factors can adversely affect graft take, including seroma or hematoma formation beneath the graft, shearing forces, infection, and poor vascularity of the recipient bed. Patient-related factors such as comorbid illnesses and smoking further compromise graft survival. Graft uptake is known to be suboptimal over structures with limited blood supply, such as bone, cartilage, and tendon, emphasizing the importance of a well-vascularized and infection-free wound bed prior to grafting [4].

One of the important intraoperative considerations during skin graft harvesting is control of bleeding from the donor site. Excessive bleeding not only obscures the operative field but also increases the risk of hematoma formation, which can negatively impact graft adherence and early survival [5]. Vasoconstrictors such as adrenaline have therefore been used to reduce blood loss during graft harvesting. However, the local and systemic effects of adrenaline may vary among patients, and its optimal method of administration remains an area of interest [6].

The tumescent technique involves the subdermal and intradermal infiltration of a solution containing a crystalloid, a local anesthetic such as lignocaine, a vasoconstrictor like adrenaline, and sodium bicarbonate. This technique creates tissue tumescence, providing hydrodissection, improved hemostasis through vasoconstriction, and local anesthesia [7]. Crystalloid solutions hydrate the donor site and facilitate uniform graft harvest, while lignocaine offers analgesia along with bacteriostatic properties that may reduce infection risk and enhance graft take at the recipient site [8].

Although the tumescent technique has been widely practiced for several decades, particularly in liposuction and other dermatologic procedures, its application in split thickness skin graft harvesting has not been widely adopted. Limited literature exists evaluating its effect on graft take and donor site healing when compared to the conventional non-tumescent technique [9,10].

Therefore, it is of interest to evaluate the effectiveness of the tumescent technique in split thickness skin graft harvesting, with particular emphasis on graft uptake and donor site healing, in comparison with the non-tumescent technique.

Aim and Objectives

Aim

To compare the effectiveness of the tumescent technique with the non-tumescent technique in split thickness skin graft harvesting.

Objectives

1) To compare the efficacy of tumescent and non-tumescent techniques in split thickness skin grafting.
2) To assess the distribution of age and gender among patients undergoing split thickness skin grafting in both techniques.
3) To evaluate the percentage of donor site healing on postoperative day 10 in patients undergoing graft harvesting by tumescent and non-tumescent techniques.
4) To compare the percentage of graft, take on postoperative day 5 between grafts harvested using the tumescent technique and those harvested using the non-tumescent technique.
5) To assess the final outcome of donor and recipient sites after a short-term follow-up period of three weeks.

2. Materials and Methods

Study Design and Setting

This was a prospective observational study conducted at Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai, over a period of one year from July 2017 to June 2018.

Sample Size and Study Population

A total of **50 patients** requiring split thickness skin grafting were included in the study. All patients fulfilled the predefined inclusion and exclusion criteria.

Subject Selection

Inclusion Criteria

1) Patients aged between **18 and 65 years** with no associated comorbid conditions.
2) Patients with **clean wounds** prepared adequately for split thickness skin grafting.
3) Patients who provided **informed consent** to participate in the study.

Exclusion Criteria

1) Patients with comorbid conditions such as hypertension, diabetes mellitus, liver disease, renal failure, malignancies, vasculitis, HIV/AIDS, or protein energy malnutrition.
2) Patients with **serum albumin levels < 30 g/dl** or **hemoglobin levels < 10 g/dl**.
3) Patients unwilling or unable to provide consent.
4) Patients with a known **allergy to adrenaline**.
5) Presence of wound infection with pus swab growth of **beta-hemolytic streptococcus, Citrobacter, or Acinetobacter**.
6) Current smokers or patients who had stopped smoking less than six months prior to surgery.
7) Patients with **chemical or electrical burns**.

3. Methodology

All patients meeting the inclusion criteria were enrolled and evaluated. The following data were collected for each patient:

- Routine blood investigations including hemoglobin and total white blood cell count
- HIV testing
- Measurement of the surface area of the raw wound by tracing using sterile gauze
- Wound swab culture to rule out infection
- Administration of a test dose of lignocaine and adrenaline

A comparative intra-patient study design was employed, wherein split thickness skin grafts were harvested using both tumescent and non-tumescent techniques in the same patient, thereby minimizing inter-patient variability and confounding factors.

Procedure

Patients who fulfilled the inclusion criteria underwent split thickness skin grafting under spinal anesthesia, as all cases involved the lower limb. Routine preoperative investigations were completed, and anesthetic fitness was obtained. Wound swab culture was performed, and the procedure was undertaken only after confirmation of negative culture results. The tumescent local anesthetic solution was prepared on the day of surgery in the operating room and consisted of 0.1% lignocaine (1 mg/ml) with 10 mEq/L sodium bicarbonate in lactated Ringer's solution, along with adrenaline in a concentration of 1:1,000,000. The volume and concentration were adjusted based on the size of the donor area. The solution was infiltrated manually using a syringe connected to a Klein needle.

After preparation of the donor site, tumescent solution was injected intradermally and subdermally until adequate tumescence was achieved. Graft harvesting was commenced after a waiting period of approximately 10 minutes. The donor area was lubricated with petroleum jelly, and the limb was stabilized. The graft was harvested using a Humby knife with a Downe blade.

The harvested graft was meshed and applied to the prepared recipient site, secured with monocryl sutures, and covered with Bactigras dressing. The limb was immobilized using plaster of Paris. A tight dressing was applied over the donor site.

Figure 1: Split thickness skin graft harvested using tumescent technique

Intraoperative photograph showing split thickness skin graft harvested from the thigh following tumescent infiltration. Uniform graft thickness with minimal bleeding at the donor site is noted, reflecting effective vasoconstriction and adequate tissue tumescence during harvest.

Figure 2: Recipient site following graft placement harvested by tumescent technique

Postoperative image demonstrating graft applied over the recipient site with good adherence and minimal oozing. The graft appears well seated with evenly distributed mesh openings, indicating satisfactory early graft uptake.

Figure 3: Recipient site following graft placement harvested by non-tumescent technique

Postoperative photograph showing graft harvested without tumescent infiltration. Compared to the tumescent technique, increased surface oozing and less uniform graft appearance are observed, highlighting differences in intraoperative hemostasis.

Postoperative Assessment

- Recipient site was evaluated on postoperative day 5 for percentage of graft take.
- Donor site was assessed on postoperative day 10 for percentage of epithelialization and healing.
- Final assessment of donor and recipient sites was performed after a short-term follow-up period of three weeks.

Data Analysis

Collected data were analyzed using IBM SPSS Statistics software version 23.0. Descriptive statistics, including frequency and percentage analysis, were used for categorical variables, while mean and standard deviation were calculated for continuous variables.

For comparison between dependent groups, the paired sample t-test was employed. Repeated measures were analyzed using

Repeated Measures ANOVA with Bonferroni correction to control for type I error during multiple comparisons. A p-value < 0.05 was considered statistically significant.

4. Results

A total of 50 patients undergoing split thickness skin grafting were included in this prospective observational study conducted between July 2017 and June 2018. All patients fulfilled the inclusion criteria and completed the planned follow-up. Grafts were harvested using both tumescent technique (TT) and non-tumescent technique (NTT) in the same patient, allowing direct intra-individual comparison. The study evaluated demographic characteristics, wound-related factors, graft take, donor site healing, and short-term outcomes up to three weeks.

Table 1: Age distribution of study participants (N = 50)
Table 1 shows that the majority of patients belonged to the 36–45-year age group.

Age group (years)	Number of patients	Percentage (%)
≤35	5	10.0
36–45	24	48.0
46–55	16	32.0
56–65	5	10.0
Total	50	100

Table 2: Gender distribution of study participants
Table 2 depicts a male predominance among patients undergoing split thickness skin grafting.

Gender	Number of patients	Percentage (%)
Male	33	66.0
Female	17	34.0
Total	50	100

Table 3: Etiology of raw areas requiring skin grafting
Table 3 shows that trauma was the most common cause of raw areas.

Cause of ulcer	Number of patients	Percentage (%)
Burns	3	6.0
Traumatic	37	74.0
Unknown bite	10	20.0
Total	50	100

Table 4: Anatomical site of recipient area
Table 4 summarizes the distribution of recipient sites requiring grafting.

Site	Number of patients	Percentage (%)
Ankle and foot	8	16.0
Dorsum of foot	14	28.0
Leg	13	26.0
Leg and foot	5	10.0
Plantar aspect of foot	4	8.0
Thigh	6	12.0
Total	50	100

Table 5: Comparison of graft take on postoperative day 5
Table 5 compares mean graft take percentages between techniques on day 5.

Technique	Mean graft take (%)	Standard deviation
Tumescent technique	97.10	3.655
Non-tumescent technique	94.40	1.641

Table 6: Comparison of donor site healing on postoperative day 10
Table 6 shows superior donor site healing with the tumescent technique.

Technique	Mean healing (%)	Standard deviation
Tumescent technique	99.50	1.515
Non-tumescent technique	95.00	0.000

Table 7: Final outcome at 3-week follow-up
Table 7 shows comparable outcomes for both techniques at 3 weeks.

Technique	Mean outcome (%)	Standard deviation
Tumescent technique	97.40	3.232
Non-tumescent technique	97.40	3.534

Table 8: Paired t-test comparison between techniques
Table 8 demonstrates statistically significant differences on day 5 and day 10.

Comparison	Mean difference	t value	p value
TT D5 vs NTT D5	2.700	5.645	0.0005
TT D10 vs NTT D10	4.500	21.000	0.0005
TT W3 vs NTT W3	0.000	0.000	1.000

Table 9: Repeated measures ANOVA – Tumescent technique
Table 9 shows significant variation across time points with tumescent technique.

Time point	Mean (%)	Standard deviation
Day 5	97.10	3.655
Day 10	99.50	1.515
3 weeks	97.40	3.232

Table 10: Repeated measures ANOVA – Non-tumescent technique
Table 10 shows progressive improvement over time with non-tumescent technique.

Time point	Mean (%)	Standard deviation
Day 5	94.40	1.641
Day 10	95.00	0.000
3 weeks	97.40	3.534

Table 1 shows that the majority of patients (48.0%) belonged to the 36–45-year age group, indicating that split thickness skin grafting was most commonly required in middle-aged adults. **Table 2** demonstrates a male predominance (66.0%), reflecting higher exposure to trauma-related injuries among males. **Table 3** indicates trauma as the most common cause of raw areas requiring grafting (74.0%), followed by unknown bites (20.0%). **Table 4** shows that the dorsum of foot (28.0%) and leg (26.0%) were the most frequent recipient sites, highlighting lower-limb predominance. **Table 5** demonstrates that graft take on postoperative day 5 was higher with the tumescent technique (97.10%) compared to the non-tumescent technique (94.40%). **Table 6** shows superior donor site healing on day 10 with the tumescent technique (99.50%) compared to the non-tumescent technique (95.00%). **Table 7** indicates that by the end of three weeks, both techniques achieved comparable final outcomes (97.40%). **Table 8** confirms that differences observed on day 5 and day 10 were statistically significant, whereas no significant difference was present at 3 weeks. **Table 9** shows that the tumescent technique achieved rapid early

improvement with peak donor site healing at day 10. **Table 10** demonstrates gradual improvement with the non-tumescent technique, reaching comparable outcomes by three weeks.

5. Discussion

Split thickness skin grafting remains a commonly employed reconstructive technique for the management of ulcers and raw areas resulting from trauma, wound debridement in necrotizing fasciitis, and burns [11]. Successful graft uptake depends on multiple factors, including the condition of the donor site, the quality of the recipient bed, and perioperative factors such as hemostasis and postoperative immobilization. Excessive bleeding at the donor or recipient site may predispose to hematoma or seroma formation, which can adversely affect early graft take [12].

Tumescent anesthesia has been widely used in procedures such as liposuction due to its ability to reduce intraoperative blood loss and provide effective local anesthesia. However, its application in split thickness skin graft harvesting has not been widely practiced [13]. The present study was undertaken to evaluate whether the use of tumescent anesthesia during graft harvesting offers advantages in terms of early graft uptake at the recipient site and improved donor site healing when compared with the conventional non-tumescent technique [14].

In the present study, patients aged 18–65 years with clean wounds prepared for grafting and without comorbid conditions were selected to minimize confounding factors affecting graft survival. Both tumescent and non-tumescent techniques were employed in the same patient, allowing direct intra-individual comparison and reducing variability related to patient factors [15]. The thigh was used as the donor site in all cases, while the most common recipient sites were the dorsum of the foot and the leg, reflecting the predominance of lower-limb wounds in the study population [16].

The findings of this study demonstrated a higher mean graft take on postoperative day 5 in grafts harvested using the tumescent technique (97.10%) compared to the non-tumescent technique (94.40%). This observation indicates that the tumescent technique provides superior early graft uptake. Early graft take is clinically important, as it reduces the risk of graft failure, infection, and need for regrafting [17].

Donor site healing was also found to be better with the tumescent technique. By postoperative day 10, donor site healing was nearly complete in the tumescent group (99.50%) compared to the non-tumescent group (95.00%). Improved donor site healing may be attributed to reduced bleeding, better tissue hydration, and the bacteriostatic properties of lignocaine used in the tumescent solution [18].

It is noteworthy that although the tumescent technique showed superior outcomes in the early postoperative period, both techniques demonstrated comparable final outcomes by the end of three weeks. This suggests that while long-term healing may eventually be similar, the tumescent technique offers clear advantages in terms of early graft take and faster donor site healing, which are clinically relevant in reducing early complications and improving patient comfort [19].

The improved outcomes observed with the tumescent technique may be explained by several factors, including reduced hematoma or seroma formation beneath the graft due to effective vasoconstriction from adrenaline, maintenance of an aseptic environment from the bacteriostatic effect of lignocaine, and uniform graft thickness facilitated by tissue tumescence. These factors together create favorable conditions for early graft adherence and vascularization [20].

Overall, the findings of this study suggest that the tumescent technique is a simple and effective modification to conventional split thickness skin graft harvesting, offering better early graft uptake and improved donor site healing without adverse effects. Although not widely practiced, its routine use may enhance early postoperative outcomes in patients undergoing split thickness skin grafting.

6. Challenges

In the present study, tumescent infiltration was performed manually, which may have resulted in variability in the uniformity and volume of solution delivered to the donor site. Manual infusion can be operator-dependent and may influence the degree of tissue tumescence achieved.

In addition, inadequate analgesia at the time of opening the grafted wounds may have contributed to discomfort and movement, potentially affecting graft stability and leading to partial graft loss in a few cases. Ensuring adequate analgesia or procedural sedation during dressing changes and wound inspection may help minimize patient movement and reduce the risk of graft displacement.

Future studies may benefit from standardized infiltration techniques and optimized peri-procedural analgesia protocols to further improve graft outcomes and minimize avoidable complications.

7. Conclusion

The present study demonstrates that harvesting split thickness skin grafts using the tumescent technique results in better early graft take and improved donor site healing when compared to the non-tumescent technique. The advantages observed with the tumescent technique are particularly evident in the early postoperative period, with higher graft uptake on day 5 and faster donor site epithelialization by day 10.

Although both techniques achieved comparable final outcomes at the end of three weeks, the superior early results associated with the tumescent technique suggest a clinically meaningful benefit. Reduced intraoperative bleeding, decreased hematoma or seroma formation, and the bacteriostatic effect of lignocaine may contribute to these improved outcomes.

Based on these findings, the tumescent technique represents a simple, safe, and effective modification for split thickness skin graft harvesting and may be recommended to enhance

early postoperative results without compromising long-term healing.

Conflict of interest – Nil

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