

Surgical Outcome in Tumescent and Non-Tumescent Method of Harvesting Split Skin Graft - An Observational Study at KR Hospital, Mysuru

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ABSTRACT

BACKGROUND

The study was started with the aim to determine take up rate in tumescent technique compared to non-tumescent technique for harvesting split skin graft. Tumescent technique has been practiced for over forty years especially in liposuction. Tumescent anaesthesia is a combination of crystalloid, lignocaine, adrenaline and sodium bicarbonate. Using tumescent local anaesthesia for harvesting a split thickness skin graft is not in much practise. This study was designed to provide strong evidence of this technique.

METHODS

This was an observational study. Two treatment groups of patients, tumescent (group A, N = 21) and non-tumescent technique (group B, N =21), who fulfilled the inclusion criteria were randomly assigned. Tumescent technique involved administration of Klein's formula. No prior administration of agent was performed in non-tumescent technique. The recipient site was opened in both groups on the fifth day after surgery and take rate assessed.

RESULTS

The difference in take up rate between the two groups was found to be statistically significant. Compared to the patients in group B, patients who underwent tumescent technique (group A) had higher take up rate (> 12 %, P = 0.005). We did not find any statistically significant difference in donor site percentage healing between the tumescent and non-tumescent groups, P = 0.379.

CONCLUSIONS

Tumescent technique gives better take up results and is more effective than non-tumescent technique in harvesting split skin graft. The subdermal injection creates a smooth, dense surface which assists donor harvesting. This can be implemented preoperatively in split-thickness skin grafting.

KEYWORDS

Split Skin Graft, Take Up Rate, Harvesting, Tumescent, Non-Tumescent, Local Anaesthesia

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BACKGROUND

Skin Grafts

Skin grafting techniques date back to > 3000 years in India. Skin grafts are broadly classified into split-thickness and full-thickness grafts. Split-thickness skin graft (STSG) refers to a graft taken with epidermis and only a part of the dermis. Along with epidermis when the graft comprises whole of the dermis, it is referred to as full-thickness skin graft. Split thickness skin grafts are further classified into mesh skin grafts, stamp skin grafts, and chip skin grafts, based on their shape.^{1,2} The amount of dermis included with the graft determines both the likelihood of survival and the level of contracture.³

Types of Skin Grafts

Split Thickness

Thin (Thiersch-Ollier) 0.006 – 0.012 inch, Intermediate (Blair-Brown) 0.012 – 0.018 inch, Thick (Padgett) 0.018 – 0.024 inch.

Full Thickness

Contains variable thickness of entire dermis (Wolfe Krause).

Composite

Full-thickness skin with extra tissue which may include fat, cartilage, or muscle.

Properties of the Graft

The regeneration of epidermis of donor site is due to epidermal cell immigration from adnexal structures and the shafts of hair follicle which are left in the dermis. Unlike epidermis, the dermis seldom regenerates. Since only a part of dermis is removed in split-thickness skin grafts, the previous donor site may be used again for harvesting a split-thickness skin graft subsequently. So, the number of times the STSG that can be harvested from a donor site is directly proportional to the thickness of donor site dermis. Though, healing of donor site is by re-epithelialization, it is most of the times visibly evident that the particular area has been utilised as donor site. Less catchy donor sites are the scalp or buttocks. A healthy wound bed if not grafted and left alone, will undergo a series of changes like granulation, contraction, and re-epithelialization to cover its surface. A skin graft on a wound bed, alters these processes.⁴ The response of a skin graft after placing it on the graft bed was similar to response of skin to chemical or physical injury. The changes in wound healing brought about by the skin graft can also be described as a general adaptation of connective tissue to a diminished blood supply.⁵

Histological Characteristics of the Graft

Through the initial 4 days after grafting, there is enhanced activity in the epithelium of graft, which causes increase in crusting, scaling & thickness. It is because of – 1) swelling of the cytoplasm and epithelial nuclei, 2) altered mitosis of

glandular and follicular cells, 3) epithelial migration towards graft surface.

Cellular Components of Dermis

The availability of fibroblast as to where they are obtained from (in the skin) is unclear but thought to be not from indigenous fibrocytes. Fibroblasts decline in their concentration during the initial three days post grafting. The residual fibrocytes are arranged in 2 layers; 1) at dermo-epidermal junction 2) just over the host bed. Following three days of graft, fibroblast like cells make their appearance in the graft bed initially and then the graft itself. By seventh day postgraft enzymatic activity and fibroblast concentration rises owing to neovascularisation & capillary ingrowth. Majority of the collagen in an autograft perseveres through the day 40.

Research has revealed that STSG and full thickness skin autografts have significant turnover of collagen. Hyalination of dermal collagen occurs by day 3 or 4 following grafting and replacement of all the collagen by small fibres takes place by day 7 after grafting. This replacement continues till 21 days after grafting, and the complete replacement of old collagen occurs by 6 weeks. During the initial two–three weeks after grafting, the collagen turnover rates and epithelial hyperplasia simultaneously reach the peak. The resilience of the skin is because of the elastin fibers contained in the dermis. Integrity of elastin fiber is sustained till the day 3 after graft, but the fibers become stubby, short, and fragment by day 7 postgraft. Elastin degeneration occurs till 3 weeks after graft and by 4 – 6 weeks new fibers start growing. This process of replacement is similar in STSG & full thickness skin grafts. Though, both STSG & full thickness skin grafts show the activity of sebaceous gland, functional sebaceous glands are not present in thin STSG and will be brittle & dry after up-take. Similar hyperplastic stimuli is also seen in hair follicles as that of the graft. The original hair falls off and the graft will be hairless by day 4 after graft.

Skin Graft Adherence

Adherence to the wound bed is a requirement for the graft up-take. This occurs in 2 phases. 1) Placement of the graft on the recipient bed, to which the graft adheres due to fibrin deposition which lasts for nearly seventy-two hours. 2) Fibrous tissue ingrowth and neovascularisation into the graft.

Meshed Graft Versus Skin Sheet Graft

Multiple small slit like incisions are made using a blade, form a meshed skin graft, which allows expansion of the graft. A meshed skin graft covers a larger body surface area, as meshing allows stretching and facilitates drainage through the holes. Meshed skin grafts result in a “pebbled” appearance, which sometimes may not be aesthetically acceptable. In contrast, a sheet skin graft often leads to a superior aesthetic result with continuous, uninterrupted surface but disadvantages are that it does not allow drainage

of blood and serum through it and needs a skin graft of larger area.

Selection of Donor Site

The following factors determine selection of a graft donor site: 1) type of the graft ie, whether a full-thickness or a STSG is required, 2) possible morbidity of harvesting a graft at that particular site, 3) whether the recipient bed & the donor site are similar in colour. Donor site should be similar to the recipient site in terms of consistency, thickness, colour, and texture.⁶ Commonly selected donor sites for full-thickness skin grafts of the head and neck are anterior auricular region, postauricular area, nasolabial crease, eyelids, neck and supraclavicular region. STSG can be harvested from any part of the body, including the scalp. The donor site of a split thickness skin graft is usually scarred or discoloured. When taking a graft from a hair-bearing region, it is important to take a thin graft, because thicker split-thickness grafts will contain undesired hair follicles and eventually lead to hair in the graft and hair loss in the donor site.^{7,8}

Graft Expansion

Meshing is the terminology used for making slits in a sheet graft and stretching it open before transplantation. Advantages of meshed grafts over sheet grafts: (1) A greater extent of coverage with lesser morbidity (2) collection can easily drain through the holes of a meshed graft (3) the contour of a meshed graft can be adapted to fit in a regular recipient bed (4) in case of a localized bacterial contamination, only a small portion of meshed graft will be affected (5) a meshed graft provides for multiple areas of potential re-epithelialization.⁹ A small ratio of expansion 1 : 1.5 and pulling the graft lengthwise to narrow the skin perforations to slits before transplantation lessens these problems.^{10,11}

Graft Contracture

Contraction of wound is a crucial part of wound healing as it decreases the size of wound. A wound which is contracted is usually immobile, and stiff and there is induration, and distortion of the normal surrounding tissue. The degree of contraction of a graft can be tailored to some extent by regulating the thickness and proportion of dermis in the graft. More is the portion of dermis, lesser is the chance of contracture. Graft contracture is classified as follows-

Primary Contracture

Primary contraction is the degree to which a graft shrinks after harvesting and before grafting. It is the instantaneous recoil of freshly harvested grafts because of the presence of elastin. More is the dermis in the graft, more will be the primary contraction. So split thickness skin graft has less primary contracture, more secondary contracture and more chances of healing.^{12,13}

Secondary Contracture

It is the contraction of a healed graft and is possibly the effect of myofibroblast activity. It is the degree to which graft shrinks while the healing process is on. Thickness of dermis regulates the chances of contracture. The contracture inhibiting effect of dermis depends on the percentage of dermis included in the graft with greater portion of dermis showing greater inhibition. STSG cause a rapid decline in the number of myofibroblasts, and wounds contract less than comparable non grafted sites.¹⁴ Decrease in the myofibroblast population is even faster in full-thickness grafts, and wounds have minimal contraction.

Graft Failure

Survival of a skin graft depends to some extent on meticulous surgical technique. Care must be taken in the following aspects- (1) atraumatic handling of graft (2) harvesting a well-vascularized and scar-free bed (3) achieving haemostasis (4) clearing off of collected blood and clots before dressing the wound (5) post-operative immobilisation of the recipient site.

Graft Uptake

It occurs in four phases namely plasma imbibition (diffusion of nutrients from recipient to graft in first 24 to 48 hours), plasma inoculation (donor and recipient vessels align and form vascular network), angiogenesis (revascularisation of graft ie, vascular ingrowth in graft in 4 - 7 days), and reinnervation.

Factors That Affect Take Rate

This includes haematoma/seroma formation, poorly vascularized and contaminated wound bed, post-operative immobility, and technical aspects. Also, comorbid conditions, medications like steroids, smoking, and malnutrition affect take up. Tissues with limited blood supply such as bone, tendons, cartilage or sites with necrotic tissue or infection do not take up the graft. Streptococcus should not be present in the latest pus culture report before grafting as it can 'eat up' the skin graft within a day. Systemic diseases, nutritional and vascular disorders should be treated before the procedure is undertaken.

Tumescent Local Anaesthesia (TLA)

Tumescent anaesthesia is subdermal/subcutaneous injection of a combination of crystalloid, lignocaine, adrenaline, and sodium bicarbonate. The tumescent solution for local anaesthesia was developed by Klein for liposuction procedures in 1975. Klein's formula containing 0.1 % lidocaine, sodium bicarbonate 12.5 mEq (12.5 ml of an 8.4 % NaHCO₃) and 1 : 1 million adrenaline in 1 litre of saline was used, it allowed safe usage of the recommended maximum of doses of anaesthetic agent with vasoconstrictor, which was 7 mg/kg. Crystalloid is used for hydrating the donor site and creating a plane for harvestment. Adrenaline is used to harvest skin grafts due to its vasoconstriction effect which limits blood loss,^{15,16}

contribution to prolonging the anaesthetic effects of lidocaine, slowing and delay of lidocaine absorption.

Lignocaine with its bacteriostatic property aids in efficient graft uptake on the recipient site. According to guidelines, the maximum dose for subcutaneous infiltration of lignocaine with adrenaline is 7 milligrams per kilogram (mg/kg) & lignocaine without adrenaline is 4.5 mg/kg. Therapeutic concentrations of lidocaine can be up to 5.5 milligrams per litre (mg/L), whereas a plasma level of 8 - 12 mg/L and above is associated with central nervous system (CNS) and cardiotoxicity.¹⁷ The most critical aspect of local anaesthetic is appropriate dosing.

Sodium bicarbonate (NaHCO₃) was added to Klein's formula aiming to reduce the pain of infiltration and to increase the antibiotic action of lidocaine. When the acidic local anaesthetic solution is injected into healthy tissue, buffers within the tissue fluids will neutralise the solution towards the physiologic pH, favouring the formation of more membrane-crossing base form.¹⁸ This mechanism can be complicated by the presence of acute inflammation. This may limit the formation of the non-ionised base form of the local anaesthetic as the formation of the cation will be favoured in more acidic conditions. The local anaesthetic will essentially be trapped in the ionised form and less free base form will be available to penetrate the nerve, delaying the onset of anaesthesia and possibly limiting it altogether.¹⁹ It would be advantageous to have a local anaesthetic that could counteract the limitations of the low pH levels associated with areas of inflammation. The sodium bicarbonate added to the local anaesthetic agent, increases the pH of the solution as well as results in the formation of carbon dioxide and water. Carbon dioxide augmented the action of local anaesthetic agent by showing that, nerve conduction blockade was significantly greater in the presence of carbon dioxide than in its absence.

Tumescent technique is in practice for more than forty years, especially in liposuction. Many studies have proved that it is useful in preventing blood loss. This is important in this era of inadequate blood and blood products. Information on local and systemic effects of adrenaline vary in literature with some authors saying the effects are minimal and transient while others believe that it adversely affects the harvested graft and healing of donor site.²⁰

Advantages of TLA

(1) Anaesthesia for larger body surface area (2) Hydro-dissection as a surgical tool (3) easy and effective method (4) decreased blood loss (5) better haematoma resorption (6) longer duration of action of local anaesthetic (7) extended post-operative pain control (8) antimicrobial action.

Disadvantages of TLA

1. Fluid extravasation into the surgical site (2) execution of infiltration is a laborious process.

Ulcers that were formed after wound debridement for cellulitis, necrotising fasciitis, burns and trauma with a healthy granulation tissue were treated by split thickness

skin graft harvested from a normal anatomical site preferably thigh, after tumescent local anaesthesia and grafted on the recipient site.

We wanted to assess the percentage graft take up on day 5 in both groups i.e, tumescent and non-tumescent group of patients.

METHODS

This observational study (prospective) was conducted on 42 patients divided into 2 groups; tumescent (group A, N = 21) and non-tumescent technique (group B, N = 21), who fulfilled the inclusion criteria for a period of one year (between December 2019 and December 2020) at Krishnarajendra Hospital, Mysore Medical College and Research Institute, Mysuru.

Inclusion Criteria

- Age 18 years and above.
- Wounds clean and ready for grafting.

Exclusion Criteria

- Serum albumin less than 3 gm/dl.
- Haemoglobin less than 10 gm%.
- Patient refusal for surgery.
- Patients who are known to be allergic to adrenaline.
- Pus culture showing growth of beta-haemolytic streptococcus.

Statistical Analysis

The Statistical analysis for the study was performed using IBM statistical package for social sciences (SPSS) statistic v 26. Two treatment groups of patients who fulfilled inclusion and exclusion criteria were randomly assigned as tumescent and non-tumescent group. Both groups were assessed for percentage of graft take up on day 5 on recipient site. Both groups were also assessed for percentage of healing at donor site on day 14. The mean value was calculated for each group separately. The means of the two groups were compared using independent student t test for both percentage of graft take up on day 5 of recipient site and percentage of healing on day 14 of donor site. 'P' value for each of the mean comparison was calculated using independent student t test. 'P' value < 0.05, calculated by student t test is considered significant.

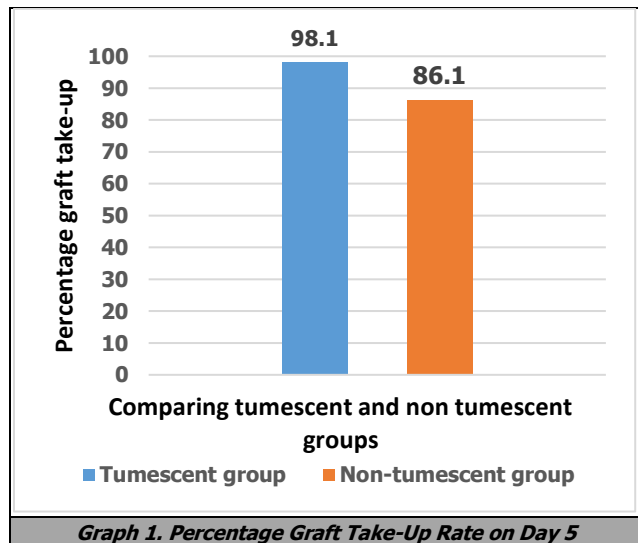
RESULTS

- The mean graft take up rate in tumescent method of harvesting split skin graft was 98.1 % and that of non-tumescent method was 86.1 %.
- The take up rate was 12 % more in tumescent technique as compared to non-tumescent technique.
- On day 14, no difference was seen in healing rates of donor sites in both the groups, P = 0.379.

	Average in Tumescient Group and SD	Average in Non-Tumescient Group and SD	p Value
Percentage graft take up rate on day 5	98.1 ± 3.2	86.1 ± 18.1	0.005*
Percentage healing of donor site - day 14	99.2 ± 0.6	99 ± 0.8	0.379

Table 1. Mean of Percentage in Both the Groups, Standard Deviation (SD) and P Value

*indicates significant statistical difference



DISCUSSION

Tumescent technique is one of the ways of minimising iatrogenic blood loss. Tumescent local anaesthesia can be used for split skin graft harvesting to decrease the blood loss associated with graft harvesting and is found to give early and better uptake of graft on recipient site but tumescent anaesthesia for split skin graft is not much in practice. The patients in each treatment group had comparable demographic and physical characteristics. The commonest site of raw area was leg and graft was harvested from thigh. The use of tumescent technique locally has been low in split skin graft surgery. This is probably because surgeons are not confident about the outcomes of the graft and the donor site. This study was designed to provide strong evidence of this technique.²¹ In the present study, we found that the skin graft take rate was 98.1 % in the tumescent group of patients and 86.1 % in the non-tumescent group (P = 0.005). This result conveyed that skin graft take up rate is better in tumescent group. This affirmed that the viability of the harvested graft is not affected by the infusion of the tumescent solution. Tumescent technique had better outcome and the reason can be attributed to less haematoma/seroma formation on recipient site, bacteriostatic property of lignocaine which maintained aseptic environment under the graft.

CONCLUSIONS

From this study we conclude that harvesting graft with tumescent technique gives better results compared to non-

tumescent technique. The subdermal adrenaline/saline injection creates a smooth, dense surface which assists debridement and donor harvesting. This can be implemented preoperatively in split-thickness skin grafting.

Data sharing statement provided by the authors is available with the full text of this article at jebmh.com.

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