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Original Article

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Original Article

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Modified Limberg Flap for Sacrococcygeal Pilonidal Sinus: A Prospective Institutional Study

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Abstract

Background: Sacrococcygeal pilonidal sinus is an acquired disease commonly seen in young adults especially males in gluteal cleft and it is known for recurrence and affects the patient's quality of life. Rhomboid excision of sinus with Limberg rotation flap coverage is a well-known surgical modality for this. This prospective study is carried out to determine the effects of the Limberg flap rotation surgery especially for its feasibility in a General surgical unit for the sacrococcygeal pilonidal sinus patients, their compliance, outcomes of the surgery such as wound infection, postoperative pain relief, recurrence rates, and back to routine duration.

Patients and methods: This is a prospective study of 40 Limberg flaps done from 2017 January to 2018 December in general surgical unit by the same surgical team for both primary and recurrent Pilonidal sinuses, and patients who previous incision and drainage had done for the pilonidal abscess. The various demographic, clinical and surgical data are studied and compared to other studies.

Results: There were 34 (85%) male patients and 6 (15%) female patients and all patients successfully underwent surgery, with very minimal postoperative pain, stayed in hospital for average 10 days, returned to work after 3 weeks. The operative time, blood loss, hospital stay, surgeon's performance scale, wound hypothesia, wound cosmoses score, patient satisfaction score, and patient quality of life were studied. The Limberg flap surgery had better clinical results regarding frequency of seroma formation and time to drain removal, pain score and early return to normal works. Out of the 40 patients operated 1 (2.5%) developed superficial skin necrosis, 2 (5%) developed seroma, and 1(2.5%) type-1 diabetic female developed surgical site infection.

Conclusion: In this procedure of Limberg flap there are significant benefits in terms of postoperative pain, infection rates, less hospital stay and early return to work with almost nil recurrences.

Keywords: Flap; Limberg; Pilonidal; Rhomboid; Sinus; Sacrococcygeal.

Introduction

Sacrococcygeal pilonidal sinus is an acquired disease most commonly affects the young adults. Male are affected twice more than female and occurs both after puberty and before the age of 40 years [1] Commonly the sinus is seen in the gluteal cleft, however in other sites such as the umbilical, axilla and inter digital especially in barbers and other areas also rarely it manifest [2]. The Pilonidal sinus is diagnosed by identifying the epithelialized follicular opening of the sinus. "*Pilonidal* "means "nest of hairs." in Latin. It causes

significant morbidity from both disease and surgery done for the same.

The epidemiological studies shows an estimated incidence of 26 per 1,00,000 population [3,4]. The pilonidal sinus normally presents as a cyst, abscess, or sinus tracts with or without discharge[5]. Mayo in 1833 first reported these cases and proposed the pathogenesis is due to congenital origin secondary to the persistent remnant of an epithelial lined tract from postcoccygeal epidermal cell rests or vestigial scent cells. However this theory is disputed as congenital tracts do not contain hair and are lined by cuboidal epithelium and the view is now shifted toward acquired theory [6]. It is now attributed to the persistent local irritations and resultant aberrations, poor hygiene, excessive hairiness and presence of deep anatomical natal cleft [7]. The presence of high quantity of hair, extreme force, and vulnerability to infection were the three cardinal factors for the development of this disease as per the study of Karydakis et al. [8].

The surgical treatment is the corner stone for this disease and various procedures like excision and packing and leaving it for secondary granulation and healing, excision and primary closure, marsupialization, and flap techniques have been suggested for the treatment [9].

Recurrence following treatment is the major concern and it is reported regardless of the technique followed there is about 20 to 40% recurrence for this disease [10]. The causes of recurrence were widely studied and postulated as leaving behind some tracts, sutures in midline causing more trauma with repeated infection with accumulation of perspiration, and friction with tendency of the hair getting incorporated into the wound [11]. No technique is termed as gold standard treatment method at present. An ideal operation should be simple, with less hospital stay, low recurrence rate, with minimal pain, wound care and less the patient's time off-work and early return to works [12].

Limberg in 1946 designed rhomboid flap for sacrococcygeal pilonidal sinus [13]. It is a technique of closing a 60° rhombus-shaped defect with a transposition flap. As this flap was easy to perform, with sutures away from the midline giving rise to a tensionless flap of unscarred skin in the midline, which helps in good hygiene maintenance, reducing sweating, maceration, erosions, and scar formation, it gained wide usage.

Literature study shows, In Limberg flap with wide rhomboid excision of the sinus and covering it with transposition flap, is much better than primary closure, or other flap coverage methods. It is also stated to be a safe and reliable method with low complications and recurrence for the treatment of sacrococcygeal pilonidal sinus [14].

In our institution the primary excision of the sinus and through curetting followed by dressing to enhance granulation and secondary healing was followed. As this method postulated had much appreciated quicker relief we resorted to carry on this study in our setup to evaluate the usefulness of Limberg flap procedure in sacrococcygeal pilonidal sinus, patient compliance, complications, and long-term recurrence rates following the procedure.

Methods

The study was performed in the General surgical unit of Kanyakumari Government Medical college Hospital from January 2017 to December 2019 and total 40 patients (34 male and 6 female) were included in the study.

An informed written consent was obtained prior to surgery.

Inclusion criteria

- Sacrococcygeal pilonidal disease.
- Age between 16 and 50 years.
- Primary or recurrent disease.
- Willing for the study.

Exclusion criteria

- Unfit for surgery.
- Unwilling.
- Severe co morbidities and bleeding disorders.

All patients were prospectively evaluated for age, gender, indication of surgery, duration of symptoms, co morbidities, and location of sinus, operative time, postoperative stay and complications.

The study was approved for ethical clearance by the ethical committee of the Medical College.

Procedure

Patients who had pilonidal abscess were first managed by incision and drainage they later underwent definitive surgery. Surgery was performed under general or regional anaesthesia.

Patients were placed in prone jack-knife position with buttocks strapped for wide exposure.

After painting and draping, the area to be excised is marked and flap lines are marked so as to be able to excise all of the pits and sinuses enbloc. Care was also taken to leave minimum midline scar (Fig. 1).

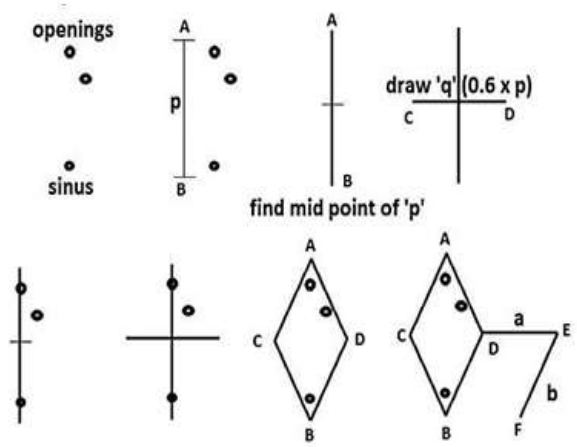

Fig. 1: General schematic of creating a limberg flap.

The long axis of the rhomboid in midline is marked as A–B, B being adjacent to peri anal skin, A and B are marked such that all diseased tissues can be included in the excision. The line C–D transects the midpoint of A–B at right angles and is 60% of its length. D–E is a direct continuation of the line C–D and is of equal length to the incision C –A, to which it will be sutured after rotation. E–F is parallel to D–B and of equal length. After rotation, it will suture to A–D. (Fig. 2).

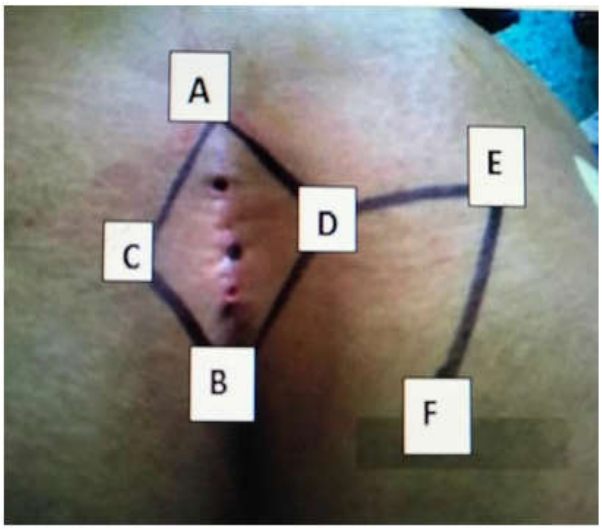

Fig. 2: Markings for creating Limberg flaps

The rhomboid incision with each side equal in length, includes the sinus, is made down to the presacral fascia. The flap is constructed by extending the incision laterally down to the fascia of the gluteus maximum muscle (Fig. 3).

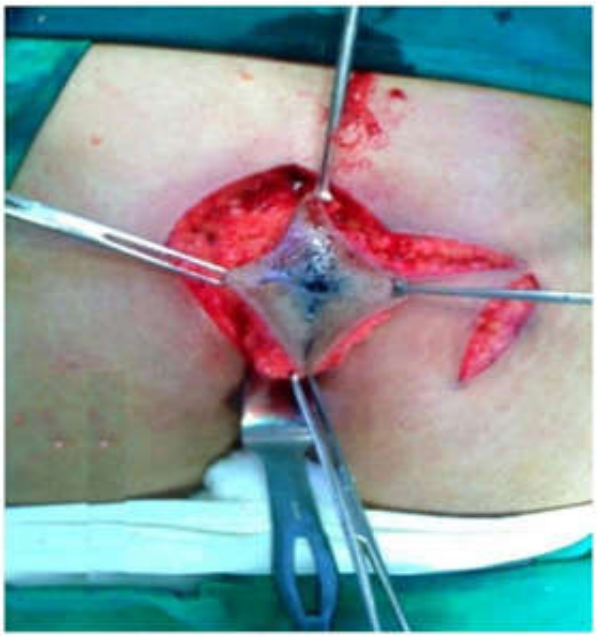

Fig. 3: Excision till deep fascia

After securing the haemosatasis the flap is transposed to the rhomboid defect created by excision of the sinus (Fig. 4).

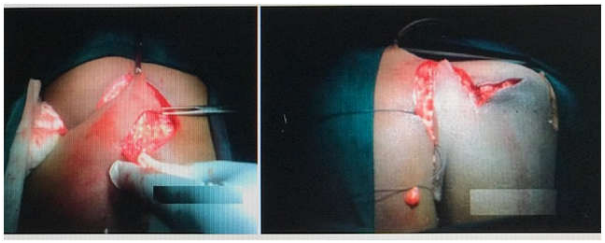

Fig. 4: Rising of flap and rotating over the defect

Subcutaneous tissue is approximated with interrupted vicryl 2-0 suture with a drain fixed. The skin is approximated with interrupted nylon 3-0 suture (Fig. 5).

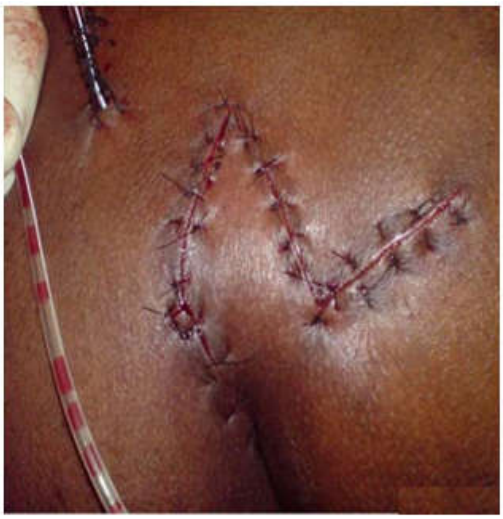

Fig. 5: Final outcome after suturing

Drain is removed after 48–72 hours. Alternate sutures are removed on 9th postoperative day (POD). Rests of the sutures are removed on the 10th day. Postoperatively patients' are advised to avoid prolonged sitting or exercise for two weeks. The general cleanliness and keeping the area dry and remove the dense hair if any for one month. Patients are followed up in OPD monthly for 6 months. Length of hospital stay, time taken for return to work, postoperative complications and recurrence were recorded.

Results

Forty patients were operated by rhomboid excision and Limberg flap reconstruction. Among them there were 34 males (85%) and 6 females (15%). The mean age of presentation was 28 years old (range 16–50 years old). Seven patients presented with recurrent sinus (17.5%). Twenty five patients (62.5%) presented with discharge, 10 patients (25%) presented with pain, four (10%) with infection and one with pilonidal abscess. The operative time ranged from 60 to 100 minutes. Hospital stay ranged from 10 to 12 days. The demographic profile and intraoperative details are tabulated in Table 1.

Out of the 40 cases that were operated, 1(2.5%) developed superficial skin necrosis at the tip of the rhomboid flap (<1 cm), 2 (5%) developed seroma postoperatively which resolved with conservative treatment, and 1 (2.5%) type-1 diabetic female developed wound infection which was treated by laying open of a single suture and allowing to heal by secondary intention. None of them required any surgical intervention. No recurrences were noted in the follow up period ranging from 12 months to 2 years. The complications noted in our study are tabulated in Table 2.

Table 1: General, demographic and clinical data

Variable	Value
Age	28 years (16-50)
Gender	
Male	34 (85.1%)
Female	6 (15%)
Number of sinuses	
Single midline	28 (70 8%)
Multiple midline	12 (30%)
Co morbidities	
Hirsute nature	23 (57. 5%)
Obesity	1 (2.5%)
Smoking	4 (10%)
Symptoms	
infection	4 (10%)
Pain	10 (25%)
Discharge	25 (62.5%)
Duration of symptoms	6.52 months (2-13)
Operative time	67.05 min (60-90)
Post op stay	10.05 days (9-12)

Table 2: Complications

	Number	Percentage
Hematoma	0	0
Superficial skin necrosis	1	(2.5%)
Wound gaping	0	0
Flap edema	2	(5%)
Seroma	2	(5%)
SSI	1	0
Recurrence	0	(2.5%)

Table 3: Comparison of results with other studies

Author/s	Patients (no.)	Hospital stay (days)	Complication (%)	Recurrence (%)
Katsoulis et al. [23]	25	4.0	4 (16%)	1(4%)
Akin et al. [20]	411	1–10	15.75%	12 (2.91%)
Urhan et al. [25]	110	3-7	7%	5 (4.9%)
Mentes et al. [2]	353	2–19	11%	11 (3.1%)
Aslam et al. [24]	110	3.0	5%	1 (.9%)
El-khadrawy [21]	60	5–11	40%	6 (10%)
U Jethwani et al.	67	9-12	11.94%	1 (1.49%)
Current study Jayalal et al.	40	10-12	3 (7.5%)	0

Discussion

Pilonidal sinus diseases are caused by forces exerted on the midline of the natal cleft (tension = force/surface area) especially on the point of coccyx turning anteriorly [14], vacuum effect created between the buttocks, by virtue of it the anaerobic bacteria are gravitated to this point along with hair or debris [15], the ensuing friction movement of buttocks [16] in the presence of other risk factors such as obesity, hirsuteness, and bad hygiene [17]. An effective surgical technique will eliminate this shearing forces, vacuum effect, and friction movement [18].

Excision of the diseased tissue down to the sacrococcygeal fascia is the standard prerequisite for an effective surgical treatment for this sinus. However the next step of what to do with defect is a matter of concern and debate. The patient compliance, postoperative pain, infection, recurrence rates, hospital stay, frequent wound dressings, and cosmetic outlook with preservation of the bottom are the main criteria which decide the surgical option.

Recurrence is the main problem associated with all modalities of surgeries used in the treatment for pilonidal sinus which ranged from 21.4% to 100% for incision and drainage, 5.5%–33% for excision and open packing, 8% for marsupilisation, 3.3%–11% for Z plasty [19]. Flap techniques have been associated with lower recurrence rates.

Limberg flap has many advantages as it is easy to perform, design and flattens the natal cleft with a large well-vascularised pedicle which is sutured without tension. Also it has the benefits of reducing midline dead space and midline scar is avoided. Limberg flaps are useful in recurrent pilonidal disease and reduce hospital stay and time to resume normal activities. The Lamberg flap procedure was found much better than simple excision and closure, marsupialization, or other postulated flap procedures such as Bescom and Karydakis [8,15].

The review of various reported studies on this technique were compared with our study report and most of the factors are comparable. In our study, 40 patients with sacrococcygeal pilonidal disease were managed with rhomboid excision and Limberg flap reconstruction. No recurrence was noted in this study. Akin et al. [20] operated on 411 patients and reported recurrence rates of 2.91%. Superficial necrosis was seen in one patient (1.49%), which may be due to the design of the long flap or fault technique. El-khadrawy [21] operated on 40 patients and had superficial necrosis at the tip of the flap in four patients (10%). Time off-work in our study patients was 12–18 days. This was similar to that reported by Abu Galala et al. [22] Katsoulis had 25 patients, with 16 of them having complications with no recurrences [23]. Aslam had 110 patients, with 5 of them having complications and 1 recurrence [24]. The comparative table of various studies and reported complications are tabulated in (Table 3).

Conclusion

Sacrococcygeal pilonidal sinus is a treacherous disease for both the patient and the surgeon by virtue of its recurrent infection, persistent troublesome pain with discharge, and high recurrence rates inspite of good surgical procedures. Following Limberg flap reconstruction after excision of the pilonidal sinus, the resultant distortion and shape of the gluteal regions are averted and as there is no recurrence the agonizing continuous discharge of foul smelling pus are stopped.

The technique is easy to perform in quick time by the General surgeons and this procedure can be used in both primary and recurrent diseases, with very low complication rates. The advantages are obliteration of the midline natal cleft and scar pressure in the midline, quick healing time, short hospital stay, and early return to daily life. It is a feasible best option for the sacrococcygeal pilonidal sinuses.

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Original Article

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Efficacy of HBOT as Adjuvant in Burn Patient

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Abstract

Background: It a great challenge which requires great efforts to treat the patient with burn injury. Immediate treatment significantly improves mortality rates. Management of a burn case usually involve, appropriate fluid resuscitation, attainment of resuscitation targets using consensus formulas for initial fluid administration, topical agents to control pain, reduction of fluid loss as well to prevent bacterial growth.

Objective: our aim was to look for the evidence of effectiveness of HBOT and the patient's satisfaction improvement due to reduction in wound pain.

Study Design: Study carried out was prospective case control study.

Place of Study: Prana HBO Centre, located in the Northern parts of Mumbai, in India.

Methods: In group I in comprised of 22 patients with burn injury who got regular HBO therapy. HBO therapy was given with compressed with air at a pressure of 2.5 atmosphere absolute (ata). At this pressure the patient breathed 100% oxygen via facial mask. The HBO therapy protocol included 90 minutes oxygen breathing at 2.5 ata, twice daily over 6 days. 20 sessions were performed for each patient. In group II patients with burn injury were 21 who also received burn treatments in our setup but without HBO therapy.

Results and Discussion: The mean improvement in pain relief in group I was 4.9 ± 1.2 in comparison to group II which was 3.2 ± 0.85, comparatively improvement in pain score was significantly higher in group I and at par with group II. Hyperbaric Oxygen therapy can improve pain score and patient satisfaction in our study. However the possibility of cost effectiveness of the HBO therapy would need further discussion. Future, the clinical trials with large sample size and different types of burn injury shall be considered.

Conclusion: Findings shows the beneficial effects of HBO therapy, as well suggests that the HBO therapy has a significant improvement in the pain relieve and satisfaction improvement. Hence, HBO therapy, as an adjuvant treatment, could be helpful for pain control and satisfaction associated with burn injuries.

Keywords: Patients satisfaction; Pain relief; HBOT; Burn Injury.

Introduction

Damage to skin integrity depending upon depth, subcutaneous tissues or organs resulting due to high temperature, electricity, chemicals or radiations is termed as Burns [1]. The classifications of burns are based on depth expressed in degrees and their related corresponding symptoms. Burn causes skin barrier, which serves as protection from various external environmental factors, which is interrupted leading to homeostasis and

physiological disruption. In superficial burns damage of epidermis causes swelling and blister formation. In deep dermal full thickness burns it leads to loss of skin barrier causing loss of water by evaporation from wound, as well loss of thermoregulatory function and decrease in number of electrolytes and proteins [2,3]. Later due to progressive dehydration causes disruption of process of repair, cell damage as well it inhibits the regenerative changes in wound environment. Similarly, cell membrane damage, increase in vascular permeability leads to leakage of body fluids in intracellular spaces followed by gradual onset of swelling, as water leaks through the burn wound to the environment [4,5].

In burn wounds, swelling affects development of hypoxia, adjacent tissues and leads to accumulation of harmful cellular metabolites, leading to formation of inflammation and necrotic tissues which ultimately delays the process of healing. Hence Necrosectomy is usually performed after five to seven days after the injury at the latest. By the end of fifth day after injury, microorganisms begin to colonize necrotic tissue, which serves as a good medium [6]. Hence in order to normalize patient physiological condition and to restore hemostasis, after surgical debridement of burn wound, its protection through application of autologous skin graft or skin substitutesshould be the priority [7]. As such Thermal burns are with maximum morbidity and mortality, they are complex and injury which involves both local and systemic consequences. It is seen if there is more than twenty percent of the total body surface area, severity increases [8].

It a great challenge which requires great efforts to treat the patient with burn injury. Immediate treatment significantly improves mortality rates. Management of a burn case usually involve, appropriate fluid resuscitation, attainment of resuscitation targets using consensus formulas for initial fluid administration, topical agents to control pain, reduction of fluid loss as well to prevent bacterial growth. It is observed in past two decades that early closure of full thickness wounds had improved the outcome in extensive burn cases by preventing colonization and infection [8].

To get a good outcome in cases with thermal burns, HBO therapy is used as adjuvant therapy and this and been well studied. HBOT is application of hundred percent oxygen at two or three times the atmospheric pressure at sea level, at environmental pressures between 1.4 and 3.0 atmosphere absolute (ATA), for periods between 60 and 120 min once or more daily [9]. It causes most of the physiological and therapeutic effects. This therapeutic procedure has a range of positive effects for the inhaling process and it is being prescribed along with other treatment in various other clinical situations [10]. The Undersea and Hyperbaric Medical Society recognizes 14 valid medical indications for hyperbaric oxygen therapy, commonly ate diabetic foot ulcer, radiation tissue injury, condition with acute ischemia which includes crush injuries as well in acute poisoning by carbon monoxide, acute occlusion of central retinal artery, diving accidents, severe anemia and burns [11].

For acute thermal burn injury the undersea and hyperbaric medical society (UHMS) had approved and HBO therapy is an adjuvant treatment for burn patient and it specifically reduces the length of hospital stay of the patient and cost of care is also reduced [12]. In this study our aim was to look for the evidence of effectiveness of HBOT and the patient's satisfaction improvement due to reduction in wound pain.

Patients and Methods

Study setting

The study was carried out at the Prana HBO Centre, which is owned by the Investigator and located in the Northern parts of Mumbai, in India. The center has one Sechrist Monoplace hyperbaric chamber and a TCOM machine with 3 electrodes. The oxygen gas supply is from oxygen cylinders of 7000 liters' capacity each. The center has all the requisite certifications and registrations as required by the local authority in Mumbai. Study was conducted over a period of 2 years and patient with Burn injury referred to the Hyperbaric Unit at Prana HBO center. Center took care in a specialized form and provided care to patients with burns and critical soft tissues conditions and was responsible for caring for all patients. Written informed consent was obtained from the patient and patient's relative.

Study Design

Study carried out was prospective case control study.

Study Population

In our study total 43 patients with burn injury were included which were referred to our Prana hyperbaric center Mumbai over a period of two years. Furthermore, all the patients were screened

for eligibility to be included in the study and they had no previous or current history of pain disorders and no known neurologic, rheumatologic or psychiatric clinical features in association with chronic pain.

Inclusion Criteria

Burn injury patients referred to Prana Hyperbaric center, without a history of chronic pain and any further treatment of burn received were included in the study.

Exclusion criteria

All of the following patients who died during the treatment, with excessive comorbidities, burn injury area more than 60% of the total body surface area, patient suffering with septic shock or showing unstable vital signs were excluded from the study.

Ethics review

This study was performed within the scope of international ethical guidelines and legislation. Ethics review and approval was provided by Stellenbosch University (number: U16/06/015) and the ethics committee of the Hyperbaric Society in India.

Procedure

In our study the selected patients were divided into two groups and both group received regular wound dressing and surgery as per requirements. In group I in comprised of 22 patients with burn injury who got regular HBO therapy. HBO therapy was given with compressed with air at a pressure of 2.5 atmosphere absolute (ata). At this pressure the patient breathed 100% oxygen via facial mask. The HBO therapy protocol included 90 minutes oxygen breathing at 2.5 ata. 20 sessions were performed for each patient. In group II patients with burn injury were 21 who also received burn treatments in our setup but without HBO therapy. Selection of the patients was random. In our study all patients received burn wound treatments which includes dressing, pain control, infection control and if required surgical intervention in the form of debridement and skin grafts was given. During the study all of the following parameters such as HBO sessions given to the patients of group I, age, sex, inhalation injury status, total body surface area, hospital stay duration, and location of scars with its characteristics were all documented meticulously. Vancouver Scar scale was used to evaluate the condition of scar and very well documented. Visual analog Scale was used to score and assess pain. Patients satisfaction was documented by the principal investigator of the study, patients were asked to mark the satisfaction score about the current health status on a scale of one to ten, before and after the whole course of therapy and the differences in subjective score was graded accordingly.

Statistical Analysis

A descriptive table prepared to present the distribution of HBO and non HBO group of therapy. The graphical presentation was used to present the improvement after burn injury treatment by patient's satisfaction. The small sample t-test was used to compare the difference between mean of TBSA and scare improvement. The odds ratio was used to determine the relative risk. The Chi-square test was used to test the association between age and pain relief score. The complete statistical analysis was done by MS-Excel software.

Results

Total 43 patients with burn injury were enrolled in our study, of which 22 in group I and 21 in Group II were included. In or study patient s burn wound were mostly on the extremities, group I consist of 18 males were as in group II it comprised of males. The mean age of Group I is 28 and for group II is 26 with an average of 39.7 and 41.84 respectively in both group. The mean TBSA of wounds in group I was 23.8 ± 9.7 in group I and 26.3 ± 10.9 in group II which did not showed up significant difference. The mean improvement in pain relief in group I was 4.9 ± 1.2 in comparison to group II which was 3.2 ± 0.85, comparatively improvement in pain score was significantly higher in group I and at par with group II. The mean debridement time in group was 1.4 ± 0.4 as compared to that of 0.9 ± 0.7 in group II, which reflected not much significant differences. The mean skin graft times in group I was 3.1 ± 1.2 and in group II 1.9 ± 1.4 which also reflected that there is not much significant differences. The mean length of hospital stay of the patients in group I showed 31.5 ± 8.9 days and in Group II was 34.8 ± 10.1 days, it also had no significant differences. In group I significant improvement in patient's satisfaction was 90.9% in comparison to group II where it was 66.7%.

Relative risk estimation: Odds Ratio = 5 (Total no. of cases is 43)

Table 1: Descriptive analysis of baseline parameters

Parameters		Group - I HBO (n = 22)	Group - II Non-HBO (n = 21)	Total
Age	Min. Age	28	26	26
	Average	39.7	41.84	40.
	Max. Age	56	59	59
Sex Ratio (Male : Female)		18 : 4	16 : 5	34 : 9
TBSA		23.8 ± 9.7	26.3 ± 10.9	25.7 ± 10.4
Pain Relief		4.9 ± 1.2	3.2 ± 0.85	4.2 ± 0.96

Table 2: Result of different characteristics in HBO and Non HBO groups

Parameter score	HBO (n = 22)	Non- HBO (n = 21)
Debridement times	1.4 ± 0.4	0.9 ± 0.7
Skin graft times	3.1 ± 1.2	1.9 ± 1.4
Patients stay (in days)	31.5 ± 8.9	34.8 ± 10.1
Development in scar	0.8 ± 1.1	1.7 ± 1.4
Infection rate (in %)	34%	49%

Table 3: Satisfaction improvement between HBO and Non-HBO groups by Odds ratio

Improvement		HBO (n = 22)	Non - HBO (n = 21)	Total
Significant improvement of satisfaction	No. of Patients	20	14	35
	Percentage (%)	90.9%	66.7%	81.4%
No Significant improvement of satisfaction	No. of Patients	02	07	8
	Percentage (%)	9.1%	33.33%	18.6%
Total	No. of Patients	22	21	43
	Percentage (%)	100%	100%	100%

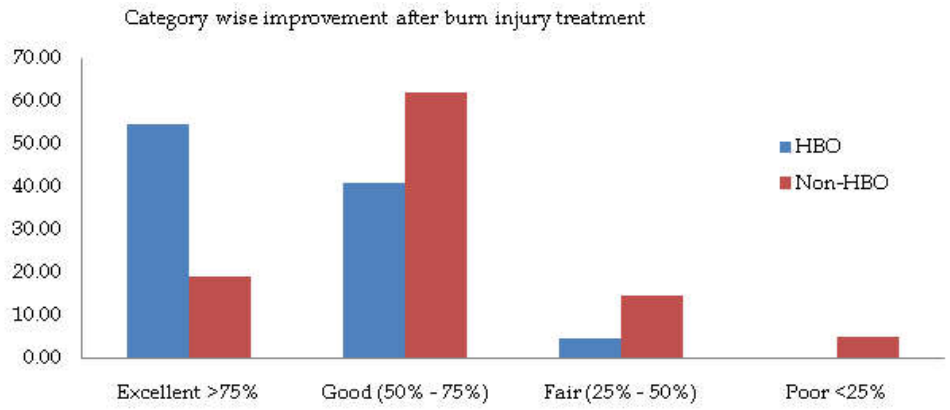

Fig. 1: Category wise Improvement after treatment

At 95% Confidence interval is, The Lower value = 3.21 & The Upper value = 6.79 of odds ratio is recorded.

To compare the mean value of TBSA of wounds between HBO and Non-HBO groups by using small sample t-test, at 5% level of significance the p-value is 0.2893 which is greater than α=0.05, It means there is no significant difference between them.

Similarly to compare the scar improvement between HBO & non-HBO groups.

The p-value is 0.0837 > 0.05 which showed there is no significant difference of scar score between two groups.

Discussion

The tissue damage in burn injury is due to multiple factors which include the failure of surrounding tissue to supply borderline cells with oxygen and nutrients which are necessary to sustain

viability [13]. Impediment of the circulation below the injury results in desiccation of the burn wound, as fluid cannot be supplied through the thrombosed or obstructed capillaries. As such topical agents and dressings may reduce but they cannot prevent the desiccation of the burn wound and inexorable progression of deeper layers. Altered permeability is not caused by heat injury all alone; even oxidants and other mediators like prostaglandins, kinnins and histamines all of them contribute to vascular permeability [14]. Neutrophils are a major source of oxidants and injury in the ischemia or reperfusion mechanism, they may be complex but favorablyaffected by several interventions. Therapy is focused on the reduction of dermal ischemia, reduction of edema and prevention of infection. During the period of early hemodynamic instability edema reduction has a markedly beneficial effect as well as modulating later wound conversion from partial to full thickness injury [15].

Infection remains the leading overall cause of death in case of burn injury cases, infection susceptibility is tremendously increased due to loss of the integumentary barrier to bacterial invasion, ideal substrate in the burn wound and the compromised or obstructed microvasculature that prevents humoral and cellular elements from reaching the injured tissue, along with additionally immune system is seriously affected, which demonstrate levels of immunoglobulin's and serious perturbations of polymorph nuclear leukocyte functions [16,17], that includes disorders of chemo taxis, phagocytosis and diminished killing ability. These functions greatly increase morbidity and mortality. Progressive ischemic process can be potentiated by poor tissue perfusion, experimental data significantly support the adjuvant use of hyperbaric oxygen therapy in burn patients, it is evident that this improves microcirculation of the wounded area whereas it decreases wound depth and size.

Several investigators clearly pointed out that hyperbaric oxygen therapy promotes wound healing, by direct increase in fibroblast replication, collagen synthesis as well neovascularization. Giving oxygen at the cellular level will increase leukocyte bactericidal activity and gives direct lethal effect on anaerobic organisms [18].

Korn et al. presented second degree burn wounds heal faster when treated with HBO_2 [19]. Research on epithelial tissue pointed that it can survive without oxygen, but cells cannot divide or migrate [20]. Enough oxygen in tissue to enable epithelial cells to migrate and divide is required to wound healing [21]. Epithelisation process is dependent on the total cell population which survives initial and subsequent later injury as well as mitosis and migration. HBO_2 surely had an affect the process by allowing minimum wound desiccation and destruction as well increasing oxygenation of hypoxic, thermally damaged cells which may not survive otherwise [22]. Perrins et al. reported that there is no effect of HBO_2 in a pig scald model [23]. Niccole et al. also highlighted that there is no advantage in wound healing achieved by HBO_2 when the modality was compared to topical antibiotics [24]. They pointed and made a proposal that HBO2 alone acted just as a mild antiseptic.

Cianci, 2004 [25] reported that the WBC that fight the infection in the ulcer use twenty times more oxygen when they are killing bacteria. Also it is proposed that the more oxygen the more efficiently the repair of the connective tissues. New capillaries mean that more blood gets to the site of the ulcer, which spreads healing. High oxygen levels also make RBC cells more flexible so they can get through the twists and turns of the capillaries and get to where are needed.

The Hyperbaric Oxygen therapy has a treatment modality for around a broad range of ailments, which includes chronic pain, and reduces pain in animal models. Clinical research had indicated that the HBO therapy is useful to modulate human pain. A research carried out by Katznelson et al. highlighted a reduction in pain, swelling, and allodynia and an improvement in skin color and range of motion in patients with complex regional pain syndrome after completionof three weeks of HBO therapy [26].

Our research reflected that the HBO group had better pain relieve and satisfaction improvement, it may be probably only due to the gratification of receiving HBO therapy. However, we cannot exclude the possibility of few complications for HBO therapy such as barotrauma, sinus or tooth squeeze, all such conditions will affect satisfaction; further more meticulous studies with more number of patients and parameters need to be done. In our study we excluded persons with excessive comorbidities; if the patient had excess comorbidities, it may loss to followup during the course of study likely chance as well even after well explaining the risk for HBO therapy, many patients with excess comorbidities did not tolerate and refused the management. Hyperbaric Oxygen therapy can improve pain score and patient satisfaction in our study. However, the possibility of cost effectiveness of the HBO therapy would

need further discussion. Future, the clinical trials with large sample size and different types of burn injury shall be considered.

Conclusion

In this study to conclude the impact of hyperbaric oxygen therapy in burn injury patients, outcome is favorable to Burn injury patients. Our findings shows the beneficial effects of HBO therapy, as well suggests that the HBO therapy has a significant improvement in the pain relieve and satisfaction improvement. Hence, HBO therapy, as an adjuvant treatment, could be helpful for pain control and satisfaction associated with burn injuries. Consequently, when pairing the clinical experiences and laboratory data, justification for using HBOT as an adjunct for managing Burn injuries is strong. Despite these encouraging results further research is needed to more clearly define the mechanism and potential role of HBOT following Burn injury. However, in no situation should HBOT be used as a substitute for indicated surgical and medical interventions.

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Conflict of Interest: The author declares no conflict of interest for this study.

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I **Dinesh Kumar Kashyap**, hereby declare that the particulars given above are true to the best of my knowledge and belief.

Sd/-

(Dinesh Kumar Kashyap)

Original Article

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Role of Bates-Jenson Wound Assessment Tool (BJWAT) in Wound Management

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Abstract

Wound management is an integral part of surgical specialties. The process of wound healing has been studied in detail and the management of wound and its myriad treatment options have been evolving since the advent of scientific advancements. Proper wound assessment is an important part of wound management. Here we share our experience with the use of Bates-Jenson Wound Assessment Tool in the assessment of wounds.

Keywords: Bates Jenson Wound Assessment Tool (BJWAT); Wound assessment; Management.

Introduction

From the time of injury body initiates a process of tissue repair and wound healing. Wound healing is a dynamic process involving cellular, humoral and molecular mechanisms and consists of phases such as inflammation, proliferation and wound remodeling. Wound healing is a multifactorial process; hence both local and systemic factors should be included for effective assessment of wound. Appropriate assessment enables interventions at the right time. An adequate assessment is essential for making treatment and recognizing and preventing wound possible complications. Various wound assessment tools are described in literature. Here we describe our experience regarding decisions and management of healing process which involves monitoring t and recognizing and preventing wound possible complications. Various wound assessment tools are described in literature. Here we describe our experience regarding the use of Bates- Jansen wound assessment tool in assessment of wounds and thus further management.

Materials and Methods

This study was conducted in the department of plastic surgery in a tertiary care center during the period January 2019-March 2019. Informed consent was taken from all participants included in the study. Here we studied the use of Bates-Jenson Wound Assessment Tool in the management of wounds. A total of 10 patients were included in the study who were admitted and treated in the plastic surgery ward. Three patients were cases of

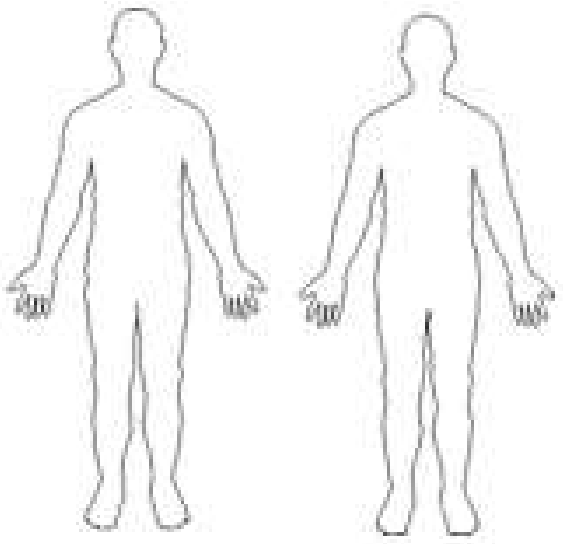
posttraumatic raw area, 4 cases were of diabetic ulcer, 2 were of postsurgical raw area following surgical site infection and one was a case of Fournier's gangrene. Wound assessment was done using BJWAT Chart on admission and weekly after start of therapy for 4 weeks. Following are the details and guidelines followed while using BJWAT Chart: [3]

Bates-Jensen Wound Assessment Tool

Name

Complete the rating sheet to assess wound status. Evaluate each item by picking the response that best describes the wound and entering the score in the item score column for the appropriate date.

Location: Anatomic site. Circle, identify right (R) or left (L) and use "X" to mark site on body diagrams:



Sacrum & coccyx	Lateral ankle	
Trochanter	Medial ankle	
Ischial tuberosity	Heel	Other Site

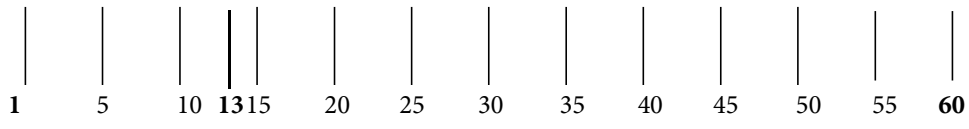
Shape: Overall wound pattern; assess by observing perimeter and depth.

Circle and date appropriate description:		
Irregular	Linear or elongated	
Round/oval	Bowl/boat	
Square/rectangle	Butterfly	Other Shape

Item		**Assessment**	**Date Score**	**Date Score**	**Date Score**
1. Size	1	= Length x width <4 sq cm			
	2	= Length x width 4--<16 sq cm			
	3	= Length x width 16.1--<36 sq cm			
	4	= Length x width 36.1--<80 sq cm			
	5	= Length x width >80 sq cm			
2. Depth	1	= Non-blanchable erythema on intact skin			
	2	= Partial thickness skin loss involving epidermis &/or dermis			
	3	= Full thickness skin loss involving damage or necrosis of subcutaneous tissue; may extend down to but not through underlying fascia; &/ or mixed partial & full thickness &/or tissue layers obscured by granulation tissue			
	4	= Obscured by necrosis			
	5	= Full thickness skin loss with extensive destruction, tissue necrosis or damage to muscle, bone or supporting structures			
3. Edges	1	= Indistinct, diffuse, none clearly visible			
	2	= Distinct, outline clearly visible, attached, even with wound base			
	3	= Well-defined, not attached to wound base			
	4	= Well-defined, not attached to base, rolled under, thickened			
	5	= Well-defined, fibrotic, scarred or hyperkeratotic			
4. Under-mining	1	= None present			
	2	=Undermining < 2 cm in any area			
	3	= Undermining 2-4 cm involving < 50% wound margins			
	4	= Undermining 2-4 cm involving > 50% wound margins			
	5	= Undermining > 4 cm or Tunneling in any area			
5. Necrotic	1	= None visible			
Tissue	2	= White/grey non-viable tissue &/or non-adherent yellow slough			

Type	3	= Loosely adherent yellow slough
	4	= Adherent, soft, black eschar
	5	= Firmly adherent, hard, black eschar
6. Necrotic	1	= None visible
Tissue	2	= < 25% of wound bed covered
Amount	3	= 25% to 50% of wound covered
	4	= > 50% and < 75% of wound covered
	5	= 75% to 100% of wound covered
7. Exudate	1	= None
Type	2	= Bloody
	3	= Serosanguineous: thin, watery, pale red/pink
	4	= Serous: thin, watery, clear
	5	= Purulent: thin or thick, opaque, tan/yellow, with or without odor
8. Exudate Amount	1	= None, dry wound
	2	= Scant, wound moist but no observable exudate
	3	= Small
	4	= Moderate
	5	= Large
9. Skin	1	= Pink or normal for ethnic group
Color	2	= Bright red &/or blanches to touch
Sur-	3	= White or grey pallor or hypopigmented
Rounding	4	= Dark red or purple &/or non-blanchable
Wound	5	= Black or hyperpigmented
10. Peripheral	1	= No swelling or edema
Tissue	2	= Non-pitting edema extends <4 cm around wound
Edema	3	= Non-pitting edema extends >4 cm around wound
	4	= Pitting edema extends < 4 cm around wound
	5	= Crepitus and/or pitting edema extends >4 cm around wound
11. Peripheral	1	= None present
Tissue	2	= Induration, < 2 cm around wound
Induration	3	= Induration 2-4 cm extending < 50% around wound
	4	= Induration 2-4 cm extending > 50% around wound
	5	= Induration > 4 cm in any area around wound
12. Granu-	1	= Skin intact or partial thickness wound
Lation Tissue	2	= Bright, beefy red; 75% to 100% of wound filled &/or tissue Overgrowth
	3	= Bright, beefy red; < 75% &> 25% of wound filled
	4	= Pink, &/or dull, dusky red &/or fills < 25% of wound
	5	= No granulation tissue present
13. Epithelialization	1	= 100% wound covered, surface intact
	2	= 75% to <100% wound covered &/or epithelial tissue extends >0.5 cm into wound bed
	3	= 50% to <75% wound covered &/or epithelial tissue extends to <0.5 cm into wound bed
	4	= 25% to < 50% wound covered
	5	= < 25% wound covered
	Total Score	
	Signature	

Wound Status Continuum



Tissue Health — Wound Regeneration — Wound Degeneration

Plot the total score on the Wound Status Continuum by putting an **"X"** on the line and the date beneath the line. Plot multiple scores with their dates to see-at-a-glance regeneration or degeneration of the wound.

BJWAT was used and scores were calculated every week whenever the wound was debrided and wound bed preparation was done (Figs.1-3). The assessment tool was used by 5 Plastic surgery trainees on their patients. Feedbacks were collected from them at the end of the study on the basis of which it was concluded whether B JWAT was helpful in their treatment protocol for their patients.

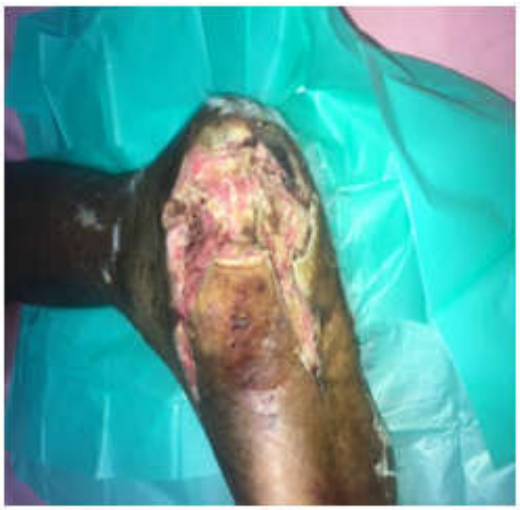


Fig. 1: Wound with BJWAT Score 45 at admission

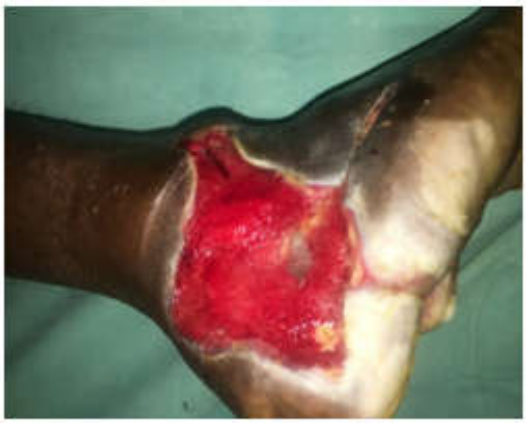


Fig. 2: Wound with BJWAT score 25 after Wound Bed Preparation (WBP)

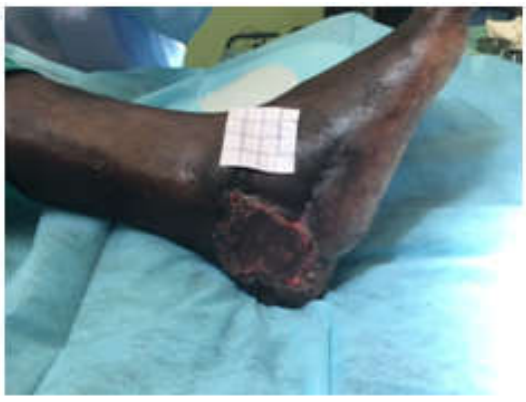


Fig. 3: BJWAT Score 13 after treatment (skin grafting)

Results

BJWAT was used in 10 patients by 5 Plastic Surgery trainees and scores were calculated over a period of 4 weeks. The scores decreased from high to low during the period of 4 weeks, signifying wound regeneration. The assessment scores helped in decision making and planning further management in addition to evaluating efficacy of the ongoing therapy. Based on the scores surgeons were able to plan their appropriate interventions for the desired results. It was found that BJWAT was useful in wound assessment but 2 surgeons felt that it required modifications since it did not consider systemic factors affecting wound healing such as diabetes mellitus, anemia, hypoalbuminemia, smoking etc.

Table 1: BJWAT Scores

S.N.	Week 1	Week 2	Week 3	Week 4
1.	55	35	20	13
2.	50	25	15	15
3.	55	43	20	14
4.	45	22	16	15
5.	40	20	18	13
6.	35	23	15	13
7.	30	21	18	13
8.	50	33	20	15
9.	45	25	17	14
10.	35	23	18	13

Table 2: Questionnaire

Questions	Participants				
	1	2	3	4	5
Is the assessment tool easy to use and comprehend?	Yes	Yes	Yes	Yes	Yes
Were you able to assess the wound condition and able to plan the management?	Yes	Yes	Yes	Yes	Yes
Were you able to correlate the wound condition with the changing score?	Yes	Yes	Yes	Yes	Yes
Were you able to make changes in your management approach based on the score?	Yes	Yes	Yes	Yes	Yes
Do you think modifications are needed in the score?	No	No	Yes	Yes	No

Discussion

Wound assessment is an important aspect in efficient and effective management of wounds. Choosing a proper wound assessment tool becomes imperative in this set up. It is essential in deciding topical treatment based on wound status

and for recognition of healing and deterioration requiring other interventions [1]. The process of wound assessment should be simple according to Doughty [2]. According to Harris C, wound assessment is a complex process requiring substantial visual and physical assessment skills, combined with clinical judgement and experience [3]. Kobza and Scheurich attribute a significant portion of increased costs associated with wound care to inadequate or variable assessment and inconsistent documentation [4]. One method of improving this process is the use of standardised instrument designed to guide clinicians through a systematic and consistent assessment and documentation [5]. Various wound assessment tools are used in medical practice including PUSH (Pressure ulcer scale for healing), BJWAT (Bates Jensen Wound Assessment Tool), DESIGN (Depth, Exudate, Size, Infection/Inflammation, Granulation tissue, Necrotic Tissue), DESIGN-R (Depth, Exudate, Size, Infection/Inflammation, Granulation tissue, Necrotic Tissue, Rating), PUHP (Pressure ulcer healing process), Wound bed Sore (WBS), Diabetic foot ulcer assessment scale (DFUAS). Most of the assessment tools are based on wound parameters like size, area, volume, depth, exudate, tissue type, signs of infection and inflammation.

Bates-Jenson wound assessment tool is one of the most prevalent wound assessment tools. Originally developed in 1990 as the Pressure Sore Status Tool (PSST), it was redesigned in 2001 and renamed by Barbara Bates-Jenson [4,6].

Although developed initially for assessment of pressure sores, BJWAT has been used to assess healing of chronic wounds of different etiologies and acute wounds as well. BJWAT assesses 13 wound characteristics with a numerical rating scale and rates from best (1) to worst (5). Total score ranges from 13 (skin closed) to 65 (profound tissue degeneration) (Table 3). Lower scores indicate a better healing index. It is imperative to watch the total score to note whether wound is healing or not. BJWAT has evolved to include measuring and predicting wound healing. Average content validity is 0.62 [6]. Validation studies indicate that in addition to having good content validity, BJWAT has excellent intra-and interrater reliability when used by experienced wound care clinicians [7]. There are very detailed instructions for using the BJWAT and Harris and colleagues gave a pictorial guide to help novice clinicians [3]. BJWAT assesses 13 parameters including size, depth, edges, undermining, necrotic tissue type, necrotic tissue amount, exudate type, exudate amount, skin colour surrounding wound, peripheral tissue oedema, peripheral tissue induration, granulation tissue, epithelisation. Higher scores indicate tissue degeneration and lower scores indicate tissue regeneration. A descriptive tool like BJWAT is not set out to be an outcome measure but rather used for initial assessment.

Conclusion

This is a preliminary study to assess the use of BJWAT in wound management in a limited setting with limited number of cases. The assessment tool doesn't consider systemic factors of the patient which also plays an important role in wound healing. A positive effect was found but a large multicentric, double blinded control study with statistical analysis is required to substantiate the results.

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Original Article

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Evaluation of Effect of Negative Pressure Wound Therapy on Split Thickness Skin Graft Take

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Abstract

Background: Conventional dressing of choice is a cotton bolster or sterile compressive dressing that is used for at least five days. The negative pressure wound therapy using reticulated open cell foam dressing conforms to the wound geometry by addition of negative pressure and promotes skin graft adherence while removing exudates and oedema from surrounding tissues.

Methodology: An observational comparative study was conducted in our department from November 2016 to may 2018. A total of 60 patients were included and the subjects were divided in 2 study groups Group-A i.e. standard dressing group and Group-B i.e. negative pressure wound therapy group of 30 patients each. Initially, during intra-operative period, size of the grafted area was measured in surface area using graph sheet method. Photographs were taken intra operatively and on post operative day 7, Percentage of graft take was measured on post operative day 7. Besides these some other variables were also compared.

Result: In Group B, the mean area of grafted wound was 396.70 cm^2 with standard deviation of 94.57 and the graft take on postoperative day 7 was 391.83 cm^2 with standard deviation of 93.23 showing the statistically significant difference when compared group A. None of the patients in Group B had shown any evidence of haematoma/seroma. Mean numbers of days of hospital stay were less in Group B.

Conclusion: Negative pressure wound therapy is effective in improving the percentage of split thickness graft take.

Keywords: Wound; Therapy; Negative pressure; Skin graft; Haematoma.

Abbrevation: NPWT – Negative pressure wound therapy; STSG – Split thickness skin graft; ROCF - Reticulated open cell foam; VAC – Vacuum assisted closure.

Introduction

STSGs currently represent the most rapid, effective method of reconstructing large skin defects. Graft survival is by following physiological events; i.e Plasmatic imbibition, inosculation and neovascularisation. The initial 'take' (or incorporation) occurs by diffusion of nutrition from the recipient site, termed 'plasmatic imbibition'. Revascularisation generally occurs between days 3 and 5 by reconnection of blood vessels in the graft to recipient site vessels or by in growth of vessels from the recipient site into the graft [1]. The major causes of graft loss are hematomas

and formation of blisters under the graft which interferes with graft survival [2,3]. The Successful STSGs take require immobilisation of the graft to prevent shearing, infection and seroma or haematoma formation beneath the graft. To achieve all of the above requirements, we need uniform pressure over the entire grafted area through a non adherent, semi-occlusive, absorbent dressing material. Conventional dressing of choice is a cotton bolster or sterile compressive dressing that is used for at least five days. The negative pressure wound therapy using reticulated open cell foam (NPWT/ROCF) [4] dressing conforms to the wound geometry by addition of negative pressure and promotes skin graft adherence while removing exudates and oedema from surrounding tissues. This study was conducted to evaluate the clinical outcomes of rate of STSGs uptake treated with NPWT and conventional dressing.

Methodology

An observational comparative study was conducted in our department from November 2016 to may 2018. A total of 60 patients were included and the subjects were divided in 2 study groups Group-A and Group-B of 30 patients each. Initially, during intra-operative period, size of the grafted area was measured in surface area using graph sheet method (Fig. 1).

Graph method to measure wound size

Impression of wound taken using transparent sheet and drawn over graph sheet. Area of one square is 1 sq cm. Complete square is counted as 1. Half squares counted as half squares and more than half squares counted as 3/4 and less than half squares as ¼

Total area (in cm^2) = No of Complete squares X 1+ no of half squares X ½ + no of more than half squares x ¾ + no of less than half square X 1/4

Example: Figure 1: shows 306 full squares and 12 half squares

Total area = 306 X1 + 12 half squares X1/2

= 306+6

= 312 cm^2

The donor site and the site to be grafted was cleaned with Betadine solution and saline solution. The STSG was harvested, taking opposite thigh as a donor area. The STSG was meshed with a scalpel no.11 and was fixed to recipient site with sutures or skin staples. Once the graft was fixed, the patient was randomly assigned to standard dressing (Group-A) Or negative pressure wound therapy (Group B)

Group-A: Standard dressing is a cotton bolster dressing to ensure contact and immobilization between the split thickness skin graft and host bed.

Group-B: In NPWT group, the non adherent dressing is placed over STSG. The vac sponge was cut to match the contour of the wound and was secured to surrounding skin using adherent occlusive dressing. The VAC tubing was then connected to a pump that provides 125 mmhg continuous negative pressure. (Figs. 2 to 8)

Splinting was done for immobilization in extremity skin grafts. NPWT was continued till post operative day 7. On postoperative day 7, the percentage of graft take was assessed in both the groups. Photographs were taken intra operatively and on post operative day 7, Percentage of graft take was measured on post operative day 7.

Percentage of STSG take

$$= \frac{\text{Area with graft take}}{\text{Grafted area}} \times 100$$

Results

A total of 60 patients (n=60) were included in our study. In all the patients, wound cultures were sent prior to grafting. None of the wound cultures had shown any growth of organisms. The mean age of the study subjects in NPWT Group was 36.07 years and in Standard dressing Group was 39.27 years [Table 1]. Different variables were being analysed between the two groups using appropriate statistical methods namely Chi-square test, Student –T test and Fisher test. taking 0.05 as P -value just significant at 5 percent level when the mean of the sample lies just within 95 percent confidence limit.

Table 1: Demographics of the patients, aetiology and distribution of wounds

Variable	Standard dressing n=30	NPWT n=30
Age (in years) (Mean ± SD)	39.27 ± 9.35	36.07 ± 8.82
Sex		
Male	17 (57%)	20 (67%)
Female	13 (43%)	10 (33%)
Cause of wound		
Post infective	9	10
Post traumatic	16	15
Burn	5	5
Site of wound		

Upper limbs	1	1
Leg and thigh	5	11
Thigh	16	9
Leg	8	9

There was no statistically significant difference in the distribution of the ages in the two groups (p Value = 0.178).

Table 2: mean area of wound, mean graft take and loss and mean duration of hospital stay

Variable	Standard dressing Mean ± SD	NPWT Mean ± SD	p-value
Area of wound grafted (cm sq)	328.43 ± 87.56	396.70 ± 94.57	0.005
Graft take (cm sq)	274.9 ± 49.87	391.83 ± 93.23	<0.001
Duration of Hospital Stay (in days)	9.83 ± 3.72	7.0 ± 0	<0.001

In NPWT Group, there were 20 males and 10 females out of total 30 study subjects whereas in STANDARD dressing Group, there were 17 males and 13 females. However, the difference was not statistically significant (p Value = 0.426). The total number of patients with post infective raw area were 10 and 9 in NPWT and standard dressing group respectively. The total number of patients with post traumatic raw area were 15 and 16 in NPWT and standard dressing group respectively. The total number of patients with post burn raw area were 5 each in NPWT and standard dressing group respectively.

The anatomical area of raw area were thigh, leg and forearm.

In NPWT group, the mean area of grafted wound was 396.70 cm^2 with standard deviation of 94.57 and the graft take on postoperative day 7 was 391.83 cm^2 with standard deviation of 93.23. In standard dressing group, the mean area grafted wound was 328.43 cm^2 with standard deviation of 87.56 and the graft take on postoperative day 7 was observed to be 274.9 cm^2 with the standard deviation of 49.87. The difference was statistically significant with *p-value* <0.001. The mean percentage of graft take in the NPWT group was 98.37% with standard deviation of 0.85 and the mean percentage of graft take in standard dressing group was 84.23% with standard deviation of 9.14. The difference was statistically significant with p Value <0.001 [Table 2].

Decreased graft take was observed in patients of standard dressing group and haematoma/seroma were seen as the commonest cause for decreased graft take.

Haematoma/seroma were seen in 6 patients, out of total 30 patients in standard dressing group.

None of the patients in NPWT group had shown any evidence of haematoma/seroma. Mean numbers of days of hospital stay in NPWT Group were 7.0 days whereas in Standard Group those were 9.83 days. There was statistically significant difference in the total duration of hospital stay in the two groups (p Value <0.001).

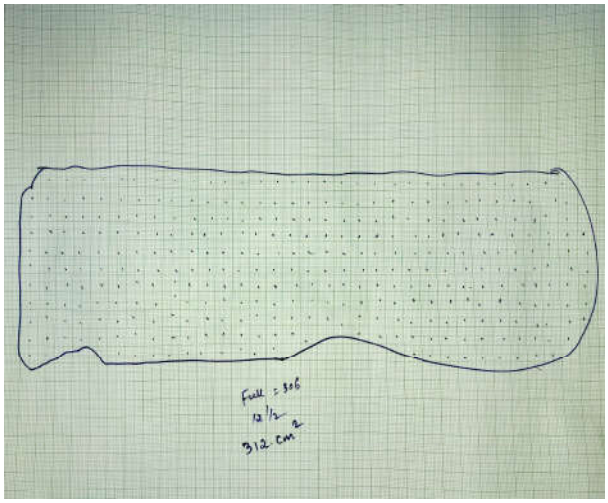

Fig. 1: Graph Sheet Method

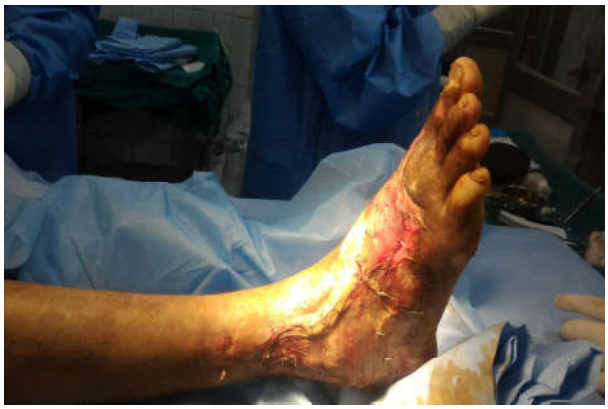

Fig. 2: The Raw Area Resurfaced With Split Thickness Skin Graft

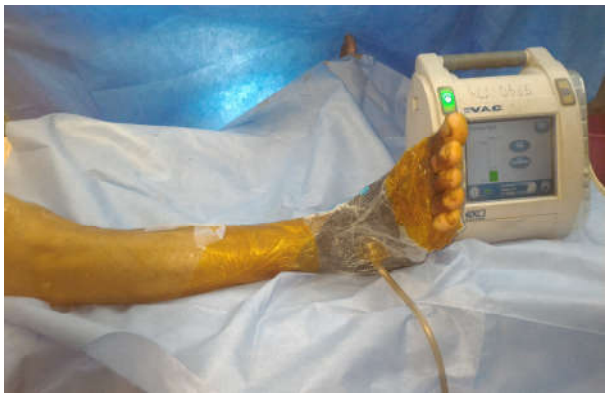

Fig. 3: The Npwt Dressing was Done Over The STSG

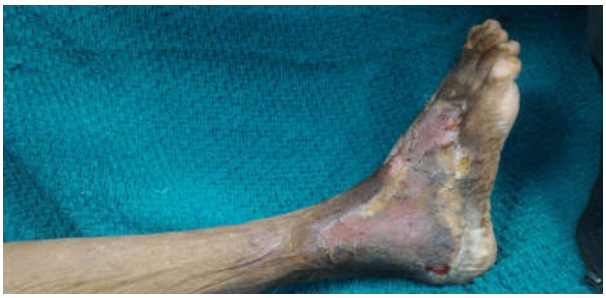

Fig. 4: Post Operative Day 7: Showing Almost 98% Graft Take

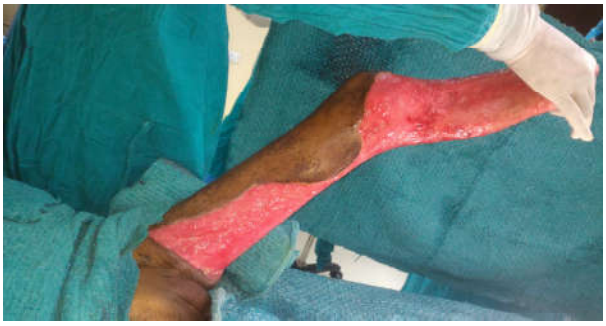

Fig. 5: Post Traumatic Raw Area Over Thigh And Leg

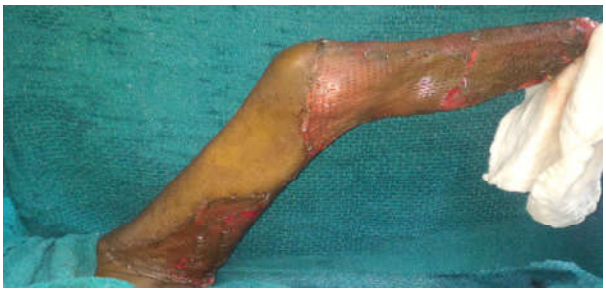

Fig. 6A:

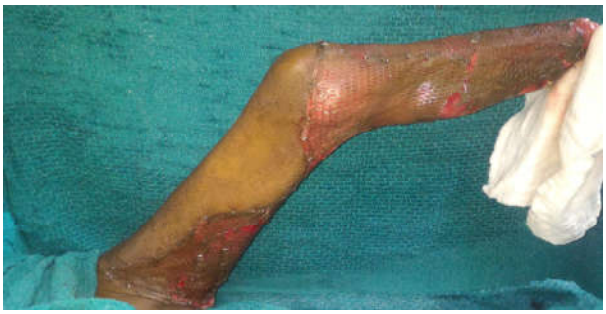

Fig. 6: The Raw Area Resurfaced with Split Thickness Skin Graft

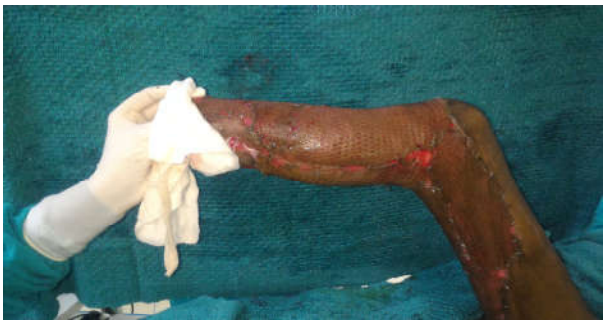

Fig. 7: The Raw Area Resurfaced with Split Thickness Skin Graft

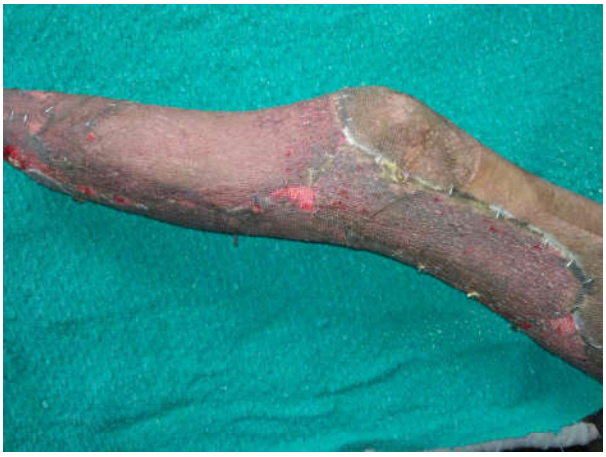

Fig. 8: Post Operative Day 7: Showing Almost 97% Graft Take

Discussion

In our study, out of 60 patients, 37 were male patients and 23 were female patients. The predominant age group are between 31-40 years. NPWT has been used for the integration of STSG for wounds of varied aetiologies. Most of the wounds in both the groups of our study were caused by trauma, burns and infection.

Trauma was the leading cause of wounds in the series presented by Moisidis et al. [5] and Jeschke et al. [6] as seen in our study where out of total 60 patients with raw area, 15 patients in NPWT group and 16 patients in standard dressing group were caused due to trauma. While Llanos et al. [3] Scherer et al. [7] reported the use of NPWT over graft mostly in burns. NPWT has been used over STSG for the coverage of wounds ranging from small to large sizes. The mean wound sizes of the two groups of our study were 396.70 ± 94.57 cm2 in NPWT and 328.43 ± 87.56 cm^2 in Standard dressing groups, respectively. Scherer et al. [7] have reported similar mean wound size as our study. Nonstandard/custommade NPWT has been used over STSG by Llanos et al. [3] Petkar et al. [8] and Dorafshar et al. [9] with comparable results.

Assessment of postoperative graft take.

The mean percentage of graft take in the NPWT group was 98.37 with standard deviation of 0.85 and the mean percentage of graft take in standard dressing group was 84.23 with standard deviation of 9.14. the difference was statistically significant with p Value <0.001. Mir Mohsin et al. [2] assessed a post graft take in NPWT group was 99.74% ± 0.73% compared to 88.52% ± 9.47% in the non-NPWT group which is similar to our study. Several studies like scherer et al. [7], Llanos et al.[3],

jeschke et al. [6]., moisidis et al. [5], have reported statistically significant difference in the quality and quantity of graft take using NPWT over graft as compared to conventional dressing, similar to our results [3,5,6,7]. In our study, None of the patients in the NPWT group and standard dressing group required second coverage procedure. Moisidis et al. [5]. Reported no need for regrafting any case in either of the two groups. Initial graft survival with NPWT reduces the need for regrafting, which may eliminate repeated surgical procedure, surgical expenses and hospital stay [10]. Many studies like scherer et al. [7], Llanos et al. [3], Blume et al. [10], have reported significant reduction in the reoperation rates in the grafts covered by NPWT as found in our study. In our study the skin graft take was assessed on post operative day 7 in both the groups and patients with standard dressing required a longer healing period as the graft take was relatively less when compared with NPWT group. All the patients with NPWT group were discharged on 7th day from the day of grafting. whereas in standard dressing group, 4 cases had to stay beyond 10 days.

The length of post STSG hospital stay was reduced in NPWT group. Mean numbers of days of hospital stay in NPWT Group were 7 days whereas in Standard dressing Group those were 9.83 days. With standard deviation (S.D) as 0.0 and 3.72 respectively. The difference in total hospital stay between the standard dressing group and NPWT group was found out to be statistically significant with p value <0.001 which was co-related with similar study done by Llanos et al. [3] Llanos et al. [3] who noted that the mean postgrafting hospital stay was 8 days (range 7–13 days) in the negative pressure group versus 12 days (7–23 days) in the control group which was statistically significant (p = 0.001) and is Similar with our study. On utilising NPWT, the use of uncomfortable splinting techniques to immobilise extremities has become unnecessary. Morykwas et al.found in their studies that 125 mmHg of subatmospheric pressure applied to the wound bed was the most efficacious concerning the blood flow. The same pressure level was also applied in consecutive studies described in their paper [11]. We used a subatmospheric pressure of –125 mmHg for all patients age included in our study. Negative pressure dressings improves graft survival. First, an important aspect to successful graft take is maintaining good apposition between the graft and the wound surface. By design, continuous negative pressure dressings provide an uniform distribution of negative pressure and apposition between the graft and the wound bed in most cases, even if the surface contour is irregular [12,13]. This becomes particularly important for patients with traumatic injuries necessitating skin grafting as these grafts are often in irregularly contoured regions such as the wrist, knee and ankle. Second, accumulation of hematoma or seroma under the graft contributes to graft loss. The negative pressure dressing provides continuous removal of wound fluid, which prevents the accumulation of hematoma or seroma while maintaining graft to wound apposition [12,14]. Third, desiccation is detrimental to wound healing [15] and is reduced with the occlusive nature of the NPWT dressing, in which a moist environment is maintained. Lastly, infection contributes to graft loss. NPWT has been associated with lower bacterial counts at wound sites 2, and this reduction in the local bacterial flora may enhance graft survival. In standard dressing group, the most common cause of graft loss was found out to be haematoma/seroma which was observed in 6 out of 30 patients and None of the patients in NPWT group, the complication like haematoma / seroma was not seen.

Conclusion

NPWT is a safe, useful and effective technique in integration of STSG. The NPWT increases the percentage of graft take when compared to standard dressing the NPWT, decreases the need for second stage grafting and reduces the duration of hospital stay. To conclude, negative pressure wound therapy is effective in improving the percentage of split thickness graft take.

*Conflict of Interests***:** None

*Funding Source***:** None

Ethical Approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Declaration: The study is inaccordance with the ethical standardsof the responsiblecommitteeon human experimentation (Institutional or Regional) and with theHelsinkideclaration of 1975, as revised in 2000.

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Original Article

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Role of Microporous Polysaccharide Hemosphere Technology in Wound Healing

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Abstract

Hematoma and infection are the greatest enemies of a plastic surgeon. Various hemostatic agents are used in surgery. From application of direct pressure, use of tourniquets, ligatures, electro cautery, laser coagulation medical science is now exploring the use of various topical hemostatic agents. Here we share our experience with the use of micro porous polysaccharide hemospheres for hemostasis of split thickness graft donor site in 6 patients.

Keywords: MPH technology; Wound; Healing; Hemostasis.

Introduction

Attaining good hemostasis is an integral part of surgical advancements. Various methods of attaining hemostasis have been described. Together with conventional methods of attaining hemostasis, of late a lot of absorbable hemostatic agents are used in operating room for various surgical procedures. Here we describe our experience regarding the use of microporous polysaccharide hemospheres in attaining hemostasis thereby aiding in wound healing. The commercial information states that their use is indicated in surgical procedures as an adjunctive hemostatic agent in capillary, venous and arteriolar bleeding. This hemostatic agent has been available in the last few years but its use is limited to cardiovascular, orthopedics, spleen and liver and renal surgeries.

Materials and Methods

This study was conducted in the Department of Plastic Surgery in a tertiary care hospital during the March-April 2019. Informed consent was taken from participants who were included in the study. Study was conducted by institutional support and there were no conflicts of interest. The patients undergoing split thickness skin grafting were included in the study during study period. A total of 6 patients were included. The hemostatic powder based on Microporous Polysaccharide Hemospheres (MPH) technology commercially available was sprinkled on the donor site of split thickness skin grafting. (Figs. 1-3). The container containing hemostatic

powder is available in a quantity of 1,3 or 5 grams and can be sprinkled in a liberal amount at the site of bleeding within the wound. It is important to remove excess blood so that the hemostatic powder can be applied immediately and directly to the site of active bleeding. Direct pressure can be applied quickly over the treated site. Excess hemostatic powder needs to be removed if bleeding continues and needs to be reapplied. Immediately upon contact with fluid, the microporous polysaccharide hemosphere swells to 5 times its original volume. Once hemostasis is achieved, excess powder is removed by irrigation and aspiration. The cost of the hemostatic agent in 1 gm applicator is about Rs 2700 in India.

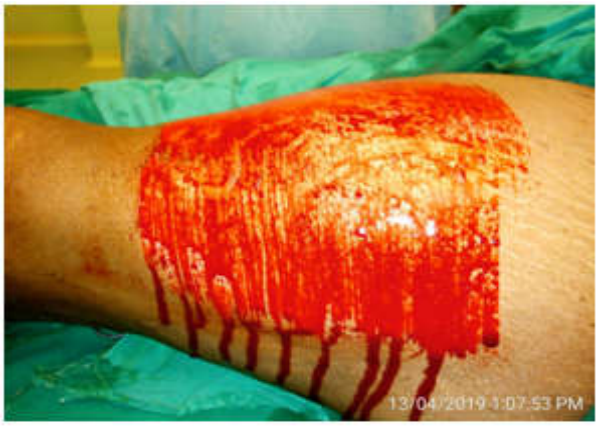

Fig. 1: Split Thickness Graft Donor Site

Fig. 2: Application Of MPH hemostatic agent

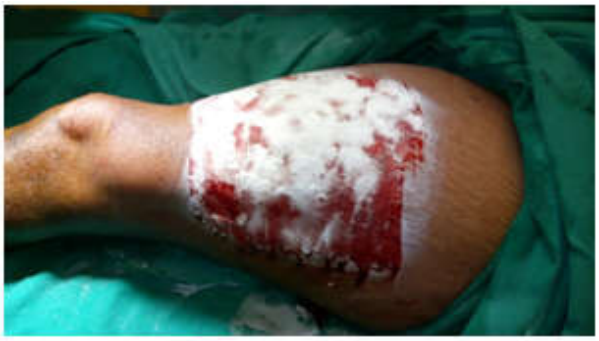

Fig. 3: After application of hemostatic agent.

Results

MPH technology was used in attaining hemostasis of split thickness graft donor site in 6 patients. Donor site was usually left or right thigh. Time of attaining hemostasis was noted. We also assessed for complications.

Serial Number	Hemostasis Time	Complications
1.	4 minutes	Nil
2.	3 minutes	Nil
3.	5 minutes	Nil
4.	4 minutes	Nil
5.	4 minutes	Nil
6.	5 minutes	Nil

Discussion

Hemostasis is fundamental part of any surgical intervention. Various hemostatic agents are used in surgical practices and use varies according to the procedure.

Mechanical measures of attaining hemostasis include manual pressure, ligature or application of a tourniquet [1]. Bleeding vessels can be sealed by using cauterization methods such as electro cautery or laser cautery but these create areas of necrosis and char which increases the likelihood of infection and impaired wound healing [2]. Some of the commonly used topical hemostatic agents include fibrin glue, cyanoacrylate gel, oxidized regenerated cellulose, microfibrillar collagen [3]. These agents exert their effect through various mechanisms such as primary hemostasis, fibrin formation or inhibiting fibrinolysis [4].

MPH technology is another method of attaining hemostasis. MPH technology is used for application to surgical wound sites as an absorbable hemostat. This technology incorporates hydrophilic, flow able, micro porous particles synthesized by crosslinking purified plant starch through a proprietary process. The powder used is a fine, dry, sterilized white powder that is biocompatible, non-pyrogenic and is typically absorbed within 24-48 hours.

The particles are hydrophilic molecular sieves that enhance natural hemostasis by concentrating blood solids such as platelets, red blood cells, and blood proteins on the particle surfaces to form a gelled matrix. The gel matrix is formed regardless of the patient's coagulation status and it enhances normal clotting reactions and creates stable hemostatic plugs.

MPH technology is relatively safe and simple because it is biologically inert, contains no human proteins, has an extended shelf life and can be easily applied in a one step process [5]. It is helpful in accelerating hemostasis time in wounds [6]. Studies show that it may be ineffective in severe external hemorrhages [7]. It should be used with caution in the presence of infection or in contaminated areas of the body. The most common reported adverse events were pain related to surgery, anemia, nausea and lab values out of normal range. It should not be injected into blood vessels as potential for embolization and death may exist.

Conclusion

In the present study we used MPH technology in split thickness graft donor site in 6 patients and and we found the hemostatic agent to be useful in attaining rapid hemostasis without any discernable adverse effects, however this study was conducted in a limited setting with few participants, hence further multicentric large randomized controlled studies are required to ascertain the hemostatic agents further uses and complete safety profiles.

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Original Article

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Role of Digital Planimetry in Wound Management

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Abstract

Wound measurement is an important aspect of wound management. Periodic wound measurement helps in assessing the effect of treatment protocol and in deciding further intervention. Digital Planimetry (DP) is an important tool for wound measurement. Using a square grid, digital image photograph and the Image-J software, the digital planimetry score is calculated and wound is assessed and treatment protocol finalised. Here we share our experience with the use of Digital Planimetry in wound management.

Keywords: Digital Planimetry; Wound Management; Photograph.

Introduction

The treatment of acute and chronic wounds remains a challenge even in this era of fast growing medical advancements. Today a number of regimens and treatment options are there for a clinician to choose from. Treatment decisions are made from clinical impressions and observations and the response of the wound to a chosen treatment option. In this aspect measurement of the wound dimensions and photographic documentation becomes important. Wound measurement provides objective information by which progress can be measured. Accurate wound measurements that signal improvement after 4-6 weeks are reliable indicator of wound healing. Digital planimetry is one of the reliable methods of wound measurements.

Materials and Methods

This study was conducted in the department of Plastic Surgery in a tertiary care institute during the period March-April 2019. Informed consent was taken from all participants included in the study. Here we studied the role of digital planimetry in wound management. Informed consent was taken from all participants of the study. A total of 5 patients were included in the study, 2 were cases of diabetic foot ulcer, 1 of Fournier's gangrene, 2 of thermal burns. Digital planimetry score was assessed periodically once at admission, during debridement and course of therapy and then at discharge. The measurements were done by 2 surgeons. The tools used were square adhesive 4x4 cm^2 with 16 square grids of 1 cm^2 each, an ordinary digital camera and Image J™ free open source software. The square adhesive was placed near the wound and wound photographs were taken. The wound photograph was then analysed

using Image J™ software. The edges of the wound were marked and the number of pixels falling under the square adhesive marker and marked wound were calculated. Since the dimensions of the square are known, it is possible to derive the exact size of marked area of wound. Following are the steps of calculating digital planimetry based measurements:

Step 1: Wounds to be photographed after placing the square grid next to the wound.

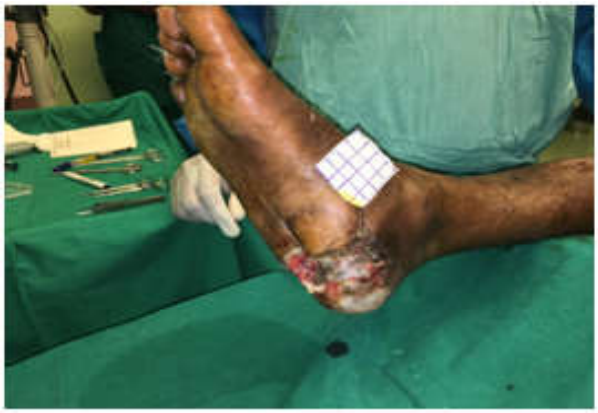

Fig. 1: Showing step1

Step 2: Open the image using Image-J™ Software

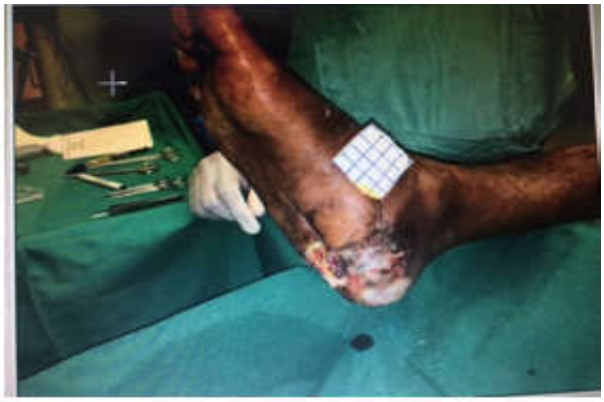

Fig. 2: Showing details of step 2

Step 3: Select the grid in the image.

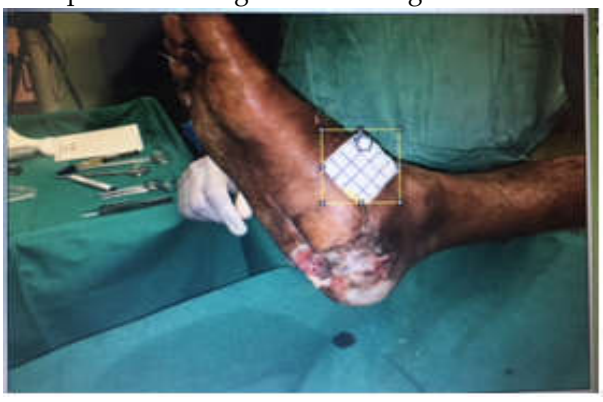

Fig. 3: Showing details of step 3

Step 4: Select Plugins-Analyse-Measure and set labels. The dimensions and pixels of the marker measured with the rectangle selection, analysed and labelled.

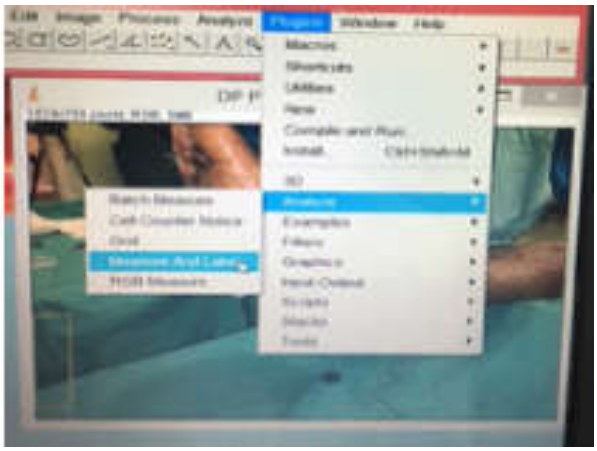

Fig. 4: Showing details of step 4.

Step 5: The output indicates the area under the grid.

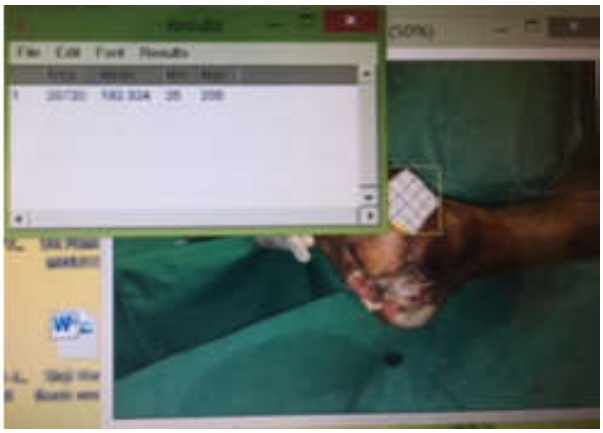

Fig. 5: Showing details about step 5.

Step 6: The wound edges marked with the free hand selection, analysed and labelled in a similar manner.

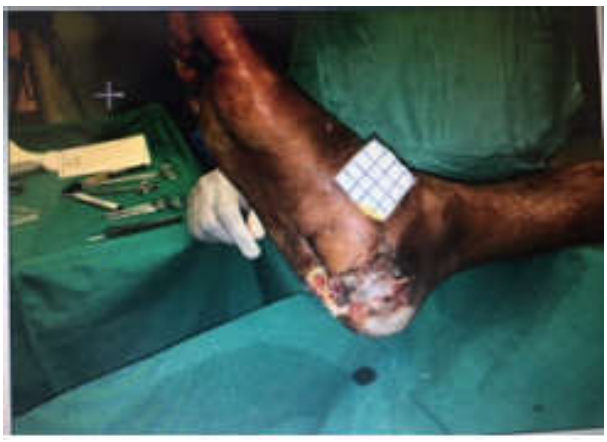

Fig. 6: Details about step 6.

Step 7: The ratio of the marker label and wound measurements give an accurate estimate of the wound size.

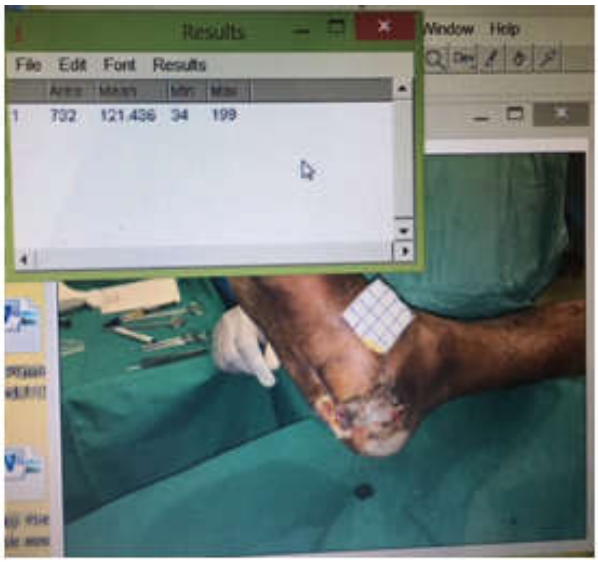

Fig. 7: Showing details about step 7

Results

Out of the 5 patients studied 3 were males and 2 were females. 2 wounds were in the lower limb, 1 in the scrotum, and 2 in the upperlimb. All the wounds were measured with the help of digital planimetry and the area was measured at admission and at discharge or at 4 weeks whichever was the earliest. The measurement values were tabulated (Table 1).

S. N.	Digital Planimetry (DP) Score 1	Digital Planimetry (DP) Score 2
1.	24 cm^2	18.4 cm^2
2.	18.6 cm^2	8 cm^2
3.	14.8 cm^2	4 cm^2
4.	34 cm^2	32.6 cm^2
5.	12.4 cm^2	4 cm^2

The decrease in the DPscores at the end of 4 weeks indicated whether the wound was healing or more aggressive intervention or change in treatment plan is required. Out of 5 wounds 3 were healing well at the end of 4 weeks and 2 wound required change in the intervention plan for obtaining the desired results.

Discussion

Wound assessment is an important part of wound healing. Periodic wound assessment helps in proper management of the wound and making decisions regarding further intervention and for planning changes in the on-goingtherapy. Wound measurement is an integral part of wound assessment. Measurement and recording of wound area helps in assessing progress of wound healing. Various wound measurement techniques have been described in the past. The methods available today can be divided into contact and non-contact methods [1]. Some commonly used techniques are the Ruler method, the graph method or planimetry [2], computerised planimetry [3], digital planimetry [4,5] acetate method and sterophotogrammetry [6]. Here we used a simple method of wound measurement using a simple grid, clinical photo and image software.

Wound measurement at regular intervals helps the clinician to know the rate of wound healing and whether procedures like grafting would be required or not. The decrease in the wound size would indicate whether the wound is healing at a faster pace or would require a change in management protocol. It has been proposed in some studies that percentage change in wound area over a 4 week period of 30% or more is a good predictor of healing [7,8]. Measuring wound using clinical photograph is not routinely practised. Each time photograph has to be taken with the same camera with the same settings at a fixed distance. Even though it is cumbersome at times but it is a good method of assessing wound and is an important aspect in medico legal documentations.

There are only few studies available on the use of Image-J software and most of them are animal studies. This technique can be used in determining graft loss and patchy take of the graft and can also be used to assess features of real life images like facial analysis before surgery.

Conclusion

This is a preliminary study to assess the use of digital planimetry in wound management in a limited setting with limited number of cases, but yet it has been seen as an effective, easily reproducible, noninvasive method of wound measurement. A large multicentric, double blinded control study with statistical analysis is required to further substantiate the results.

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Methods

The methods section should include only information that was available at the time the plan or protocol for the study was written such as study approach, design, type of sample, sample size, sampling technique, setting of the study, description of data collection tools and methods; all information obtained during the conduct of the study belongs in the Results section.

Reports of randomized clinical trials should be based on the CONSORT Statement (http:// www. consort-statement. org). When reporting experiments on human subjects, indicate whether the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional or regional) and with the Helsinki Declaration of 1975, as revised in 2000 (available at http://www.wma. net/e/policy/l 7-c_e.html).

Results

Present your results in logical sequence in the text, tables, and illustrations, giving the main or most important findings first. Do not repeat in the text all the data in the tables or illustrations; emphasize or summarize only important observations. Extra or supplementary materials and technical details can be placed in an appendix where it will be accessible but will not interrupt the flow of the text; alternatively, it can be published only in the electronic version of the journal.

Discussion

Include summary of key findings (primary outcome measures, secondary outcome measures, results as they relate to a prior hypothesis); Strengths and limitations of the study (study question, study design, data collection, analysis and interpretation); Interpretation and implications in the context of the totality of evidence (is there a systematic review to refer to, if not, could one be reasonably done here and now?, What this study adds to the available evidence, effects on patient care and health policy, possible mechanisms)? Controversies raised by this study; and Future research directions (for this particular research collaboration, underlying mechanisms, clinical research). Do not repeat in detail data or other material given in the Introduction or the Results section.

References

List references in alphabetical order. Each listed reference should be cited in text (not in alphabetic order), and each text citation should be listed in the References section. Identify references in text, tables, and legends by Arabic numerals in square bracket (e.g. [10]). Please refer to ICMJE Guidelines (http://www.nlm.nih.gov/bsd/uniform_ requirements.html) for more examples.

Standard journal article

[1] Flink H, Tegelberg Å, Thörn M, Lagerlöf F. Effect of oral iron supplementation on unstimulated salivary flow rate: A randomized, double-blind, placebo-controlled trial. J Oral Pathol Med 2006; 35: 540-7.

[2] Twetman S, Axelsson S, Dahlgren H, Holm AK, Källestål C, Lagerlöf F, et al. Caries-preventive effect of fluoride toothpaste: A systematic review. Acta Odontol Scand 2003; 61: 347-55.

Article in supplement or special issue

[3] Fleischer W, Reimer K. Povidone iodine antisepsis. State of the art. Dermatology 1997; 195 Suppl 2: 3-9.

Corporate (collective) author

[4] American Academy of Periodontology. Sonic and ultrasonic scalers in periodontics. J Periodontol 2000; 71: 1792-801.

Unpublished article

[5] Garoushi S, Lassila LV, Tezvergil A, Vallittu PK. Static and fatigue compression test for particulate filler composite resin with fiber-reinforced composite substructure. Dent Mater 2006.

Personal author(s)

[6] Hosmer D, Lemeshow S. Applied logistic regression, 2nd edn. New York: Wiley-Interscience; 2000.

Chapter in book

[7] Nauntofte B, Tenovuo J, Lagerlöf F. Secretion and composition of saliva. In: Fejerskov O,

Kidd EAM, editors. Dental caries: The disease and its clinical management. Oxford: Blackwell Munksgaard; 2003. p. 7-27.

No author given

[8] World Health Organization. Oral health surveys - basic methods, 4th edn. Geneva: World Health Organization; 1997.

Reference from electronic media

[9] National Statistics Online—Trends in suicide by method in England and Wales, 1979-2001. www.statistics.gov.uk/downloads/theme_health/HSQ20.pdf (accessed Jan 24, 2005): 7-18. Only verified references against the original documents should be cited. Authors are responsible for the accuracy and completeness of their references and for correct text citation. The number of reference should be kept limited to 20 in case of major communications and 10 for short communications.

More information about other reference types is available at www.nlm.nih.gov/bsd/uniform_requirements.html, but observes some minor deviations (no full stop after journal title, no issue or date after volume, etc).

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Tables should be self-explanatory and should not duplicate textual material.

Tables with more than 10 columns and 25 rows are not acceptable.

Table numbers should be in Arabic numerals, consecutively in the order of their first citation in the text and supply a brief title for each.

Explain in footnotes all non-standard abbreviations that are used in each table.

For footnotes use the following symbols, in this sequence: *, ¶, †, ‡‡,

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Type or print out legends (maximum 40 words, excluding the credit line) for illustrations using double spacing, with Arabic numerals corresponding to the illustrations.

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Standard abbreviations should be used and be spelt out when first used in the text. Abbreviations should not be used in the title or abstract.

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- Conflicts of interest disclosed

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- Identity not revealed in paper except title page (e.g.name of the institute in Methods, citing previous study as 'our study')

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- Uniformly American English
- Abbreviations spelt out in full for the first time. Numerals from 1 to l0 spelt out
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- No repetition of data in tables and graphs and in text.
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- Table and figure numbers in Arabic letters (not Roman).
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