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Dr. Janak Rathod
Professor and head of
orthopaedic Department,
Smimer Medical College, Surat,
Gujarat, India

Dr. Fenil Patel
3rd year orthopaedic resident,
Smimer Medical College,
Surat, Gujarat, India

Dr. Sachin Patel
2nd year orthopaedic resident,
Smimer Medical College,
Surat, Gujarat, India

Corresponding Author:
Dr. Fenil Patel
3rd year orthopaedic resident,
Smimer Medical College,
Surat, Gujarat, India

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Prospective study on vacuum assisted closure therapy in treatment of soft tissue injuries associated with Gustilo Anderson compound grade III fractures

Dr. Janak Rathod, Dr. Fenil Patel and Dr. Sachin Patel

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Abstract

Introduction: The aim of this prospective study is to know the rate of wound infection, number of days required for making the wound fit for skin cover procedures, number of days required for formation of uniform granulation tissue bed in the wound, number of days of hospital stay and healing of soft tissue injury in Gustilo Anderson compound grade III fractures treated by Vacuum Assisted Closure & by stabilization of fracture. Gustilo Anderson compound grade III Fractures are fractures with extensive soft-tissue damage, definite periosteal stripping, massive contamination & the fractured ends are exposed.

Methodology: In our institution thirty patients with Gustilo Anderson compound grade III patients were selected for this prospective study. The study period is from July 2020 to October 2021. All patients were selected based on our inclusion and exclusion criteria. Only Gustilo Anderson compound grade III fractures were included in the study.

Results: After VAC therapy, SSG was done to cover the healthy granulation tissue in 22 patients and flap cover was done for 4 patients and remaining 4 was done by routine normal dressing.

Conclusion: The time duration taken for formation of healthy granulation tissue was less.

Keywords: Compound fracture, VAC therapy, Gustilo Anderson

Introduction

Gustilo Anderson compound grade III Fractures are fractures with extensive soft-tissue damage, definite periosteal stripping, massive contamination & the fractured ends are exposed^[1]. Open fracture needs good coordinated management of both bone and soft tissue injury to achieve good healing and to avoid infection. Blood supply of bone is derived from the nutrient vessels to the bones via periosteum and also from surrounding muscles and soft tissue structures. Earlier the soft tissue injuries were managed by conventional methods like regular wound debridement, daily saline dressing, dry dressing etc. The disadvantages according to a study by caudle and stern^[2] are incidence of infections, which were 59%. Similar studies by cierny *et al.*^[3] on incidence of wound infection in open tibial fractures were 20.8% and 83.3% in early and delayed skin cover cases. More number of debridement were required, longer duration was taken for healing, longer duration were required to make the wound fit for soft tissue coverage/skin grafting & hospital stay was prolonged with conventional methods of dressings. The mechanism of Vacuum assisted closure therapy is very simple and effective method to improve wound granulation in open fracture. After proper sterile cleaning and debridement of wound, an open-cell structured foam is cut according to size and shape of the wound and then it is kept on the wound bed, a suction drain with perforations only in the end of the tube is laid on the foam. Then the entire wound is then sealed with an opsite or a transparent membrane which is adhesive then cling drape is used to make it air sealed, the other end of the suction tube is connected to a vacuum machine, once the wound is sealed and the machine is switched on the fluid from the wound is drawn through the foam into a canister which can be disposed subsequently. By this the edema from the wound is removed, new blood vessels are formed (angiogenesis) & hence leads to formation of healthy granulation bed & all this leads to earlier skin cover procedures of the wounds. The indirect effects of VAC therapy are reduced morbidity, earlier return to work, & cost effectiveness.

Incidence of infection in a study by Method *et al.* [4] and Mooney *et al.* [5] showed drastic decrease when compared with saline dressing and also the duration of hospital stay was reduced, number of debridement required were also less. This study was taken up at tertiary care hospital with aim to know a) the rate of wound infection, b) number of days required for making the wound fit for skin cover procedures, c) number of days required for formation of uniform granulation tissue bed in the wound, d) number of days of hospital stay and healing of soft tissue injury in Gustilo Anderson compound grade III fractures treated by Vacuum Assisted Closure & by stabilization of fracture.

Methodology

In our institution seventeen patients with Gustilo Anderson compound grade III patients were selected for this prospective study. The study period is from July 2020 - October 2021.

Inclusion criteria

1. Gustilo Anderson Compound Grade III Fractures
2. Willing for surgery

Exclusion criteria

1. Old neglected open fractures
2. Fractures with neuromuscular disorders/neurovascular insufficiency
3. Refusal to provide informed consent

Mode of injury

1. Road traffic accidents: 26
2. Train traffic accidents: 3
3. Accidental fall: 1

Age and Sex Distribution

30 patients were treated with VAC therapy of age between 15 yrs to 65 yrs.

Among the 30 patients 26 were male and 4 were female Assessment of wound before applying VAC therapy

1. Pus C/S
2. Size of wound
3. Area of the bone exposed
4. Area of tendons exposed
5. Any implants exposed
6. ESR
7. CRP

Initially the wound is thoroughly debrided and all the infected and foreign materials like mud etc are removed and through wound wash is given. Antibiotics are given as soon as the patient is received in the emergency ward. Initially broad-spectrum antibiotics are given and later specific antibiotics are given according to sensitivity profile.

Results

Our study includes fifty patients treated with VAC therapy. Mean age of the group is 40.5 years. The age group 30-50 dominates the series accounting for 50% among the cases. Gustilo Anderson compound grade III fractures caused by road traffic accidents includes 26 cases (86.67%), train traffic accident 3 cases(10.00%) and accidental fall 1 case(3.33%). The average duration of treatment was 26.5 days (10-30 days), and on an average the dressing change was 3.3 times.

Infection rate. Among the non-infected cases (14 cases) only one case showed infection and among the infected cases(3 cases) one case showed infection at the end of treatment for which additional wound debridement and appropriate antibiotics were given and later wound cover was done.

Duration of wound healing Mean wound size reduction at treatment completion 15mm (10-20mm), 25 patients among the 30 achieved good wound healing and the tendons which were exposed were adequately covered by granulation tissue. The mean duration required for formation of healthy uniform granulation bed was 10.5 days (9-12 days).

After VAC therapy, SSG was done to cover the healthy granulation tissue in 22 patients and flap cover was done for 4 patients, 4 patients wound healed with normal saline dressing. Duration of hospital stay- as the patient load is very high in our institute the definitive management of the fractures was delayed and the average duration of hospital stay one and a half month (range 1month -2 months).

There were no complications in our study like bleeding overgrowth of granulation tissue over the foam or deep infections.

Table 1: Distribution of Cases Based On Age

Sl. No.	Age In Years	Number of patients	%
1	15-30	11	36.67
2	30-50	14	46.67
3	50-65	5	16.67
	Total	30	100

From the above table it is very clear that majority of cases occurred in 30-50 years age group correlating with common occurrence of RTA in that age.

Table 2: Distribution Based On Location of Injury

Sl. No	Site	No. of cases	% of cases
1	Fore arm	2	6.67
2	Thigh	3	10.00
3	leg	21	70.00
4	foot	4	13.34
	Total	50	100

This table shows that Gustilo Anderson compound grade III fractures occurred in leg in 70.00% of patients.

Table 3: Distribution Based on Scoring of the Wound Prior To Vac Therapy

Sl. No	Score of the wound	No. of cases	%
1	Score-0	0	0%
2	Score-1	0	0%
	Score-2		
3	Bone exposed	20	66.67%
	Tendon exposed	5	16.67%
	Implant exposed	0	0%
4	Score-3 Bone+tendon exposed	5	16.67%
5	Score-4	0	0%
	Total	30	100%

Gustilo Anderson compound grade IIIB fractures are associated with bone exposure and tendons are also exposed in few cases depending on the site of the defect. Tendons are more commonly exposed in forearm.

Table 4: Distribution based on number of dressings applied

Sl. No	Score of the wound	No. of cases	No. of dressings
1	Score-0	0	0
2	Score-1	0	0
	Score-2		
3	Bone exposed	15+5	7+6
	Tendon exposed	5	10
4	Score-3 Bone+tendon	5	8
5	Score-4	2	4

Fifteen cases of bone exposed wounds required 7 dressing changes, ten cases of bone exposed wounds required 6 dressing changes, fifteen cases of tendon exposed wounds required ten dressing changes, five cases of bone & tendon exposed wounds required 8 dressing changes, two cases with bone exposed and with superficial infection cases required 4 dressing changes.

Table 5: Distribution of cases based superficial infection

Sl. No		No. of cases	%
1	Non-Infected cases	26	86.67%
2	Infected cases	4	13.33%

Discussion

Management of soft tissue plays a very important role in Gustilo Anderson compound fractures. Many factors play a coordinated role in wound healing like the wound environment the composition of the wound which includes physical characters of the wound, chemical composition of the wound, biological structure of the wound etc. all these play an important role in the healing.

The goals of soft tissue management are

1. Controlling bleeding.
2. New granulation tissue should replace the soft tissue defects.
3. The soft tissue defect should be covered by SSG or flap cover as soon as possible.

Many factors affect the wound healing like^[8]

1. Defect in vascular supply.
2. Defect in angiogenesis.
3. Defect in laying matrix proteins.
4. Defect in locally acting growth factors.
5. Defects in clearing the dead and necrotic cells.
6. Defect in migration of macrophages and their composition.
7. Defect in enzymes which lyse the defective cells.
8. Defect in production of new proteins for the wound.

Any of these factors or a combination of these factors affect the wound healing and the wound goes into a stage of chronic non healing. After applying VAC therapy the negative force causes more blood circulation to the wound, reduces the burden of bacterial infection and supplies more oxygen to the affected soft tissue.

Rate of infection- In our study rate of infection was 11.76% and we compared our result with the following literature study where the soft tissue injuries were managed by saline dressings. Henley *et al.*, JOT 1998- 34.7%^[10], Charalambous *et al.*, Injury 2005-27%^[11], Gopal *et al.* JBJS-B 2004-27.4%^[12] Duration required for forming new healthy granulation bed.

In our study an average of 10.5 days was taken for formation of a uniform healthy granulation bed of the wound. Similar

studies were conducted by Argenta *et al.*, Morykwas *et al.*^[13], & Joseph *et al.*^[14], & these studies also showed that VAC proved effective in shrinking of the diameter of the wound size and formation of healthy granulation tissue when compared to normal saline dressing methods.

Microscopically application of VAC therapy also showed increase in formation of new blood vessels and formation matrix tissue but the wounds treated by saline dressing showed inflammatory tissue & fibrous tissues as compared by above studies.

The uniform negative pressure delivered by the VAC therapy to the wound bed plays a significant role in formation of new healthy granulation tissue.

In normal saline dressings the gauze pad sticks to the dead tissue and while changing the dressings the dead tissue along with the new and delicate tissue formed underneath is also removed along with the gauze pad and this causes mechanical damage to the formation of new granulation tissue in the wound bed.

Duration of hospital stay- As the patient load was very high and availability of OT is limited in our institution the definitive management like split skin grafting, flap cover and fixation of the fractures was delayed and hence the duration of hospital stay was prolonged in our study.

Studies on application of VAC therapy on compound fractures is very less. And these compound fractures have high chances of going in for non union and secondary infection if they are not adequately treated. These wounds should be thoroughly debrided and skin cover should be given as soon as possible as the exposed bones, tendons & neurovascular structures should be covered as soon as possible to save these structures from infection.

The high cost of vacuum system and the cost of vacuum dressing has discouraged many doctors from its application but when compared with saline dressings which take longer duration for wound healing, more number of debridement & more number of days of absence from work when all these factors are compared with expense of VAC the treatment expense of VAC is lesser with also lesser morbidity to the patient. And lesser hospital stay and the hospital beds can be used for other patients^[15, 16].

VAC therapy has wide range of benefits it can be applied to most of the wounds but all wounds cannot be treated by VAC therapy. VAC causes bone exposed wound to be covered by granulation tissue which requires a simple split skin graft to cover the granulation tissue whereas the bone exposed area needs a more time consuming and more expertized flap cover for covering the wound.

Conclusion

- The rate of wound infection was significantly reduced.
- The wound was fit for definitive skin cover procedures like SSG & flap cover at a faster rate.
- The number of debridement of the wound were reduced.
- The granulation tissue formed was healthy and uniform.
- Soft tissue defects which lead to ugly and irregular surface was avoided by forming uniform granulation tissue and the defects were covered

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