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Studies on manual vacuum assisted closure (vac) in orthopaedic injuries

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Abstract

Background: The study was conducted on patients with orthopaedic injuries treated by Manual VAC therapy.

Materials and methods: Manual Vacuum-assisted closure (VAC) device system was used to treat 30 patients. The study participants were selected based on the inclusion and exclusion criteria. Wound assessment before and after the application of VAC was done through BJWAT Score. Follow up Protocols after VAC therapy which has been done by clinical assessment and BJWAT Score.

There are three components of Manual vacuum dressing

1. wound dressing,
2. vacuum bag/collection bag
3. vacuum pump. Data were collected for sex distribution, showing mode of injury, showing frequency in compound fracture grading, showing % age of bone exposed or not, showing tendons exposed or not, showing frequency of change of dressing, showing skin cover procedures if required, showing complications, showing mean median mode and standard deviation of different parameters in this study, showing values of pre-VAC and post VAC.

Results: Duration required for formation of healthy granulation bed, duration required for making the wound fit for skin cover procedures, duration of hospital stay and duration of healing in open injuries treated by Manual Vacuum Assisted Closure therapy were significantly less.

Conclusions: The Manual VAC was found to be preventing the complications, reducing the infections and improving wound scores among the patients with orthopaedic injuries and giving good results even in low negative vacuum pressure as compared to ideal pressure i.e 125 mmhg.

Keywords: Orthopaedic injuries, Manual Vacuum Assisted Closure therapy, Wound dressing, Negative vacuum pressure

Introduction

The history of wound care is as old as the tendency to sustain wounds since the evolution of modern humans around 200,000 years ago. Vacuum-assisted closure (VAC) therapy is a system which promotes open wound healing through the application of negative pressure (negative pressure wound therapy, NPWT) [1,2,3]. Vacuum assisted closure has recently been more frequently applied in the department of orthopaedics. The horizon of the conditions for which the technique can be used have also been increasingly explored and improved by the practitioners.

It is a system of wound care that involves sealing techniques. A unique design of dressing is applied which seals off the sub-atmosphere air pressure that is applied on the wound and the set-up are linked with the suction pump and a system to collect the drain from the wound [4].

The suction pump is controlled manually with an attached foam dressing which assists in the wound drainage. A negative pressure which can be adjusted and exerted by means of adhesive film which is airtight and is placed over the wound as cover [5]. [4]

Specifically, it has been prescribed for wounds that are large, persisting and chronic as well as the wounds that are complicated, acutely. [7] It has been recommended for most types of acute and chronic wounds to accelerate healing in wounds due to pressure sores, ulcers of leg in diabetes, wounds of lower limb, surgical incision, traumatic wounds, burn wounds, necrotic zing fasciitis, and post skin grafts [8].

The technique itself was developed on the findings made on the impact of the polyurethane sponges on the granulation of the soft tissues and the necessity to drain and the cover the wound of soft-tissues due to trauma as well as the defects that occurred as a result of the open fractures in Orthopedics [7]. In surgeries involving trauma and orthopaedics, it is very common to have skin defects [4]. Complications arising out of the large wounds has always been a matter of prime concern in the arena of trauma surgeries in orthopaedics [9]. Vacuum assisted closure is being increasingly used to replace the dressing by means of cotton gauze, which is the traditional method.

Although cost-wise cotton is a cheaper product, managing the wound by keeping it clean and tissue/wound exudate absorption, vacuum assisted closure has been seen as a better alternative that is dynamic in character which lowers the rate of wound infection and facilitates a faster closure of wound. In the treatment of the incisions made during surgeries as well for the wounds resulting from trauma, vacuum assisted closure is becoming helpful in management [10].

The usage of Manual VAC systems is novel, we couldn't find any study establishing the efficacy of Manual VAC (MVAC).

The cost effectiveness or benefits of the Manual vacuum assisted closure in orthopaedic injuries management has not been assessed /evaluated so far. The low cost of Manual VAC enthralled us to do this study which would be very ingenious and if successful then could bring down the cost of open wound management to an affordable level of Indian population.

Methods

The study was conducted on 30 patients with orthopaedic injuries treated by Manual VAC therapyin the Department of Orthopaedics, LLRM Medical College, Meerut.

The study participants were selected based on the inclusion and exclusion criteria. The study was

conducted from August 2019 to February 2021. The Study design is Prospective Interventional Study. All patients are of above 22 years of age with compound grade 3a fracture, compound grade 3b fracture,Compoundgrade 2 Bimalleolar, Compound grade 2, Traumatic Amputation were studied.

Inclusion Criteria

1. Orthopaedic open wound injuries of any size
2. Fracture with superficial infection
3. Decubitus ulcers over the limbs and torso.
4. Primary orthopaedic surgical sites where application of suction drain was not feasible.

Exclusion Criteria

1. Fractures with sequestrum
2. Pathological fractures
3. Chronic Osteomyelitis
4. Wounds with exposed major blood vessels or those in which haemostasis has not been achieved.
5. Wounds that had non-viable tissue or are contaminated with foreign bodies. (i.e., those that have not been debrided.)
6. Wounds in patients who have vascular injury or those with signs of ischemia
7. Patients on anti-coagulants, chemotherapy or corticosteroids.
8. Patients who refuse to give consent.
9. Patients who were hemodynamically unstable.

Manual Vacuum Dressing Procedure

Materials that are used

There are three components of Manual vacuum dressing.

Wound dressing

The wound dressing of different sizes is applied according to wound size which is made of hydrogel that is to create the vacuum in the wound and surrounding area.

Figure 1: Vacuum Bag/Collection bag

Vacuum bag is made of multigrade polyethylene plastic with a super absorbent pad that carries exudates and slough.

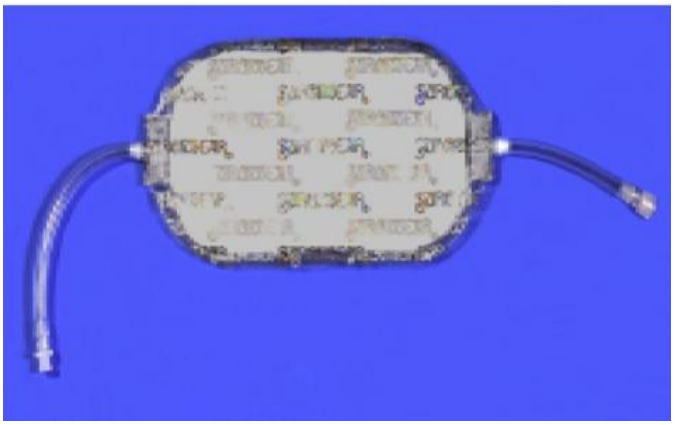


Figure 2: Vacuum pump

Vacuum pump is made of plastic with a pressure spring which acts like piston for creating negative pressure. The spring creates pressure of mmhg mercury that is required according to the wound sizes. The vacuum pressure pump used here of 80mmg ± 5mmhg.

Figure 3: Fully assembled Manual VAC

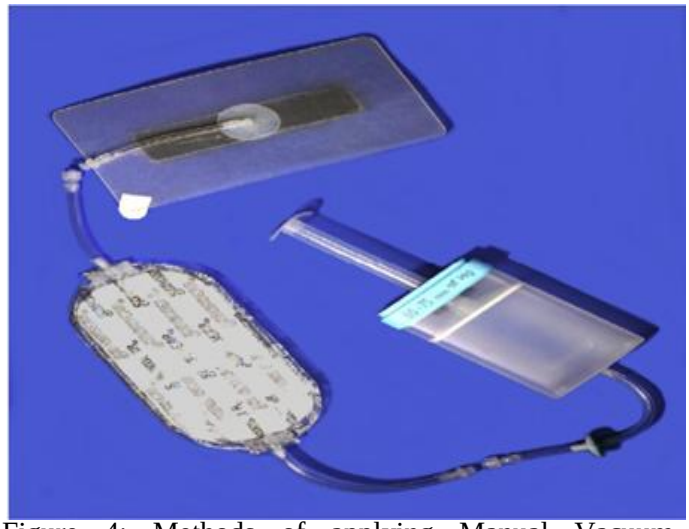


Figure 4: Methods of applying Manual Vacuum Dressing

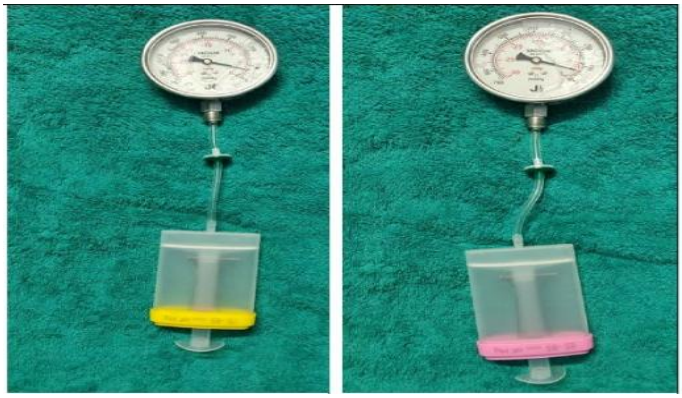
Following are the steps for applying Manual vacuum dressing

1. Appropriate debridement of the damaged and the necrotic tissue was done.
2. Various chemicals were used to remove slough like hydrogen peroxide and EUSOL or OXUM.
3. Cleaned the wound and applied sterile non-woven tissue (lint free) and foam which were contained in dressing**.**
4. Now we removed the plastic on the adhesive area of dressing and applied dressing on the wound tightly.
5. Cling drape was applied to make air tight.
6. Connected the dressing end with a collection bag and bag to the vacuum pump.
7. Then we pushed the pump 3 to 5 times and vacuum was created.

Tools used for assessing wound status and vacuum pressure

1. Bates-Jensen Wound Assessment Tool
2. Vacuum gauge as shown in figure 1.

Figure 5: Showing vacuum pump pressure measured with pressure gauge



Results

Table 1: Sex Distribution

Sex	Frequency	Percent
Male	25	83.3
Female	5	16.7
Total	30	100.0

Majority of the study participants were males (83.3%)

Table 2: Showing Mode of Injury

Mode of Injury	Frequency	Percent
RTA	27	90.0
fall from height	2	6.7
Railway track accident	1	3.3
Total	30	100.0

RTA was the major mode of injury in our patients (90%)

Table 3: Showing Frequency in Compound Fracture Grading (N=26)

Compound fracture grading	Frequency	Percent
2	2	7.7
3a	5	19.2
3b	14	53.8
3c	5	19.2
Total	26	100.0

According to the grading of compound fracture, Grade 3b was the most common followed by 3a and 3c. 2 cases were of bed sores.

Table 4: Showing % age of Bone exposed or not

Bone exposed or Not	Frequency	Percent
exposed	18	60.0
not exposed	12	40.0
Total	30	100.0

Bones were exposed in 60% of the study participants.

Table 5: Showing Tendons exposed or not

Tendons exposed or Not	Frequency	Percent
exposed	12	40.0
not exposed	18	60.0
Total	30	100.0

Tendons were exposed in 40% of the study participants.

Table 6: Showing Frequency of change of dressing

Frequency of change of dressing	Frequency	Percent
every 3rd day	30	100.0

All the patients had a change of dressing on every 3rd day till their stay in the hospital.

Table 7: Showing skin cover procedures if required

Skin Cover Procedures if required	Frequency	Percent
PTSG	16	53.3
Flap	4	13.3
Secondary Healing	10	33.3
Total	30	100.0

70% of the patients had skin cover procedures and 53.3% of them had PTSG, while 33.3% had secondary healing and 13.3% had flaps.

Table 8: Showing Complications

Complication	Frequency	Percent
None	30	100.0

None of them had any complications after the VAC.

Case-1: 65 yrs/Male, with follow up case of compound grade 3 a fracture both bone leg distal third managed by open reduction and external fixator application. Now presenting with exposed bone over distal third of leg and managed by Bone nibbling for exposed bone followed by manual VAC dressing followed by PTSG.

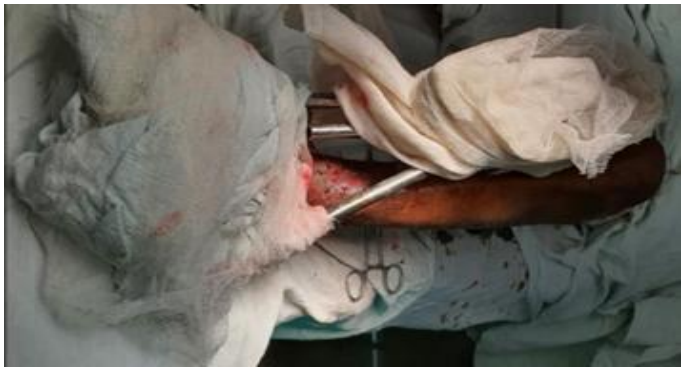
Figure 6: Post op X Ray

Figure 7: Pre-VAC

Figure 8: On day 3 After 1st VAC dressing

Figure 9: On day 6 after 2nd VAC dressing

Figure 10: On day 7 after PTSG



Case 2: 70 yrs/Male with Compound grade b communited # both bone leg left side and managed by open reduction and external fixation application with debridement followed by VAC Dressing followed by wound closure.

When patient came to emergency

Figure 11: Pre-VAC

Figure 12: On day 3 after 1st VAC Dressing

Figure 13: On day 6 after 2nd VAC

Figure 14: On day 9 after 3rd VAC

Figure15: On day 12 after 4th VAC

Figure 16: On day 15 after 5th VAC

Figure 17: On day 17 after wound closure

Figure 18: After 1 month follow up

Case 3: 34Y/Male, the patient with compound grade 3b fracture both bone leg middle third right side managed by open reduction and external rail fixator application followed by VAC dressing followed by PTSG.

Figure 19: Post of X Ray

Figure 20: Pre-VAC

Figure 21: One day 3 after 1st VAC Dressing

Figure 22: One day 6 after 2nd VAC dressing

Figure 23: One day 9 after 3rd VAC dressing

Figure 24: One day 12 after 4th VAC dressing

Figure 25: One day 15 after PTSG

Figure 26: On Day 28 after stitch removal of PTSG

Figure 27: On day 36 after follow UP

Discussion

In this research, 30 patients were taken in which 3 patients have been shown in the article which have shown improved wound healing, rapid regranulation of the tissues, reduced complications and a lesser hospital stay duration has been the subject of inquiry and research in the treatment of the open fractures in orthopaedics.Conjunction of negative pressure wound therapy with skin grafting had shown to improve the surgical outcomes in orthopaedic fractures with Gustilo Anderson grade 3b.[11]

This study (Manual VAC cost,India) Average Cost	Mohd. Ahmed et al27 Average cost	Kamamoto et al56 Average cost	Nherara et al34	In Indian scenario (Electronic VAC cost) (Unpublished data)
Rs 3228	Rs 182580(2434.4 USD.)(Suction machinecost Rs 7507.5 excluding)	Rs.65444 ($872.59)	Rs.596550($7,954)	Rs.10,165(Excluding VAC machine cost Rs 125000)

Conclusion

In conclusion, the Manual VAC was found to be preventing the complications, reducing the infections and improving wound scores among the patients with orthopaedic injuries and giving good results even in low negative vacuum pressure as compared to ideal pressure i.e -125mmg.

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