Original Research

Negative Pressure Wound Therapy (NPWT) for Joint Ill in Calves–Usage and Clinical Evaluation

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Abstract

Joint ill or septic arthritis is commonly observed in young calves and is generally transmitted by haematogenous route. The gross changes like joint diameter, range of motion and lameness pattern were studied before the treatment and on 7th, 14th, 21st and 28th day of post treatment. All the clinical parameters showed a gradual and significant improvement after the treatment. The application of Negative Pressure Wound Therapy (NPWT) provided better healing, early recovery from the disease by reducing the swelling and oedema, continuous removal of the joint discharge and increased blood supply to the joint. The animals were able to support with the affected limbs after the treatment.

Key words: Calves, Clinical Evaluation, Joint Ill, Negative Pressure Wound Therapy

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Introduction

Early mortality of calves due to any reason causes great economic losses to the farmer. Joint ill is one such disease that usually affects the calves of less than one month of age. It occurs as a result of infection entering via the umbilical cord, at or soon after birth. Joint ill in calves is classified as a tertiary septic arthritis, the primary infection is in the umbilicus, often as an umbilical abscess with extension along the umbilical vein towards the liver (Andrews, 2004). Various treatment methods, such as parenteral antibiotic therapy (Jackson, 1999), intra-articular antibiotics, arthroscopic guided joint lavage (Karl, 2011), arthrotomy (Kofler, 2006), synovectomy (Palmer and Bertone, 1994) and joint lavage (Jackson, 1999) were on record. Treatment of septic arthritis remains costly and time consuming due to repeated surgical interventions and prolonged course of antibiotic administration (Meijer *et al*., 2000). Due to the prolonged treatment period, expensive costs and lack of effective treatment, a considerable number of animals are being lost every year.

In an attempt to overcome these limitations, the present study was carried out using Negative Pressure Wound Therapy (NPWT).

Three calves were presented with the history of non-weight bearing lameness (two calves with right carpal joint affected and one calf with left carpal joint affected) or partial weight bearing on the affected limb (one calf with left carpal affected), swollen joint (left and right carpal joints in three cases, hock joints in two cases and metacarpophalangeal joint in one case) and anorexia. Two calves in which multiple joints (both carpals and hock joints) were involved were presented in recumbent state. The joints were severely distended and the animal evinced severe pain during extension and flexion. Purulent foul smelling discharge was found oozing out from the joints which were already open and observed necrosis of the surrounding tissue in two cases. The animals resisted walking and could not support and stand for a longer period of time.

Materials and Methods

The study was carried out on six clinical cases of calves presented to Department of Veterinary Surgery and Radiology, Veterinary College, Hebbal, Bangalore. All the animals were subjected to Negative Pressure Wound Therapy (NPWT). The physiological parameters including rectal temperature(°F), heart rate (beats/min), respiratory rate (breaths/min) and clinical parameters including range of motion, joint diameter and lameness score were recorded before and on 7^{th}, 14^{th}, 21^{st} and 28^{th} day after the treatment.

Statistical Method

All the results of physiological, clinical, haematological and biochemical parameters were statistically analysed using Graphpad prism (version 5.01) software with one way analysis of variance (ANOVA).

Components of the NPWT Machine (Fig.1)

The machine used for Negative Pressure Wound Therapy was manufactured by Prasaditi Medical Equipments.

a) **ON/OFF button:** It is used to switch the machine ON/ OFF
b) **O_2 Inlet:** It supplies atmospheric air or oxygen to the vacuum bandage or the wound area. One end of the tube is connected to the inlet and the other end is left free for sucking in air.
c) **NPWT Inlet:** It is to create vacuum inside the bandage. One end of the tube is connected to the NPWT inlet and the other end is connected to the canister box.
d) **Irrigation Inlet:** It is used to provide saline, diluted povidone iodine or any other medicated solution to the joints.
e) **Irrigation Outlet:** It is used to remove the solution from the vacuum bandage which gets collected in a separate canister box.
f) **Control Panel:** UP button is to increase the pressure, LOW button is to decrease the pressure and NEXT button is to proceed to next menu.

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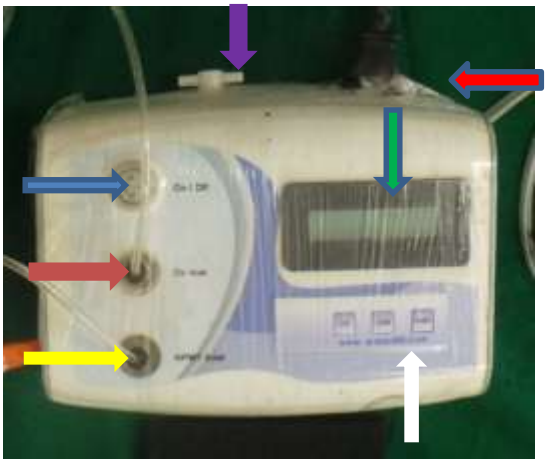

Fig. 1: Photograph showing connections of NPWT machine, ON/ OFF switch (blue arrow), Oxygen inlet port (orange arrow), NPWT inlet (yellow arrow), display (green arrow) and control panel (white arrow) irrigation port (purple arrow), power cord (red arrow)

Accessories

a) Canister Box

GSK-VAC canister box is used to create vacuum and for collection of the joint discharges/exudates.

b) Tubings

SteriSure Reel plastic tubings are used for connecting the NPWT machine with the canister and the wound bed and also to provide oxygen to the wound (Plate 2B).

c) Polyurethane Foam

SteriSure Reel polyurethane foams of pore size 400-600 μm are used directly onto the wound to provide adequate suction of the exudate and discharges and also to ensure provision of equal amount of pressure to all the wound surfaces (Plate 2A & 2C).

d) Occlusive plastic

SteriSure Reel drape was used to create an airtight bandage over the wound covering the polyurethane foam (Plate 2D).

e) Wound Pad (Nipple)

SteriSure Reel wound pads are used to connect the wound and the NPWT machine tubings to create a negative pressure and suction of the infected fluid contents from the joints (Plate 2F).

f) Miscellaneous Accessories

Measuring tape
Adhesive tapes
Sterile syringes (Dispovan-2ml, 5ml, 20ml)
EDTA vacutainers
Serum collection vacutainers
Needle – 18 gauge.
BP blade No. 22
Surgical gloves

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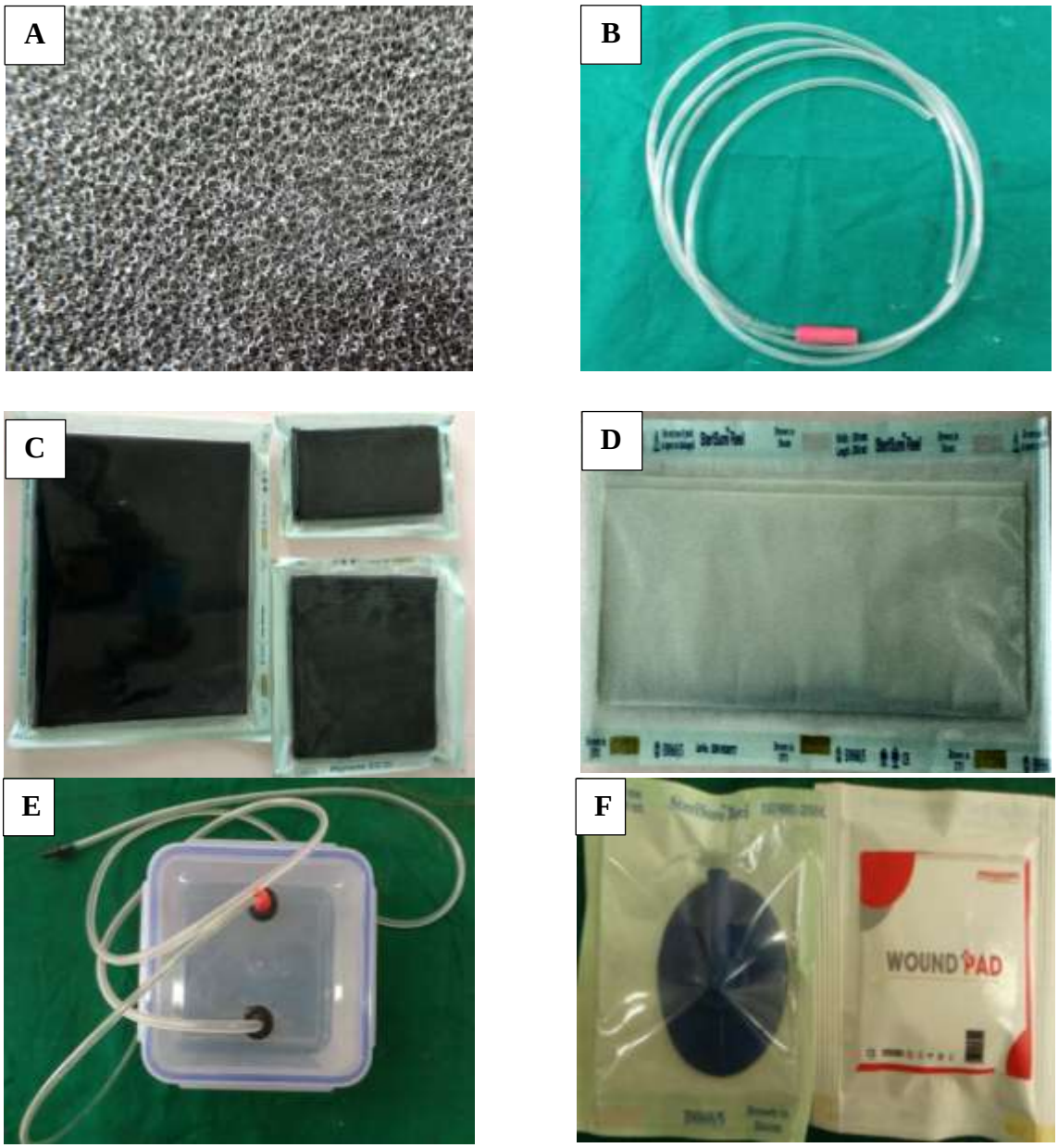

Fig. 2: Photographs showing the accessories of the NPWT machine; A) Polyurethane foam of pore size (400μm); B) Tubing; C) Polyurethane foams of different sizes D) Sterisure reel (occlusive drape); E) Canister box; F) Wound pad

The Procedure of NPWT

The wound area was thoroughly cleaned and dried before the application of the vacuum bandage. The affected joints were prepared aseptically. The hair coat on and around the joint were shaved and the area was cleaned thoroughly with Povidone iodine scrub 7.5% (W/V), followed by smearing with Povidone iodine solution 5% (W/V) (Fig. 3A). The sterile open cell polyurethane foam was gently placed on to the wound so that it completely occupy the wound space (Fig. 3B). The occlusive plastic drapes were applied

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over the polyurethane foam, encircling the joint. Additional adhesive tapes were applied at proximal and distal ends of the drapes to avoid any kind of leakage (Fig. 3C). Controlled pressure was uniformly applied to all the tissues on the inner surface of the wound with the help of NPWT machine (Fig. 1) in the range of 80-125 mmHg for 4-5 hours for 6 days (Fig. 3F).

Fig. 3: Photographs showing the step-wise procedure of NPWT application A) Preparation of the wound B) Placement of foam on the wound C) Application of occlusive plastic on the foam D) creating an opening in the bandage E) Application of the wound pad on the opening F) Calf undergoing NPWT.

Results and Discussion

All the calves presented to the clinics were with the history of non-weight bearing lameness or partial weight bearing on the affected limb, swollen joints and anorexia. The animals in which multiple joints were

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affected had a history of recumbency. Angus (1991) reported that joint ill was usually associated with history of simultaneous sudden onset of acute lameness, often with sudden deaths in a number of young calves. Bertone (1996) reported that history of recent wound, traumatic events, joint injections, systemic illness, immunocompromise provided important insight about possible joint infection. Similar history of lameness, anorexia, fatigue and local joint swelling was also reported by Ramanathan (2007) and Dogan *et al*. (2016). The clinical signs observed in the present study were, pyrexia, swollen/distended joints, severe pain during extension or flexion of the affected limb, non-weight bearing lameness, calves with multiple limbs affected resisted standing for longer time, similar findings were also reported by Madigan and House (2002), Butt (2002), Blowey and Weaver (2011) and Phil (2018). The distension of the joint is usually due to synovial effusion and peri-articular oedema in acute cases (Weaver, 1997 and Orsini, 2002). The degree of distension indicates severity of inflammatory process and varies depending upon the type, number and virulence of bacteria and the pyogenic bacteria produces the greatest degree of swelling (Radostits *et al*., 2003). In support to this, arthrocentesis of distended joints in the present study also revealed purulent discharge and pyogenic bacteria like *S. aureus, E. coli* and *Pseudomonas* were isolated from these joints. All the six clinical cases of joint ill were subjected to the NPWT. Among the physiological parameters, rectal temperature showed significant ($P<0.05$) improvement. The mean values of rectal temperature recorded in the calves on 0^{th} and 28^{th} day were 103.3±0.36°F and 101.5±0.14°F respectively. The rectal temperature declined after initiation of the treatment and gradually it reached normalcy by 14^{th} day. The significant increase in the rectal temperature could be due to the inflammatory reaction induced by the colonized bacteria (Lazarus *et al*., 1981). The gradual decrease in pyrexia might have been due to decrease in the bacterial load and systemic infection as reported by Ramanathan (2007). Heart and respiratory rates showed non-significant ($P>0.05$) changes within the normal physiological range (Table 1). Similar findings in these parameters was also recorded in calves with experimentally induced septic arthritis and in the clinical cases of cattle (Riley and Farrow, 1998, Jackson, 1999 and Ramanathan 2007).

Table 1: Mean ± S.E. values of physiological parameters recorded in the calves before and after treatment with NPWT

S. No.	Parameter	0^{th} day	7^{th} day	14^{th} day	21^{st} day	28^{th} day
1	Rectal Temperature (°F)	103.3± 0.36^{a}	102.9± 0.24^{ab}	102.0± 0.23^{bc}	101.5± 0.03^{c}	101.5± 0.14^{c}
2	Heart rate (beats/min)	96.33± 2.7^{a}	90.33± 1.8^{a}	90.5± 2.9^{a}	88.67± 3.4^{a}	89.33± 2.3^{a}
3	Respiratory rate (breaths/min)	40.67± 0.80^{b}	40± 1.62^{b}	37.5± 1.52^{b}	39.17± 0.79^{b}	39.17± 0.74^{b}

Means bearing different superscripts are statistically different within a row at ($P<0.05$)

The gross clinical parameters such as joint diameter, range of motion and lameness score were recorded and following results were obtained. The mean values of the diameter of affected joint recorded in the calves on 0^{th} and 28^{th} day were 28.2±0.58cm and 19.1±0.84cm respectively. The present study showed a

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significant reduction in the diameter of the joint from the day of presentation and 14th, 21st and 28th day post treatment. The reduction in the swelling was attributed to the continuous drainage of the inflammatory fluid/pus from the joints after the application of NPWT. This falls in line with the study of Demaria *et al.* (2011). Increased blood flow at the joint due to NPWT might have helped in the early healing of the wounds as stated by Chen *et al.* (2005). The range of motion during extension and flexion also showed significant improvement when compared to the day of presentation. There was a significant increase in the passive range of motion during extension and a significant decrease in the passive range of motion during flexion (Fig. 4 and Table 2). There was a significant improvement in the passive range of motion between the day of presentation and 14th, 21st and 28th day, which could be attributed to the considerable reduction in the joint swelling, inflammation and reduction in the pain. Similar findings were also observed by Weaver (1997), Madigan and House (2002), Radostits *et al*. (2003) and Ramanathan (2007).

Fig. 4: Photographs showing the case of a calf with joint ill in the left metatarsophalangeal joint. Note the gradual decrease in the swelling of the joint and healing of the wound after treatment with NPWT.

Table 2: Mean ± S.E. values of joint diameter, range of motion and lameness score recorded before and after treatment with NPWT

S. No.	Parameter	0th day	7th day	14th day	21st day	28th day
1	Joint Diameter (cm)	28.2± 0.58	24.22± 0.57a	22.8± 1.21ab	21.55± 1.20ab	19.1± 0.84b
2	ROM Extension	153± 2.0a	157± 1.59ac	161.3± 1.52b	164.8± 1.68bd	169.2± 1.88cd
3	ROM Flexion	56.83± 2.08a	48.83± 3.31ab	41.33± 3.22bc	31.67± 3.02c	19.17± 1.50
4	Lameness score	4.33± 0.21	4± 0.25	3.33± 0.21	2.83± 0.30	1.33± 0.21

Means bearing different superscripts are statistically different within a row, at (P<0.05); ROM: Range of Motion

The mean values of lameness score recorded in the affected calves on 0th and 28th day were 4.33±0.21 and 1.33±0.21 respectively. Sprecher *et al*. (1997) believed that lameness scoring system effectively recognizes and grades lame cattle in both commercial dairy production and dairy research settings. There was a significant decrease in the lameness between 0th and 28th day, with a significant variation between 14th day and 21st and 21st to 28th day after treatment. The values of lameness score decreased and reached the normalcy by 28th day. This was thought to be due to the considerable reduction in the swelling around the

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joint which in turn reduced the pain after the application of NPWT (Demaria *et al*., 2011). Similar findings were observed by Munroe and Cauvin (1994), Hirsbrunner and Steiner (1998) and Ramanathan (2007).

Conclusion

Joint ill is a crippling disease in young calves and it causes heavy economic losses to the dairy industry. The treatment of the disease majority of the time is ineffective, time consuming and a costly affair. The application of NPWT was found to be an effective treatment method for the treatment of joint ill as it resulted in early healing of wounds, reduction in the joint swelling and the bacterial load by continuous removal of the pus discharge or inflammatory exudates and reduction in the lameness. Further comparative studies has to be taken up to prove the efficacy of the NPWT over traditional methods.

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