

# Outcome of Modified Papineau Technique with Vacuum-assisted Closer System in the Treatment of Chronic Osteomyelitis and Infected Nonunion of Tibia

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## Abstract

**Introduction:** Infection of bone is either hematogenous or direct in the case of open fractures and is very difficult to eradicate. However, a combination of age-old Papineau technique and modern vacuum-assisted closer (VAC) system may be used for successful eradication of bone infection. Sometimes, soft tissue cover may be added if required.

**Materials and Methods:** We treated 24 consecutive patients between July 2013 and August 2015 using modified Papineau technique, who were suffering from chronic osteomyelitis tibia - 10 patients and infected nonunion of tibia - 14 patients. Among them, 18 were male and 06 were female. After initial debridement, VAC system was applied in all cases. 2-3 weeks later when healthy granulation became apparent, cancellous/corticocancellous bone grafting was done. VAC still continued until the wound healed completely or wound was covered by split skin grafting or musculocutaneous flap.

**Results:** Mean follow-up for the study group was 6 months ranging from 5 to 24 months. In approximately 80% of the cases, we were able to eradicate the bone infection completely and achieve good union in cases of infected nonunion of fracture tibia. There were no signs of relapse of infection clinically, radiologically, and hematologically. All patients returned to preinfection status and their routine activity.

**Aims of Study:** Evaluation of results of modified Papineau technique with VAC system, in the treatment of chronic osteomyelitis and infected nonunion of the tibia.

**Conclusion:** We can conclude on the basis of the results of our study that Papineau technique combined with modern VAC system of soft tissue coverage is a useful tool in the management of chronic recurrent osteomyelitis and infected nonunion cases of extremity bones. In our opinion, extensive bone and soft tissue debridement are the key to successful eradication of bone infection. Removal of necrotic avascular bone, scarred soft tissue, and musculature is absolutely necessary.

**Key words:** Chronic osteomyelitis, Infected nonunion, Papineau technique, Vacuum-assisted closer system

## INTRODUCTION

In spite of various advancements in the field of medical science including high-class antibiotics, various surgical implants and fixator, cases of chronic osteomyelitis and infected nonunion after the trauma is still a challenge to the orthopedic fraternity.

High energy trauma leads to significant soft tissue damage leading to the avascularity of bone which gets infected in case of open fractures which requires multiple repeated debridement of necrotic tissue and effective fracture stabilization, usually with the external fixator. Many patients require early soft tissue cover with local muscle flap or muscle transfer.<sup>1,2</sup>

Many techniques have been described like-cancellous bone grafting,<sup>3</sup> open cancellous bone grafting (Papineau technique),<sup>4</sup> or bone transport using the ilizarov fixator<sup>5</sup> and sometimes vascular fibular graft to cover bony defects.<sup>6</sup>

Papineau technique<sup>7-9</sup> involves thorough curettage or removal of the necrotic bone and unhealthy granulation in chronic osteomyelitis or infected nonunion of long bones

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followed by cortical and corticocancellous bone grafts in recipient bed.<sup>10,11</sup> Soft tissue cover may be added if required.

In the present study, we have used the modified Papineau technique-where vacuum-assisted closer (VAC) system has been applied along with the open bone grafting to eradicate the infection from the infected nonunion site or patients of hematogenous chronic osteomyelitis of tibia.

### **Aims of Study**

Evaluation of results of modified Papineau technique with VAC system in the treatment of chronic osteomyelitis and infected nonunion of the tibia.

## **MATERIALS AND METHODS**

We treated 24 consecutive patients between July 2013 and August 2015, using modified Papineau technique, 14 male and 10 female, aged between 10 and 55 years. 10 case of chronic osteomyelitis tibia with discharging sinus and 14 patients of the infected nonunion - tibia. Original injury was (Gustilo-Anderson classification Grade-I - Grade-III) open fractures in all infected nonunion cases.

Mode of injury was road traffic accidents in 10 patients, 4 had an injury due to fall from height. Remaining 10 patients had osteomyelitis due to hematogenous infection.

According to classification by Cierny and Mader<sup>12</sup> and Cierny,<sup>13</sup> infection was diffuse in 16 cases, localized in 5, medullary in 2, and superficial in 1.

Initial management had been done by external fixation in 8 cases, intramedullary nailing/pin fixation in 4 cases and plate fixation in 2 cases soon after the trauma.

When these patients were admitted to SRMS-IMS, Bareilly, all had discharging pus from wound site in the leg and septic skin necrosis. Osteomyelitis of tibia was located in proximal 1/3<sup>rd</sup> in 8 patients, middle 1/3<sup>rd</sup> in 11 patients, and lower 1/3<sup>rd</sup> in 5 patients. Donor site for corticocancellous/cancellous bone grafts was same side iliac crest in 18 patients and opposite side in 6 patients.

Blood investigations included-blood cell count, erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), and hemoglobin% (Hb%). Pus culture sensitivity and X-ray leg AP and lateral view were taken in all patients, before starting the treatment and repeated after every 4 weeks interval. An appropriate antibiotic therapy was initiated soon after culture sensitivity report.

Definitive surgery included removal of intramedullary implant or plate, stabilization of fracture by external fixator

AO type/Jess fixator/Rail fixator. Excision of necrotic bone and soft tissue or saucerization was done in cases of chronic hematogenous osteomyelitis.

All cases were applied VAC system after definitive surgery. VAC dressing was changed after every 4-5 days and continued till healthy granulation appeared in the bed. It took 2-3 weeks. Corticocancellous bone grafting was done using Papineau technique and VAC applied again.

Intravenous (I/V) antibiotics were given for initial 10-15 days and later oral therapy was continued for 6 weeks.

### **Surgical Techniques**

#### **Debridement**

Our first step was the removal of intramedullary implants or plate, non-viable soft tissues, and bone. Avascular sclerotic bone was excised till the healthy bleeding margins were noted on the osseous bed. Culture specimen was taken from the infected area, and the extremity was stabilized by either external fixator AO type/Jess or rail fixator. Antibiotics were given as per culture sensitivity report till the blood cell count, ESR, and CRP returned to normal. VAC system was applied soon after surgery in all cases.

After 2-3 weeks wound showing healthy granulation tissue was followed by corticocancellous bone grafting in the osseous bed taken from the outer table of iliac wing and crest. We required fasciocutaneous or musculocutaneous flap to cover the bone in 8 patients. The wound was allowed to heal by secondary intention in 12 patients. In 4 cases, we required split thickness skin graft to cover the wound, later.

After 2 weeks of I/V antibiotic therapy, we switched over to oral antibiotic which were continued for 6 weeks.

## **RESULTS**

Mean follow-up for the study group was 8 months, ranging from 5 months to 24 months, and in 80% of the cases, we were able to achieve bony union and complete eradication of infection. All patients were followed every 4 weeks. Radiographs were taken after every 4 weeks and blood investigations were also repeated every 4 weeks. There were no signs of relapse of infection clinically or radiologically (Figure 1a and b), and blood reports also were showing all parameters of chronic infection such as - total leukocyte count, differential leukocyte count, Hb%, ESR, and CRP, normal. The external fixator was removed at a mean period of 16 weeks after union (range 14-24 weeks). All patients returned to their normal routine work.

*Staphylococcus* was isolated in 18 patients, and Gram-negative bacilli were reported in 6 patients. Most of the patients had

already taken multiple courses of various broad spectrum antibiotics. In most of our patients, we used amoxiclav, ceftriaxone, ceftazidime, and sometimes clindamycin.

In 3 patients, we required local muscle flap/rotational muscle flap to cover the wound and exposed bone. These patients were kept non-weight bearing for 6-8 weeks. Later, they were allowed partial weight bearing when signs of the union were apparent radiologically. Full weight bearing was allowed only after an average of 16 weeks period, in nonunion cases.

5 patients required more than one debridement before bone grafting. Mean period from bone grafting to skin coverage was 8-10 weeks. Time to bony union and eradication of infection was on an average 22 weeks - range 16-40 weeks (Figure 2a-c).

1 patient lost to follow-up after 12 weeks. In 3 patients, we required to excise the infected bony fragment up to the length of 2-3 cm, where we used ilizarov ring fixator for compression-distraction histogenesis to achieve the union and bone length.

Pin tract infection was observed in 5 patients, and it was managed successfully by the local care and systemic antibiotics. One of our patients landed in below knee amputation because of malignant change in the ulcer.

## DISCUSSION

In the management of chronic osteomyelitis and infected nonunion of long bones of the lower extremity, our aim is to achieve the perfect control of infection and bony union. Favorable outcome may be expected by use of a combination of age-old Papineau technique of open corticocancellous bone grafting and modern technique of wound healing by VAC. In these patients, the presence of necrotic bone or scarred tissue with poor blood supply is responsible for non-eradication of the infection.<sup>12</sup> After removal of necrotic bone, a dead space is created, the ablation of dead space may be achieved by the bone grafting.<sup>12-14</sup>

Adequate antibiotic therapy, appropriate and timely soft tissue cover plays an important role in eradication of infection of the bone.<sup>15</sup>

Papineau technique was developed to assist the management of bony defect and post-traumatic osteomyelitis. Papineau and others have reported high rates of successful management in eradicating bone infection.<sup>7,8,10,16,17</sup>

Ilizarov ring fixator and AO type external fixator are also good options because they can allow the correction of axial translation and angular deformities and simultaneously

maintain mobility and weight bearing. Tissue dissection and periosteal stripping as with the internal fixation are also avoided.<sup>5,9,18</sup>

In the present study, we have reviewed our clinical results in lower extremity open fractures of the tibia which led to infected nonunion - 14 patients and 10 patients who had chronic osteomyelitis of hematogenous origin.

In all cases, Papineau technique was used. The first stage included aggressive debridement of necrotic tissues, meticulous local wound care, and application of VAC system followed by corticocancellous open bone grafting and skin cover in some cases. Repeated check of parameters of infection-like ESR, CRP, Blood counts was done.



**Figure 1: (a) Chronic osteomyelitis tibia - 12-year-old male patient treated by modified Papineau technique, (b) chronic osteomyelitis tibia in 12 years male patient. Wound healed within 18 weeks**



**Figure 2: (a) Infected nonunion tibia earlier treated by fibula grafting and hybrid fixator, (b) hybrid fixator removed and vacuum-assisted closer (VAC) applied after thorough debridement, (c) fracture united after corticocancellous bone grafting (Papineau technique) and VAC application-12 weeks post-operative**

In our series, we encountered few complications. 5 patients developed pin tract infection which was managed conservatively, and 1 of our patient landed into below knee amputation. All patients had fully developed infected nonunion with multiple surgeries or full-fledged chronic osteomyelitis. Papineau technique combined with the VAC system has resulted in salvaging the difficult cases.<sup>19</sup>

## CONCLUSION

As regards, the management of complicated infected nonunion of long bones of extremities and hematogenous chronic osteomyelitis, use of Papineau technique combined with the VAC application, is an important modality to control infection and achieve the bony union.

In our opinion, extensive surgical debridement is the most important part of the management of infection of bones regardless of the size of the defect created. Removal of the necrotic bone, soft tissue, avascular periosteum, scarred sub cutaneous tissue, and muscle is a must for the successful outcome. Patient's compliance and physiotherapy also play an important role in the overall functional outcome of the patient.

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