

THE PROSPECTIVE AND RETROSPECTIVE OUTCOME ANALYSIS OF INTERNAL FIXATION OF CLOSED FRACTURES WITH CULTURE-PROVEN INFECTION ELSEWHERE IN THE BODY

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Abstract

Background: Orthopaedics face a challenge in managing postoperative infections due to increased implant use, necrosis, and dead space. Patients with unmodifiable risk factors, such as diabetes, rheumatoid arthritis, and chronic debilitation, are prone to infection. This study aimed to evaluate the outcome of internal fixation of closed fractures with cultures harbouring infection elsewhere in the body. **Material and Methods:** This was a retrospective cum prospective analytical study of 30 patients admitted at the Government Thiruvapur Medical College from June 2020 to November 2022 who presented with closed fractures with culture-proven infection elsewhere in the body. CRP and ESR values were analysed pre-and postoperatively. Wound swab culture and sensitivity testing of distant infective foci were performed preoperatively and postoperatively. Antibiotics were administered preoperatively and postoperatively according to wound culture sensitivity. Surgical fracture fixation is performed to achieve an acceptable reduction of the fracture fragments and normal alignment of the articular surface. **Results:** Organisms found in the infective focus were not seen at the surgical site, which was confirmed by swab culture and sensitivity. All patients in our study showed a CRP value < 6 on the 4th post-op day and at the end of the 4th week. Although organisms were isolated from the distant infective foci before surgery, there was no postoperative implant-related infection after surgery from the distant musculoskeletal infective foci. **Conclusion:** A short-term follow-up of this study's results showed that surgical management of fractures with culture-proven infection elsewhere in the body can be performed with proper preoperative planning.

INTRODUCTION

The main challenge for orthopaedics is managing infections during the postoperative period. The increased use of implants in orthopaedics increases the risk of infection. Intramedullary reaming of the bone causes necrosis of bone tissues and decreases circulation to the bone which favours infection. Dead space after implant insertion favours haematoma formation which accentuates infection at the surgical site. Gustilo Anderson and Ganga scores are used for open fractures. The Tscherne

classification describes soft tissue injuries as closed fractures. The modified extremity severity score estimates the viability of an extremity after trauma. All of these are related to the local conditions of the environment in and around the fracture site. In a practical setting, patients are often admitted with multiple injuries associated with the source of infection occurring in places other than the site of implantation planned for fracture fixation.

Patients with Several unmodifiable risk factors, such as diabetes, rheumatoid arthritis, lupus, haemophilia, and chronically debilitated patients, are prone to

develop infection, and *Staphylococcus aureus* is the most common organism in such cases. Minimal bacterial concentration is sufficient to cause infection at the operating site in the presence of orthopaedic implants. The identification of high-risk patients is essential to prevent perioperative surgical complications. One of the primary reasons for surgical site infections is the patient's skin flora. *Staphylococcus epidermidis* can invade through the surgical site incision, causing infection at the operated site manifesting as redness, warmth, and discharge locally.

C-reactive protein is produced by the liver by the release of chemical factors from dead cells. Infection and inflammation of the distant musculoskeletal tissues elsewhere in the body are identified by measuring C-reactive protein preoperatively to detect postoperative infection earlier and are used for the prognosis of the treatment. Surgical site complications were reduced with the use of antibiotics. The duration, type, and dosage of antibiotics used are particularly important. Ideally, antibiotics should be administered 30 min before the surgical incision. Antibiotics should be continued until both the surgical site and the infective foci heal.

Lane's hypothesis suggests a no-touch technique to prevent infection during surgeries and to avoid life-threatening complications like sepsis and implant failure.^[1] Lister's antiseptic precautions reduced the incidence of postoperative infections. Antibiotic use significantly reduces the infection rate. The development of antibiotic resistance is an alarming problem now.^[2] Complications, such as osteomyelitis, nonunion, delayed union, and soft tissue infections can be effectively prevented before they develop. Here, we analysed the outcomes of internal fixation of closed fractures with culture-proven infections elsewhere in the body

Aim

This study aimed to evaluate the outcomes of internal fixation of closed fractures with culture-proven infection elsewhere in the body.

MATERIALS AND METHODS

This retrospective and prospective analytical study was conducted on 30 patients who presented with closed fractures with culture-proven distant musculoskeletal infective foci elsewhere in the body, admitted to the Government Thiruvapur Medical College and Hospital from July 2020 to November 2022. The study was approved by the institutional ethics committee before initiation, and informed consent was obtained from all patients.

Inclusion Criteria

Patients aged 18–70 years with closed fractures with culture-proven distant musculoskeletal infective foci were included.

Exclusion Criteria

Patients with uncontrolled blood sugar who were immunocompromised, such as those on ART, ATT, and chemotherapy with severe malnutrition, and patients with severe comorbidities such as CKD, sepsis, and severe anaemia were excluded.

Clinical evaluation

Patients with extremity injuries suspected to be fractures were evaluated for signs of fracture, including swelling, pain, abnormal mobility, and deformity. Palpation was performed to assess tenderness, and the skin status was assessed for open wounds, soft tissue contusions, and bruises. Capillary refill was noted during the initial injury period, and neurovascular examination was performed to assess tissue damage and prevent infection. Examination of other bones and joints was also conducted to rule out associated injuries.

Radiological evaluation plain radiographs

The initial radiographic assessment consisted of standard anteroposterior (AP) and true lateral radiographs of the injured area. Full-length images of the injured extremities are necessary for complete radiological examination of the injured site and are used to identify more proximal and potentially non-contiguous fractures. Additional radiographic assessment includes special views to identify articular involvement and anatomic details of the fracture.

The following implants were used in this study based on the type and site of fractures: intramedullary interlocking nails with interlocking screws and dynamic compression plate osteosynthesis. Locking compression plate osteosynthesis 1/3 tubular plate osteosynthesis reconstruction plate osteosynthesis Krishna wire and cancellous screw. Fracture fixation was conducted using open surgical methods to restore the normal articular surface and reduce fractures. After the procedure, culture swabs were used for analysis of microorganism similarity. Elevated C-reactive protein levels post-surgery normalised on day. Patients with C-reactive protein levels below the recommended limit were monitored to rule out infection at the surgical site. In cases of low C-reactive protein levels, the focus of infection was determined through clinical, biochemical, and microbiological assessments.

After surgery, combined antibiotic therapy administered just before the procedure was continued for the next two weeks intravenously. After two weeks of intravenous drug administration, then one week of broad-spectrum oral antibiotics were given. As pain is an important sign of inflammation and infection, a visual analogue score was used to analyse the pain outcome during the first, third, and sixth months of our study. During the patient's follow-up, the patient's surgical site, distant musculoskeletal infective focus, site and radiological signs of union by X-rays, and functional outcomes were analysed and evaluated in the 1st, 3rd, and 6th months for outcome analysis.

Fracture healing was assessed at the first, third, and sixth months, focusing on factors such as cortical contact continuity, disappearance of the fracture line, and presence of adequate callus. Late signs of bony union involve reformation of the trabecular pattern, fracture line disappearance, restoration of the normal medullary cavity, and cortex continuity. Appropriate radiological investigations, such as X-ray, CT, and MRI scans, are utilised for fracture management. Wound swabs were obtained for pus culture and sensitivity, guiding antibiotic use based on culture reports. Laboratory tests included C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), differential cell count, and total cell count. Preoperative planning, careful intraoperative soft tissue manipulation, and the use of various implants are crucial. The identification and management of complications, both early and late, are emphasised. Postoperative evaluation included inflammatory marker assessment (CRP on day 4 and at the end of the 4th week), antibiotic coverage based on culture reports, and regular follow-ups to anticipate late complications.

Statistical analysis

RESULTS

The number of patients in the younger age group (n = 13) was higher than that in the older age group (n = 10) and middle-aged group (n = 7). There were 24 men and 6 women. Road traffic accidents are the most common cause of injuries. The femur was the most commonly involved bone, followed by the tibia and the radius. The lower extremities were more commonly involved than the upper extremities were. Infective foci were most frequently observed in leg segment 8 patients, followed by foot and ankle segments in 5 patients. [Table 1]

Staphylococcus aureus was found in nine patients followed by Klebsiella found in four patients. Cefotaxim and amikacin combination therapy 12 were used the most. Stiffness was observed in three patients. Delayed union was observed in one patient. Plate osteosynthesis and nailing are the two commonly performed procedures. [Table 2]

If the initial CPK level is high (> 600) in Organophosphorus poisoning, patient mortality is high, and the initial serum CPK level is elevated in acute OPC poisoning if the exclusion of any other disease or conditions may cause an increase in CPK levels. This study was statistically significant, and the p-value was < 0.05. [Table 3]

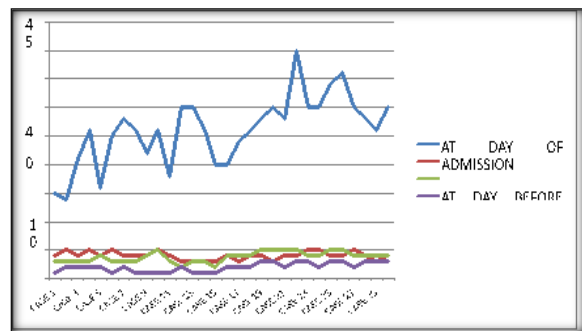


Figure 1: C reactive protein values at different intervals

C Reactive Protein was obtained on the day of admission, immediately before surgery, 4th POD and 28th POD respectively. Our study's preoperative mean values were 26.1, and 4 on the day of admission and the day before surgery, respectively. The postoperative mean values were 3.77, 2 on the 4th POD and 28th POD. [Figure 1]

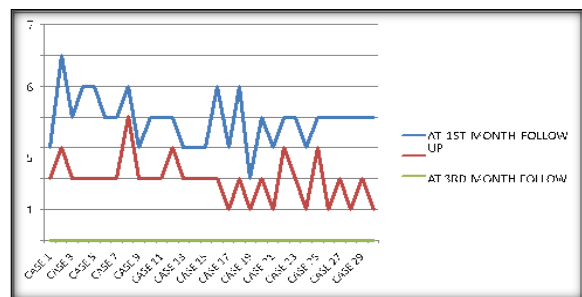


Figure 2: Visual analogue scale interpretation

The visual analogue scale score decreased at the 3rd-month follow-up. No patients experienced postoperative pain, and all patients reported zero pain at the end of the 6th month. [Figure 2]

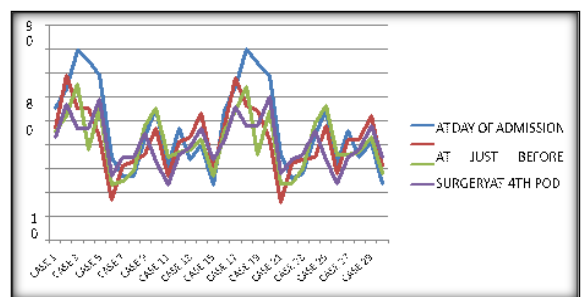


Figure 3: ESR – interpretation

ESR values and polymorphonuclear cell counts were analysed before and after the procedure. The mean preoperative ESR on the day of admission was 46.97. immediately before surgery to 41.83. The postoperative mean value of ESR at the 4th POD and 28th POD were 41.03 and 40.63%, respectively. This shows that ESR has no significance in detecting postoperative implant infection or surgical site infection when compared with CRP. [Figure 3]

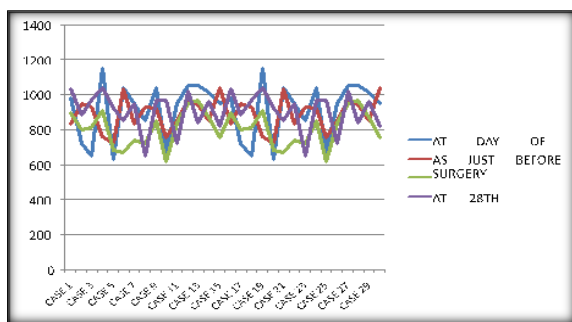


Figure 4: T L C – interpretation

Total Leucocyte count (TLC) was less significant than CRP in patients with postoperative implant infection or surgical site infection. [Figure 4]

Table 1: Demographic data of the study

		Number of Patients
Age	15-30	13
	31-45	7
	46-60	10
Sex	Male	24
	Female	6
Mode of Injury	RTA	25
	FALL	5
Bone Involved	Femur	11
	Humerus	5
	Tibia	4
	Radius	4
	Clavicle	3
	Ulna	2
	Pelvis	1
Infective Foci Area involved	Right leg	7
	Left ankle	4
	Left leg	3
	Left arm	3
	Right ankle	2
	Right arm	2
	Left knee	2
	Left forearm	2
	Abdomen	2
	Left thigh	2
	Right forearm	1

Table 2: Various distributions of the study population

		Number of Patients
Microorganisms	Staph Aureus including MRSA	17
	Klebsiella	4
	E coli	3
	Proteus	3
	Pseudomonas	2
	Coag -ve Stah aureus	1
Antibiotic Therapy (as per Wound Swab)	Cefotaxime + Amikacin	12
	Vancomycin + Amikacin	7
	Ciprofloxacin + Amikacin	6
	Piperacillin & tazobactam + Amikacin	3
Complication	Amoxyclav + Amikacin	2
	Stiffness	3
	Delayed union	1
Surgical Procedures	Plate osteosynthesis	20
	Intramedullary interlocking nailing	8
	Proximal Femoral nailing	2
	Hemiarthroplasty	1

DISCUSSION

C-reactive protein (CRP) is an acute-phase reactant and is considered a nonspecific marker of tissue damage. Therefore, it is very important to observe the natural response of CRP after accidental or surgical injury before its level can be used to diagnose septic complications. In the former study conducted by Meyer et al., the sensitivity and

negative predictive value of CRP was 100% and the specificity was around 95%.^[3]

In this study, case selection for the procedure was performed when the preoperative C reactive level was <6. No postoperative infection was observed in any of the patients who underwent internal fixation with culture-proven distant infective foci elsewhere in the body. This is evident from the 4th and 28th POD C reactive protein levels of <6, with no obvious clinical signs of infection in all cases.

Meyer et al. also showed 100% specificity and negative predictive value for CRP both pre-and post-surgery.^[3] Along the C-reactive protein level, erythrocyte sedimentation rate, and white blood cell count provided additional information regarding the possibility of infection in the preoperative and postoperative periods.

In this study, the preoperative and postoperative CRP values at shorter intervals were used to decide management in the preoperative period and detect postoperative infections and management, respectively. HO Ayo and CN Mcharo's study showed that the CRP level on the 3rd. on the postoperative day and a continual persistent increase thereafter in patients with superficial surgical site infection. However, it is a very potential early screening tool for infection before signs of infection appear on the fifth postoperative day.^[4]

In our study, none of the patients had elevated levels of C-reactive protein on the fourth POD, which indicates that none of our patients had an infection at the surgical site. Ellisgaard et al. proved that CRP value was used to detect the earlier infection in the postoperative period after hip fracture surgery.^[5]

In our study, none of the patients had implant-related infections during the postoperative period. All patients had postoperative CRP levels < 6 on both the 4th and 28th postoperative days. The CRP profile can be used to detect postoperative and posttraumatic septic complications. Subsequently, elevated CRP levels or persistent levels beyond the third day alert the surgeon to the possibility of septic complications. There are two types of postoperative infections. These are superficial soft tissue-related infections and deep-seated implant-related infections. In this study, the most common organisms detected in distant musculoskeletal infective foci were *Staphylococcus aureus* (60%), *Klebsiella* (13%), *E coli* (10%), and *Pseudomonas* (6%). None of the patients in this study had postoperative implant infection.

Staphylococcus aureus is the most common organism causing superficial surgical site infection (SSI). Four patients in this study had serous discharge, and culture and sensitivity tests reported no growth. Postoperative implant-related infections (PII), mostly monomicrobial, and microbes are rare. In this study, none of the patients developed postoperative implant-related infections. Although we could isolate the organisms from the distant musculoskeletal infective focus before an operative procedure, in our study, there was no superficial surgical site infection or postoperative deep implant-related infection from the distant culture-proven infective foci.

Standard prophylaxis consisted of either first- or second-generation cephalosporins. Adequate concentrations of antibiotics in the serum against the expected organism are essential during the preoperative and postoperative periods. The mean time interval between the administration of antibiotics and the decrease in CRP level to the cut-

off value of <6 was 2 weeks in our study. Cefotaxime and amikacin are commonly used antibiotics to control infections from a distant infective focus preoperatively. The visual analogue scale is a psychometric response scale that can be used in a questionnaire form. It is a measurement tool for subjective characteristics or attitudes that cannot be directly measured. The VAS was used to evaluate the patient's pain, which is one of the indicators of infection in the patient during the postoperative period.

In this study, except for four patients with a score of four, all patients were pain-free by the third month and VAS zero by the end of six months. Antibiotic resistance due to prolonged antibiotic intake is a serious complication that has not occurred in any patient during the preoperative and postoperative periods. During surgery, there is difficulty in achieving reduction of the fracture fragments, difficulty in achieving proper alignment of fragments, excessive bleeding, and prolonged surgical duration. Postoperatively, haematoma is one of the root causes of infection that can be prevented by proper closure of the wound, thereby reducing dead space and placing the drain.

Good functional outcomes depend on acceptable anatomic reduction of the articular surface or reasonable reduction of the bone shaft. A complete understanding of the fracture before planning surgery with proper radiographs and CT scans is essential. Implant infection is due to the adherence of microorganisms, mainly because of bacterial contamination at the time of the procedure or secondary bacteraemia from distant foci such as osteomyelitis, septic arthritis, or wounds with infection at the extremities. Surgical aseptic precautions during internal fixation of fractures with adequate antibiotic coverage have been associated with better outcomes.

CONCLUSION

Short-term follow-up was performed, and the results were analysed. These results have encouraged us to prefer surgical management of fractures in patients with culture-proven distant musculoskeletal infective foci elsewhere in the body with a proper preoperative plan. Good functional results can be achieved in cases of closed fractures with culture-proven distant musculoskeletal infective focus when the surgical intervention is timed after 1 - 4 weeks intervals for increased C-reactive protein levels to fall within normal limits. With normal levels of C-reactive protein which is the recommended and appropriate antibiotic therapy for wound management, the outcome of internal fixation of closed fractures was found to be safe and good even with culture-proven musculoskeletal infective foci present elsewhere in the body.

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