



# The Journal of Bone & Joint Surgery

**Journal club:** 15 November 2012

**Chairman:** Mr A Ajuied

**Convener:** Mr A Vasireddy

Guy's and St. Thomas' Hospitals NHS Trust

**Theme:** Classic Papers – Tibial Trauma

**Gustilo RB, Anderson JT.** Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: retrospective and prospective analyses. *J Bone Joint Surg [Am]* 1976;58-A; 453-8.

**Reviewer:** A Vasireddy

## Background

Open fractures are associated with a number of complications, particularly infection. Important aspects of managing open fractures include debridement and irrigation. This study is focussed at assessing these factors and other important aspects that affect infection rates in open fractures.

## Aims

Determine whether the following variables affected rate of infection in open fractures:

1. Primary versus secondary closure
2. Use of primary internal fixation
3. Use of antibiotics

## Methods

Combined retrospective and prospective study (level of evidence 3 and 2 retrospectively).

Retrospective study:

673 fractures identified over 14 years

87% followed up for one year.

A standardised management protocol was used. This included debridement, irrigation, primary closure where possible, post-op antibiotics and optional internal fixation.

## Prospective study:

352 fractures over 4 years. Classified according to type 1, 2 and 3.

Standardised management protocol including wound swab, peri-op antibiotics, debridement, irrigation and primary closure for type 1 and 2 injuries.

## Results

### Retrospective study:

Overall infection rate of 6.5%. The infection rate was 11% in the years 1955 to 1960. Between 1961-1968, the infection rate was 5% and this appeared to be due to a change in the antibiotics

regimen.

*Staph aureus* was the most common agent. Infection rate higher in those with internal fixation, secondary closure, significant soft tissue injury (extensive lacerations), traumatic amputations and segmental fractures.

**Prospective study:**

Vast majority of injuries were type 1 and 2 (>80%).

Infection rate was 2.4%. This result was described as a statistically significant difference when compared to the infection rate illustrated in the retrospective study. The majority of patients also had a positive culture of the wound swab taken from the open fracture site indicating the high potential for infection with open fractures.

**Discussion / Conclusions**

The paper provided guidelines on the management of open fracture, which included:

1. Type 1 and 2 injuries should undergo primary closure.
2. Type 3 fractures should be treated with initial debridement and delayed closure.
3. Avoid internal fixation.
4. Skeletal traction for open fractures with concurrent arterial injuries.
5. Peri-operative antibiotics.

**Appraisal**

The purpose of the study was clearly documented.

Study design:

Large cohorts were used. However, patient groups were not matched for demographics. Injuries were not stratified according to severity in the retrospective group.

Treatment:

Standard protocols were outlined. However, they were not always followed (e.g. it was stated that internal fixation was used more frequently than needed in the retrospective study).

Assessment:

Infection appeared to be the primary outcome of the study and was diagnosed on a clinical basis only. There was no mention of the diagnosis of occult cases. The follow-up period was relatively short, especially for the prospective study. Rates of union and functional outcomes were not explored in detail.

Statistics:

No a priori stats modelling. A p value is given in the study showing a 'statistically significant' reduction in the infection rate when comparing the prospective to the retrospective study. However, the test used is not highlighted.

**Recommendations for Practice**

This is a classic landmark paper that highlights the important tenants of peri-operative antibiotics; debridement and irrigation; delayed internal fixation, etc.

However, more contemporary research has superseded this paper.

**Keating JF, O'Brien PJ, Blachut PA, Meek RN, Broekhuysen HM.** Locking intramedullary nailing with and without reaming for open fractures of the tibial shaft. A prospective, randomized study. *J Bone Joint Surg [Am]* 1997;79-A:334-41.

**Reviewer:** Christian Smith

### Background

Reaming of open tibial fractures before intramedullary nail fixation was generally perceived as detrimental. It was thought that the endosteal blood supply would be significantly disrupted, resulting in increased rates of non-union of the fracture and higher infection rates. Previous studies had demonstrated that reamed intramedullary nails were associated with higher union rates and less complications than unreamed nails

### Aims

The paper aimed to see if there were any outcome differences between two interventions for open tibial diaphyseal fractures. The two interventions used were reamed and unreamed intramedullary nail insertion. Outcomes measures were both radiological and clinical. The time until radiological union (when 3 cortical bridges are seen on an AP and lateral radiograph) and incidence of malunion were recorded. Clinical outcomes looked at the incidence of post operative complications, range of movement and functional recovery.

### Methods

The paper is a non-blinded randomised controlled trial, high quality with a level of evidence of 1b. It was ethically approved. Patients were recruited into the study over a 4 year period from October 1989 until September 1993. All patients were included in the study unless their fracture pattern was not suitable for intramedullary nailing, it was not their primary fracture management or there was a delay in presentation. 100 patients were randomised into the two groups via sealed envelopes. 6 patients were withdrawn due to inappropriate anatomical considerations or death. Each group had similar characteristics in terms of patient demographics, fracture pattern, comminution and Gustilo and Anderson grade of open fractures. Operations were performed or directly supervised by the authors. Patients had standardised pre-operative treatment and post-operative rehabilitation.

### Results

The average age of patients was 37 years (16 to 88). 77 males and 14 females were involved in the study. Each group had similar characteristics in terms of patient age, gender and mechanism of injury.

The overall results are outlined below:

- Compartment syndrome: 2 (Reamed group) vs 1 (Unreamed group)
- Pulmonary or fat emboli: 2 (Reamed group) vs 4 (Unreamed group)
- Infection: 2 (Reamed group) vs 1 (Unreamed group)
- Union: The reamed group demonstrated a trend of slightly increased time to union in comparison to the unreamed group
- Non-union: 4 (Reamed group) vs 5 (Unreamed group)
- Malunion: 2 (Reamed group) vs 1 (Unreamed group)
- Failure: 2 (Reamed group) vs 1 (Unreamed group)
- Mobility: reduced in 3 (Reamed group) and 1 (Unreamed group)
- Return to work: 78% (Reamed group) vs 69% (Unreamed group)

- Ant knee pain: 49% (Reamed group) vs 41% (Unreamed group)

No significant differences were found in any of the outcome measures with one exception. Screw breakages were more common in the unreamed group, a trend found in many other studies.

### **Discussion/Conclusions**

Numerous studies have shown that reamed intramedullary nails have been associated with higher rates of infection and non-union compared to unreamed nails. This study was a large study and demonstrated no significant difference in post-operative complications, union rates and long term functional outcome. This fact may be due to the increased appreciation of soft tissue considerations and coverage as orthopaedic surgery evolves. There was no difference in the non-union rates, indicating that the endosteal circulation may be over-rated in the fracture healing process. There was an increased rate of metalwork failure, particularly screw breakages, in the unreamed group, a fact that has been noted by many other studies.

### **Appraisal**

This was a randomised controlled trial with appropriate randomisation. There was no power calculation. The inclusion criteria were minimal in order to remove selection bias. The intention to treat is obvious, with great efforts made to follow up patients involved in the study. All withdrawals were explained. Patients were contacted by telephone if geographical considerations made follow-up difficult. The average follow-up time period was 22 months with the maximum period being 54 months. The follow-up process was thorough and appropriate with further analyses of subsequent operations and consideration of other factors.

This was a well structured trial, the largest at the time of publication. It is a significant paper, clinically relevant and achieved its aim. Although there were no significant results, this is a significant finding, as it was thought reaming would be an inappropriate interventional step.

### **Recommendations for our Practice**

Reamed intramedullary nails are an appropriate treatment for open tibial diaphyseal fractures. Soft tissue considerations and coverage may play an equally important role in long term outcomes compared to fracture fixation.

**Mcqueen MM, Court-Brown CM.** Compartment monitoring in tibial fractures: the pressure threshold for decompression. *J Bone Joint Surg [Br]* 1996;78-B:99-104.

**Reviewer:** Daniel Reed

### **Background**

Whitesides et al (1975) first considered the importance of relative or differential pressure levels (ischaemia begins when pressure rises to within 10 to 30 mmHg of diastolic BP).

Critical absolute tissue pressure level is controversial with 30 mmHg to 45 mmHg variably quoted in the literature.

### **Aims**

To test the hypothesis that decompression should be performed when the tissue pressure rises to within 30 mmHg of the diastolic blood pressure.

### **Methods**

Prospective cohort study (level III evidence)

Over 2 years and 7 months, 116 patients with diaphyseal tibial fractures had continuous monitoring of compartment pressures at a single centre. Only the anterior compartment pressure was monitored.

Patients were monitored both preoperatively and for at least 24hrs post-operatively with separate analysis for the first 12-hours and the second 12-hours.

Patients were followed up for a mean of 15 months (6-59). They were also monitored for long term evidence of missed compartment syndrome

### **Results**

Mean delta-P 52 mmHg for first 12 hrs and 56 mmHg for the second 12 hrs

Three cases of compartment syndrome

87 patients had absolute pressures higher than 30 mmHg in the first 12 hours, but only one had low delta-P and had fasciotomy

Higher energy injuries were associated with a lower delta-P value ( $p < 0.002$ )

Fracture grade (Tscherne) has a strong correlation with delta-P

Delta-P was lower when there was a delay to surgery. There was no correlation between open/closed or nail/plate with respect to pressure values

No patients demonstrated any long-term sequelae at mean 15 months follow-up

Appropriate statistical tests

### **Discussion/Conclusions**

Absolute compartment pressure is an unreliable indicator for Compartment Syndrome and would lead to too many false positives

Use of Whiteside's recommendation of delta-P of 30mmHg successfully diagnosed all cases of compartment syndrome and none were missed

Recommendation: provided delta-P is over 30mmHg there is no indication for fasciotomy, but continued monitoring is required (two of three fasciotomies had delayed intracompartment pressure rises (falls in delta-P))

Significant and strong correlation between delta-P and the Oestern & Tscherne classification grade

No difference in pressures between open and closed injuries – no merit in argument that open injury has already decompressed compartments

Delay does not decrease pressure post-surgery, it increases it – argument for early surgery.

No significant variation in delta-P with fracture fixation method

### **Conclusions/Appraisal**

Delta-P threshold of 30 mmHg for fasciotomy seems reasonable – no evidence of missed compartment syndrome.

No indication of whether included patients were chronological or if there were inclusion/exclusion criteria

No clinical correlation mentioned

No clear description of pressure measuring technique

Appropriate length follow-up

### **Recommendations for our Practice**

Implies continuous compartment syndrome monitoring can indicate who needs fasciotomy, but no clinical correlation is described in the article. Hence, if compartment pressure monitors are unavailable this paper is of little help.

Delay before nailing/fixation of tibial fractures may increase pressure – delay before fixation needs to be avoided.

If monitoring compartment pressures, serial measurements over 24 hrs is more helpful than intermittent one-off readings.

**Court-Brown CM, Will E, Christie J, McQueen MM.** Reamed or unreamed nailing for closed tibial fractures: a prospective study in Tscherne C1 fractures. *J Bone Joint Surg [Br]* 1996;78-4:580-3.

**Reviewer:** Ahmed MH Latif

### **Background**

The controversy between the use of reamed versus unreamed intramedullary nails in closed tibial fractures remains unexplained. Previous studies have shown no benefit with either in open fractures. A randomised study in closed fractures has shown increase time to union with increasing severity of the fracture. This study compares the clinical outcomes of two types of nails, reamed and unreamed, in closed Tscherne type C1 fractures of the tibia.

### **Aims**

To conduct a randomised prospective study comparing reamed versus unreamed intramedullary tibial nails in closed Tscherne C1 fractures. The endpoint measured was time to union. Complications including revision operations, infection, lower limb joint range of motion and compartment syndrome were recorded.

### **Methods**

A prospective randomised comparative study involving 50 patients, captured over a one year period, with closed type C1 Tscherne tibial fractures was undertaken. Patients were randomised to reamed or unreamed tibial nailing (Level I). Post operatively patients were seen at 3, 6 and 12 months. Ankle and knee range of motion was recorded as well as return to activity. Radiographs were used to assess fracture healing, malunion and metal work failure. Patients with non-union at 3 months underwent exchange nailing. Compartment pressures were recorded post-operatively. Patients were followed up for 12 months.

### **Results**

The mean time to union with reamed nails was 15.4 weeks versus 22.8 for the unreamed group. This was significantly different,  $p < 0.01$ . Five of the unreamed cases underwent revision operation with a reamed nail. With unreamed nails, the complication rates were 16% for malunion, 52% for metal work failure including broken screws, and, 4% for broken nails. No statistical difference was observed. Ankle range of motion and time to return to work was similar in both groups.

### **Discussion/Conclusions**

Reamed IM nails have fewer complications and demonstrate a significantly shorter time to fracture union than unreamed nails. At 3 months, 20% of unreamed nails required a revision procedure. Metal work failure was observed in half of the unreamed nail cases.

### **Conclusions/Appraisal**

Reamed nails have shown less complication rates with bony union achieved in all cases. The unreamed nails failed in a large proportion of cases, which led to the increase in revision

operations and time to union. A 3 month revision endpoint for non union may have resulted in an increase in the mean time to union in this group. Smaller diameter nails used in the unreamed group may have compromised mechanical fixation resulting in adverse results.

### **Recommendations for our Practice**

Conventional reamed nails show a considerable advantage in enabling the surgeon to use a larger diameter nail improving mechanical properties of the nail, and increasing contact with the host bone. This confers improved mechanical stability withstanding bending and torsional forces.