

Treatment of pathological fractures of the humerus with a locked intramedullary nail

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ABSTRACT

Purpose. The humerus is a common site for metastasis. Intramedullary nail fixation has been reported to be the best form of fixation for this disease but complications occur. This study aimed to assess the use of a new humeral nail to treat pathological fractures and impending pathological fractures of the humerus.

Methods. 29 patients received 31 Austofix locked intramedullary humeral nails: 25 for pathological fractures and 6 for impending fractures; 24 nails were inserted anterograde and 7 retrograde. Cement augmentation was applied in 4 patients, and adjuvant therapy was used in 28 patients. Complications occurred in 12 patients.

Results. Fixation failed in 6 patients: 2 due to intra-operative fractures during retrograde nailing, one due to a fracture through screw holes postoperatively, and 3 due to local progression of disease. Difficulty in distal locking of the nail was encountered in 4 patients. Locked intramedullary nailing resulted in a stable humerus in 80% of patients.

Conclusion. Retrograde insertion of the nail is associated with an increased risk of intra-operative fracture, and disease progression can occur, despite the administration of adjuvant therapy.

Key words: fracture fixation, intramedullary; fractures, spontaneous; humerus

INTRODUCTION

The humerus is a common site for metastasis,¹ which may present as a fracture or as pain signalling impending fracture. When fracture is present or the deposit involves more than 50% of the humerus, internal fixation is recommended,² provided that the patient is medically fit for surgery.³

It has been reported that internal fixation provides pain relief, early return of function, and easier nursing care.³ For fractures of the humeral diaphysis, fixation with rods, nails, and plates, with or without cement, have all been reported,^{2,4–7} but long-term follow-up suggests that the best form of fixation is the use of locked intramedullary nails.^{8–10} Intramedullary nails provide effective resistance against angulation, torque, and distraction forces.³ The small incisions required also result in a lower rate of wound complications compared with plating.²

This study aimed to assess the use of a new humeral nail to treat pathological fractures and impending pathological fractures of the humerus. Although the results of the prototype of this nail have been reported by the designer,¹¹ the results of the commercially available nail have not previously been reported.

MATERIALS AND METHODS

A prospective review was conducted through the out-patient clinic, and a retrospective review was

conducted through the patient's general practitioner and relatives, and through a review of the case notes. The reviews were independent of the designer and manufacturer of the nail.

A retrospective review was conducted of all patients treated for a malignant lesion in the humerus with the Austofix humeral nail (Australian Orthopaedic Fixations Pty Ltd, Adelaide, Australia) from January 1994 to September 1998. This implant was developed as a result of trials using modified 9-mm tibial nails. The implant used in this study was an 8-mm nail made from cold worked stainless steel, with 3 proximal locking screw holes and 2 distal screw holes for static locking. The proximal holes are at diverging angles and have an undersized thread which, when used with specialised humeral head screws, are designed to prevent retrograde migration of the screws into the deltoid. This problem has been observed in initial trials,¹¹ and reported with the use of the Russell-Taylor nail.⁸

Indication for surgery was a pathological fracture or impending pathological fracture of the diaphysis of the humerus. An impending fracture was defined as a painful lesion with greater than 50% cortical bone destruction, or a permeative pattern over a length of bone greater than 2 cortical diameters. Patients were offered surgery if their life expectancy was greater than 2 weeks and if they were medically fit for anaesthesia.

We followed the surgical technique described by the designer of the nail.¹¹ Among the patients who received a total of 24 nails, the nail was inserted via an anterograde approach through the rotator cuff tendon for 22 patients. In another 7 patients, the nail was inserted using a retrograde approach through the triceps tendon. The nail was locked proximally and distally in 26 patients (a total of 28 nails), one of which also received cement augmentation by intramedullary injection of cement prior to nailing. In 3 patients who had a large, single metastasis, direct curettage of the lesion was performed, followed by cement reconstruction and augmentation of an unlocked nail. One patient with a proximal diaphyseal fracture required an open reduction. After discharge from the orthopaedic unit, patients were generally managed by the oncology or radiotherapy team and, if well enough to attend, followed up in the fracture clinic by serial radiography.

RESULTS

29 patients were treated using the implant. The humeral nail was inserted by surgeons with varying

Table
Tumour histogenesis of malignant lesions

Tumour	No.
Multiple myeloma	9
Breast adenocarcinoma	8
Renal cell carcinoma	4
Colon adenocarcinoma	1
Lung adenocarcinoma	1
Lymphoma	2
Spindle cell carcinoma	1
Others	5
Total	31

levels of training and experience with the device. One patient had bilateral impending fractures treated together under anaesthesia. Another had a fracture on one side and an impending fracture on the contralateral side treated 5 months apart. Thus, a total of 31 nails were inserted. 25 lesions were pathological fractures and 6 were impending fractures. The tumour types are shown in the Table: 14 lesions were in men, and 17 were in women. The mean age at the time of surgery was 67 years (range, 39–84 years). The left humerus was involved in 15 patients and the right in 16 patients. Lesions were located in the proximal third in 11 patients, middle third in 17 patients, and distal third in 3 patients.

10 patients with lesions in 12 humeri received preoperative radiotherapy, 19 patients with lesions in 21 humeri received postoperative radiotherapy. Eight patients with lesions in 10 humeri received preoperative chemotherapy, and 5 patients with lesions in 5 humeri received postoperative chemotherapy. One patient with myeloma had preoperative embolisation therapy. In total, 13 patients (15 humeri) had at least one form of adjuvant therapy preoperatively and 19 patients (22 humeri) had adjuvant therapy postoperatively.

One patient was lost to follow-up following discharge from the hospital. 17 patients (17 nails) were reviewed retrospectively and 11 patients (13 nails) were reviewed prospectively. At the time of this review, 25 patients had died, after a mean survival of 6 months. There were 4 surviving patients with a mean survival of 25 months (6, 16, 19, and 60 months, respectively).

Early complications included intra-operative fractures in 2 patients, and difficulty with obtaining distal locking in 4 patients. There were no cases of wound infection, wound breakdown, or radial nerve palsy. The intra-operative fractures were sustained in 2 of the 7 patients who had undergone retrograde

nailing: the first sustained a supracondylar fracture of the humerus at the nail insertion site through the tumour distal to the nail. The fracture was treated non-operatively with residual pain and no function until 4 weeks postoperatively when the patient died. Another patient with a re-operative fracture of the mid-shaft and an impending fracture of the distal third of the diaphysis required reaming, owing to a narrow intramedullary canal. A nail was inserted spanning both lesions, and a fracture was sustained through the distal deposit. The distal fracture developed a mobile nonunion, with late ulnar nerve compression at the elbow, which required ulnar nerve transposition and external splinting.

Insertion of the distal locking screw was difficult for 4 patients: the humerus of one patient was locked distally with a small fragment set cancellous screw because of difficulty with insertion of the Austofix distal locking screw. In another patient, the distal locking screw was stripped and only passed through one cortex; this was prominent and mildly painful, and was left in place.

In another patient, multiple cortical perforations were made with the drill in an attempt to pass a distal locking screw. A fracture was subsequently sustained through a cortical perforation 16 weeks after surgery. In another case, there was a breakdown in sterility during distal locking when the drill passed through the arm rest.

Problems with proximal locking occurred in one patient, who complained of a painful shoulder postoperatively. Radiographs showed the proximal locking screws entering the glenohumeral joint. These were removed 18 months postoperatively when the fracture had united.

Late complications in 3 patients were due to local progression of disease and resulted in loss of fixation. All of them had received adjuvant therapy. One patient with an impending fracture from myeloma in the distal third was treated initially with an anterograde locked nail. One year postoperatively, this patient developed a pathological fracture just proximal to the distal locking screw. This did not unite, and led to loosening of the distal locking screws and a mild ache in the elbow. The nail spanned both lesions, and there was only mild limitation of function, which did not require further operative intervention.

A patient with a renal cell carcinoma and a pathological fracture of the distal third was treated with curettage, cementation, and an unlocked intramedullary nail. Local recurrence of the tumour at 11 weeks postoperatively resulted in extrusion of the cement and collapse of the fracture with protrusion of the nail proximally. Following radiotherapy, the

patient had good function of the hand and elbow, but limited range of motion of the shoulder due to impingement by the protruding nail.

A patient with prostatic adenocarcinoma sustained a further pathological fracture distal to his anterograde nail at 16 weeks. He had significant pain and limitation of function, but declined further surgery. In addition, one patient developed shoulder stiffness that required manipulation under anaesthesia 6 weeks after prophylactic anterograde insertion of a nail with cement augmentation.

DISCUSSION

This study reports the largest series and is the most comprehensive review of locked intramedullary nails for managing malignant disease of the humerus. Ingman and Waters¹¹ treated 15 pathological fractures in their series of 41 nails using the prototype of the nail used in this study. Of the 15 patients, 8 died within 3 months, and the longest follow-up period was 7 months. 12 had nails inserted at the elbow, and no intra-operative fractures were reported. They recommended the use of the retrograde route to enable earlier return of shoulder function for crutch walking. Although this approach is more relevant to the setting of multiple trauma, it may also be applicable in the setting of malignancy if crutch walking is required because of disease elsewhere. This study found an increased incidence of iatrogenic fractures when the retrograde approach was used. Retrograde nailing may produce greater stress in the humerus than the anterograde approach, which may predispose to fracture in already weakened bone. Even in the situation of a non-rigid humeral nail, the retrograde approach has been reported to be associated with a higher-than-usual iatrogenic fracture rate, even in normal bone.¹² For this reason, we do not recommend the retrograde approach for insertion of rigid humeral nails.

Internal fixation of pathological humeral fractures has been reported, but long-term follow-up is scarce. Hyder and Wray⁴ treated 16 pathological fractures of the humerus with multiple Ender's nails that were introduced retrograde. Initial results were good but no long-term follow-up was reported. Ikpeme⁸ included 9 pathological fractures treated by use of the Russell-Taylor humeral nail in a series of 39 patients but provided no specific follow-up of the outcome of the pathological fractures.

Rommens and Blum¹⁰ reported the results of retrograde nailing using an unreamed humeral nail in a series of 190 fractures, which included 26 pathological fractures, but no results were specified for the

pathological fractures. Other studies have provided follow-up data, but have been limited by small numbers of patients and poor patient survival. Redmond et al.⁹ reported the results of intramedullary locked humeral nails for 16 humeral lesions in 13 patients. No loss of fixation was observed in the 4 survivors, but a problem with a proximal screw was reported. Vandeweyer and Gebhart⁶ reviewed the results of the use of Hackett rods inserted retrograde with excision of the lesion and cement augmentation. In their series of 18 patients, median survival was 2 months and only 4 patients survived longer than 6 months.

Yazawa et al.⁷ reported the results of treatment of 35 pathological fractures of the humerus, the majority treated with Rush pins and cement augmentation. Failure was reported in 2 cases due to loss of fixation. The researchers recommended that cement should be used to assist fixation in proximal metaphyseal and diaphyseal lesions. In addition, life expectancy should be a consideration when selecting the method of fixation.

Tome et al.⁵ reported the results of the use of the Seidel nail in 14 patients. The results were poor, with 2 persisting radial nerve palsies and 5 patients unable to use the arm for activities of daily living. The lack of rigid distal locking was reported as the cause for the failures,

a problem that has also been documented by others.¹

Dijkstra et al.² reported the results of treating 38 metastatic lesions, 20 using plate fixation and 18 with intramedullary nails. The initial technique was unlocked but early failure subsequently led to static locking of all nails. Fracture was reported in one patient, and the mean survival was 4.8 months.

Locked intramedullary nailing can provide secure fixation of pathological humeral fractures but can be a technical challenge. The results of this study, with mean survival of more than 6 months, indicate that malignant disease requires stable fixation. Adjuvant treatments such as radiotherapy or chemotherapy may not prevent progression of disease; hence, the longest nail possible should be used to reduce the risk of loss of fixation due to disease progression. Static locking is recommended. Cement augmentation alone may not provide sufficient stability but may increase the rigidity of the construct and provide improved screw fixation if the locking screws have adjacent lesions. The insertion of distal locking screws with this nail can be difficult, and multiple drill holes resulted in a fracture in one patient. Drilling a Kirschner wire through this hole under image-intensifier guidance before drilling may assist accurate placement of the distal locking screw and reduce the risk of iatrogenic fracture.

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