Concomitant injuries to the ipsilateral shoulder in patients with a fracture of the diaphysis of the humerus


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Antegrade intramedullary nailing of fractures of the shaft of the humerus is reported to cause impairment of the shoulder joint. We have reviewed 33 patients with such fractures to assess how many had injuries to the ipsilateral shoulder. All had an MR scan of the shoulder within 11 days of injury. The unaffected shoulder was also scanned as a control. There was evidence of abnormality in 21 of the shoulders (63.6%) on the injured side; ten had bursitis of the subacromial space, five evidence of a partial tear of the rotator cuff, one a complete rupture of the supraspinatus tendon, four inflammatory changes in the acromioclavicular joint and one a fracture of the coracoid process. These injuries may contribute to pain and dysfunction of the shoulder following treatment, and their presence indicates that antegrade nailing is only partly, if at all, responsible for these symptoms.

Fractures of the diaphysis of the humerus are common. Many studies have examined both the short- and long-term outcome of various methods of treatment including functional bracing,\(^1\-^3\) operative fixation with an intramedullary (IM) nail,\(^4\-^6\) plate fixation using either dynamic compression\(^7\,^9\) or bridging,\(^10\) minimally-invasive plating\(^11\) and external fixation.\(^12\) In recent years, plating has gained popularity over nailing as a means of internal fixation, partly because of the belief that nailing may cause impairment of function of the shoulder joint.\(^6\,^7\,^13\-^18\) However, the exact nature and cause of this problem is poorly understood. It has been suggested that damage to the rotator cuff at the site of entry of the nail may cause subacromial impingement\(^17\) which, in turn, may result in pain and stiffness of the shoulder joint. Some early reports have recorded an incidence of pain in the shoulder as high as 41% following antegrade nailing.\(^15\) Once this complication was recognised, greater care was taken to avoid damage to the rotator cuff and to bury the nail adequately. However, further studies still described a high incidence of shoulder dysfunction.\(^13\,^14\) Other complications and re-operations may obscure the true cause of shoulder pain.\(^5\,^14\,^19\) Fractures of the shaft of the humerus treated with retrograde nailing have also been noted to have an incidence of pain and dysfunction in the shoulder of between 7% and 12%.\(^20\,^21\)

There are only a few reports dealing with shoulder function after plate fixation of the humerus or non-operative treatment.\(^8\,^22\-^24\) These suggest that function does not fully recover even without violation of the rotator cuff. There has been no previous study examining the incidence of concomitant injury to the ipsilateral shoulder in the presence of a fracture of the diaphysis of the humerus, although there have been several reports of dislocation in conjunction with fracture of the shaft.\(^25\,^26\) We have investigated the incidence of concomitant injury to the shoulder in association with fracture of the shaft of the humerus by performing an MRI of both shoulders at the time of injury.

Patients and Methods
Between September 2002 and May 2004, all patients seen with fractures of the diaphysis of the humerus were recruited to this study. Patients were questioned as to any problems in the shoulder. Those with a history of pain, stiffness, or previous surgery, including injection of the subacromial space, were excluded from the study. Others excluded were those with associated fractures of either the surgical neck of the humerus or of the clavicle, an obvious injury to the acromioclavicular joint or with multiple fractures from high velocity trauma. Patients with a head injury, and who required endotracheal intubation, were also excluded because of their inability to give an accurate history of their accident.

Patients were included whether they had non-operative or operative treatment of their
fractures. All were seen within five days of injury. The mechanism of the injury and hand dominance were recorded. An MRI of both shoulders was carried out within 11 days of injury in all patients. The unaffected shoulder was used as a control.

Statistical analysis. The results were collected and recorded on a standard database (Microsoft Excel, Windows 2000; Microsoft Corporation, Redmond, Washington). Statistical analysis was performed using Student’s t-test to determine whether factors such as age and gender could contribute towards the results. Analysis of variance (ANOVA) was used to analyse differences between the group with an ipsilateral shoulder injury and those without. A chi-squared analysis of data was performed. A p-value ≤ 0.05 was considered significant. All data were provided with a 95% confidence interval (CI) when appropriate. Analysis of data was performed using a commercially-available package by SPSS for Windows 12.0 (SPSS Inc., Chicago, Illinois).

Results
During the period of the study, 43 patients attended with a fracture of the diaphysis of their humerus. Ten patients were excluded from the study; four had received a previous injection of the subacromial space for impingement problems, two had associated fractures of the surgical neck of humerus, one had an associated fracture of the ipsilateral clavicle, and one had a grade 3 subluxation of the ipsilateral acromioclavicular joint. A further two patients were excluded as they had head injuries and required endotracheal intubation. This left 33 patients. Their mean age was 36 years (19 to 57). There were 21 fractures of the right humerus and 12 of the left. There were 30 patients, with right hand dominance, of whom 20 had fractures on the right side. The mechanisms of injury and patterns of fracture are shown in Table I.

All patients were treated initially in a U-slab cast. Subsequently eight required operation as a result of unacceptable alignment. Of these, four had an open reduction and internal fixation with dynamic compression plating. The other four had IM nailing; three by the retrograde technique using a Marchetti-Vincenzi IM bundle nail (Zimmer, Warsaw, Indiana) and one with an antegrade Russell-Taylor IM nail (Smith & Nephew Orthopaedics, Memphis, Tennessee). In the patient who had antegrade nailing, the MR scan was carried out before surgery in order to avoid any interference with the rotator cuff.

Asymmetrical MR scans were seen in 21 of the 33 patients (63.6%), with the abnormality on the same side as the fracture in all. A signal change suggestive of subacromial bursitis was seen in ten (Fig. 1), five had a partial tear of the rotator cuff, one had a complete rupture of the supraspinatus tendon, four had inflammation of the acromioclavicular joint (Fig. 2), of which three were acute and one acute-on-chronic, and one had an undisplaced fracture of the coracoid process (Figs 3 and 4). All of the MR scans were reported by a single, experienced radiologist.

There was no statistically significant relationship between either the type (chi-squared test, p = 0.132) or mechanism (chi-squared test, p = 0.1459) of injury and an ipsilateral shoulder injury. The chi-squared test showed no statistically significant relationship between any independent factors such as age (p = 0.1535), gender (p = 0.1348), type (p = 0.1383) or mechanism (p = 0.1595) of injury between those with, and those without an ipsilateral injury.

Discussion
The treatment of fractures of the shaft of the humerus remains controversial. The rationale for non-operative treatment largely stems from the work of Sarmiento et al. and Klenerman. Sarmiento et al. had a rate of union in closed injuries of 98%, with all patients achieving a satisfactory return of function. However, most authors have had difficulty in replicating these results. Klenerman demonstrated that there is little loss of function with up to
3 cm of shortening, 30° of varus angulation, and 20° of angulation in the anteroposterior (AP) plane.

Internal fixation is indicated following failure to maintain satisfactory alignment with conservative treatment. It may be necessary in victims of polytrauma who need stabilisation to aid in nursing care or to assist in movement. Other indications include pathological fractures and associated vascular injury. Where there is damage to neurological structures, particularly the radial nerve, some advocate early exploration^{34-37} but others disagree, noting the high rate of spontaneous recovery, and advise a policy of expectancy.^{38-44} An obvious advantage of fixation is that once the limb is stabilised it can be used early without external support, and allows the patient the comfort of sleeping in the supine position.^{5,20} Additionally, the angular deformity so often seen with conservative treatment^{1-3,29} is effectively prevented.

Where internal fixation is indicated, most of the recent literature has recommended dynamic compression plating rather than antegrade nailing,^{7-9} since there is a high reported incidence of shoulder dysfunction, pain and non-union after nailing.^{7,13,14} A fracture may occur around the end of the locked nail.^{45} However, nailing offers the advantage of less soft-tissue injury, a lower rate of infection and no need for exposure of the radial nerve.^{5} It is preferred by some for open fractures, comminuted fractures, pathological fractures, and those associated with osteoporosis.^{5,6,46,47} Other studies have demonstrated no difference in
outcome between plating and nailing for open or comminuted fractures, but the numbers have been small. Gardner et al described a series of patients with osteoporosis who sustained fractures of the shaft of the humerus and had good results following treatment with a hybrid locking plate system.

Ajmal et al, in a review of 33 patients, found an incidence of nonunion of 30% after locked antegrade IM nailing. Pain was experienced either in the shoulder or at the fracture site in 56% of patients, and 41% had poor shoulder function. Only 51% were satisfied with the outcome and 42% needed further surgery. Chapman et al observed a significant restriction of movement and increased pain in the shoulder after nailing compared with plate fixation in a prospective randomised trial.

McCormack et al found no difference in shoulder and elbow scores, shoulder pain, or range of movement between nailing and plate fixation in a prospective randomised trial. Lin and Hou reported good functional outcome in a group of 38 patients treated with antegrade nailing. Flinkkilä et al studied the recovery of shoulder function, comparing patients who had antegrade nailing with those who were plated. They concluded that symptoms, the range of movement and isometric strength do not fully recover after uncomplicated antegrade nailing or plate fixation, although there was a higher rate of shoulder pain which was not statistically significant in the group treated by nailing.

It has been suggested that injury to the rotator cuff during insertion of the nail is not the main reason for residual problems in the shoulder joint. Changulani et al compared the use of IM nails with dynamic compression plating in a series of 47 patients. Function of the shoulder was found to be similar in both groups. The rate of union was also similar, although the time to union was significantly shorter in the group who had nailing. They also found a higher rate of infection in the group which were plated. Bhandari et al undertook a meta-analysis of randomised trials, comparing compression plate fixation with nailing. Fixation with a plate appeared to reduce the risk of re-operation and shoulder impingement, although it was concluded that the cumulative evidence was unclear and inconclusive.

Some studies have compared antegrade nailing with other forms of treatment other than plate fixation. Scheerlinck and Handelberg found a reduction in movement and in the power of abduction with antegrade compared with retrograde nailing. Chiu et al observed no difference between Ender nailing and plate fixation with regard to movement of the shoulder.

Most authors have considered impingement of the rotator cuff as the most important factor contributing to problems in the shoulder joint. Other technical factors which are thought to cause poor recovery include massive injury of the rotator cuff with inadequate repair, prominence of the head of the nail or the locking screws, axillary nerve injury, and intra-operative comminution of the humeral head. Incision into the supraspinatus tendon is made in order to gain access for insertion of the nail. This is near a so-called ‘critical zone’ in the tendon, which has been believed to have a poor blood supply, leading to problems with healing. Further studies have shown this area to be hypervascular, and that even degenerative ruptures of this zone heal following surgical treatment. O’Brien et al described using a transrotator cuff approach for arthroscopic surgery and found that this healed without causing problems. Other reports support the idea that antegrade nailing, when carried out correctly, is not the cause of impairment of function. It has been speculated that soft-tissue injury, pain, or immobilisation may play an important role. Insertion of a nail through the rotator cuff may worsen the effect of these factors and make post-operative rehabilitation more difficult. Nailing may be associated with complications which require repeated incisions through the rotator cuff, and this can lead to serious problems.

We recognise that there are weaknesses to this study. The patients were not randomised into groups for different modes of treatment. We did not carry out functional shoulder and elbow scores at follow-up, which would have allowed us to attach clinical significance to our findings. All the MR scans were interpreted by a single radiologist, albeit an experienced one, who was not blinded to the side of injury. However, we have clearly demonstrated the high incidence of shoulder injury associated with this fracture, using the highly sensitive method of MR scanning. We do recognise, however, that there have been studies reporting a higher incidence of shoulder pain and dysfunction following antegrade IM nailing compared with plate fixation. It seems that shoulder pain and dysfunction after antegrade IM nailing is a multifactorial problem, and not solely a result of surgical access to the humeral head through the rotator cuff. Most of the pathology detected on MR scanning probably pre-dated the injury to the humeral diaphysis, although no patient in the series had a history of shoulder problems. It is known that a certain incidence of asymptomatic rotator cuff disease exists in the population. Part of the problem leading to pain may be violation of the rotator cuff through an already damaged cuff or subacromial space, albeit in patients with asymptomatic disease. In addition, in patients with asymptomatic acromioclavicular disease, the fall itself may exacerbate preceding pathology. Further prospective studies are required to fully elucidate these problems.

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References


