Original Research

THE ANTERIOR ACROMIAL APPROACH FOR ANTEGRADE INTRAMEDULLARY NAILING OF THE HUMERAL DIAPHYSIS

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ABSTRACT

At three institutions, 71 humeral intramedullary nails were inserted into the shoulder; 67 were reviewed at 6 months and at completion of treatment. Fifty-one utilized the anterior acromial approach and 16 were inserted lateral to the acromion. Shoulder motion was rated as: excellent (asymptomatic and within 15° of normal); good (normal daily function within normal motion); and poor. Nails were also inserted into the humeral diaphysis of eight cadaver shoulders. Fifty-one nails were inserted via the anterior acromial incision; 48 were graded as excellent, one as good, and two with traumatic axillary neuropathy and reflex sympathetic dystrophy as poor. Sixteen nails were inserted lateral to the acromion; 8 were rated, 7 good, and 1 poor. Motion returned in an average of 17 weeks (range: 0-29). The greatest clinical concern is not ultimate shoulder function, but the rate of return. The authors conclude that either the anterior acromial approach or an extraarticular entry portal must be utilized for antegrade humeral diaphyseal nailing.

The principles of locked intramedullary nailing have gained acceptance more slowly for the humerus than for the long bones of the lower extremity, partly due to lack of extraarticular and linear access to the medullary canal.1-12

Robinson et al9 reported a 56% rate of shoulder stiffness utilizing the Seidel nail through an oblique incision originating from the anterolateral acromion (the anterolateral approach).4,11 Riemer et al,8 utilizing the same anterolateral approach, reported a 50% rate of shoulder stiffness. When switching to an incision originating anterior to the acromion (the anterior acromial approach), shoulder motion returned reliably but slowly.8

We present further clinical experience reviewing antegrade intramedullary humeral nailing through an oblique incision originating from the anterolateral acromion (the anterolateral approach) and an incision anterior to the acromion (the anterior acromial approach), and anatomic dissections (Figs 1-3) to determine why such a small change in incisions can so seriously affect ultimate shoulder function.

MATERIALS AND METHODS

Between April 1, 1988 and August 31, 1991, 71 humeral intramedullary nails were inserted through the shoulder at the three institutions

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Fig 1: A shoulder viewed from above. The deltoid has been reflected off the anterior and lateral acromion (arrows). Forceps are under the coracoacromial ligament (A). Note that the entry portal for the anterior acromial approach (D) lies under the coracoacromial ligament. The entry portal for the anterolateral approach (C) lies between the coracoacromial ligament and greater tuberosity (B). The results were represented by the authors. Several surgeons were involved at each institution. Only acute fractures were analyzed, excluding pathologic fractures, delayed fractures, and nonunions. Patients with contractures from massive head injuries were also excluded. Sixty-seven patients were reviewed at 6 months, or at completion of treatment and plateau of shoulder function.

Sixteen nails were inserted via the anterolateral approach (Fig 2) and 51 through the anterior acromial approach (Fig 3). Sixty-one Seidel, three Russell-Taylor, and three True-Flex nails were inserted. Patients were assessed for infection, iatrogenic neurologic injuries, and comminution. Final shoulder motion and the interval to plateau of shoulder function were analyzed.

Shoulder motion was rated as excellent if asymptomatic and had less than 15° of loss of motion. It was rated good with a loss of between 15° and 30° of motion with normal daily function. Shoulders were considered poor if greater than 30° of motion was lost.

Anatomic dissections: Eight shoulders from six cadaveric specimens were dissected. The deltoid muscle was incised longitudinally 5 mm medial to the acromioclavicular joint. The muscle was reflected off the distal clavicle and the anterior and lateral acromion. This exposed the rotator cuff and the coracoacromial ligament (Fig 1).

All dissections were done with the shoulder extended 30°. An incision was made through the rotator cuff as recommended by Seidel (the anterolateral approach) and reported by Robinson et al (Fig 2). This incision originated at the anterolateral edge of the acromion and violated the rotator cuff at its insertion. The incision was made in line with the fibers of the tendon. A 9 mm straight Kuntscher nail was inserted through this rotator cuff incision.

A second rotator cuff incision was made in line with its fibers anterior to the acromion (the anterior acromial approach) (Fig 3) as recommended by Riemer et al. A 9 mm straight Kuntscher nail was inserted into the humeral diaphysis through this rotator cuff incision.

RESULTS

Clinical Results: Of the 16 nails inserted through the anterolateral approach, eight (50%) were rated excellent. Seven shoulders were rated good, having lost between 15° and 30° of shoulder motion. These patients had minor symptoms of impingement. One shoulder was rated poor, with an iatrogenic fracture of the humeral head. One patient sustained iatrogenic comminution of his proximal fragment from too far posterior a starting point. There were no infections or prominent nails.

Of the 51 nails inserted via the anterior acromial approach, 48 (94%) were rated excellent. Many patients lost between 5° and 15° of shoulder motion in full abduction and forward flexion, but did not have functional deficits in their shoulders. Many patients could be forced to fully elevate their shoulder, but this was not a fluid and functional motion. One shoulder was rated good in a patient with a grade II open humeral fracture who sustained a soft tissue injury subcutaneously almost to the shoulder joint. Two shoulders were rated poor: one with a traumatic axillary neuropathy, and one with reflex sympathetic dystrophy. Five nails were left prominent, protruding above the cortex of the humeral head due to technical errors or equipment failures. The patients impinged until nail removal and subsequently regained excellent shoulder function.
Fig 2B: A 9 mm straight Kuntscher nail is inserted through the anterolateral approach medial to the greater tuberosity. Note that, to gain linear access to the medullary canal, the nail has to be pushed medially against the lateral fibers of the coracoacromial ligament (A).

Two fractures, open grades II and IIIA, became infected without secondary shoulder infections. One patient developed chronic osteomyelitis with a sequestrum requiring metal removal and serial debridements, including removal of a medullary sequestrum. One patient required a metal removal and two debridements. Three humeri were comminuted in their distal segments after linear access to the medullary canal was achieved via the anterior acromial approach.

The interval to plateau of shoulder function could be determined in 39 patients. Shoulder motion returned in an average of 17 weeks (range: 0-29). This excluded two patients whose shoulder motion returned in 50 and 91 weeks, respectively; one sustained a traumatic radial neuropathy and one a traumatic brachial plexopathy.

Patients were positioned on the operating table for closed intramedullary nailing with the contralateral arm abducted to allow a C-arm to be brought across the chest to view the operative arm. In this abducted position, one patient sustained a transient brachial plexopathy of her contralateral shoulder. Nails were inserted without traction devices on the operative arm, and there were no other iatrogenic injuries to the brachial plexus, radial nerve, axillary nerve, artery, or vein.

Results of Anatomic Dissections: An incision through the rotator cuff in line with its fibers originating from the anterolateral edge of the acromion (anterolateral approach), as recommended by Seidel, placed the rotator cuff incision in its most avascular portion (Fig 2).

Fig 3A: Surface anatomy of the anterior acromial approach. The line of the clavicle has been drawn as it enters the acromioclavicular joint (E). An incision is made over the anterior half of the acromion (arrows). The surface anatomy of the entry portal for the anterior acromial approach (D) is indicated.

Fig 3B: A 9 mm straight Kuntscher nail has been inserted via the anterior acromial approach, allowing linear access to the medullary canal. Note the open area (C) lateral to the nail which was part of the incision for the anterolateral approach. The forces are shown holding the cut edge of the coracoacromial ligament (A), which was transected over the anterior edge of the acromion (arrows) while exposing the rotator cuff.

The insertion point for the intramedullary nail was in the sulcus medial to the greater tuberosity. Insertion of a straight nail through this incision did not allow linear access to the medullary canal. To gain access to the medullary canal, the nail had to be pushed medially, tearing the medial fibers of the rotator cuff and the lateral fibers of the coracoacromial ligament (Fig 2B). Once inserted into the humeral diaphysis and buried within the substance of the humeral head and the shoulder abducted, the rotator cuff incision was brought under the coracoacromial ligament and acromion with abduction. Residual irritation or thickening of the rotator cuff tendon or the coracoacromial ligament could cause impingement and stiffness. Extension of the shoulder to 20° to 30° was necessary to allow the nail to clear the anterior acromion.

An incision anterior to the acromion (the anterior acromial approach), as recommended by Riemer et al., is shown in Figure 3. With a roll under the scapula and the shoulder extended 30°, the humeral head was brought out from underneath the acromion. The rotator cuff was incised in line with its fibers anterior to the
Fig 4: An incision over the anterior acromion allows linear access to the medullary canal.

acromion. This placed the dissection over the coracoacromial ligament (Fig 3). The rotator cuff incision transected the coracoacromial liga-
ment (Fig 3B). A 9 mm straight Kuntscher nail, inserted anterior to the acromion, had linear access to the medullary canal (Fig 4). Note the open rotator cuff lateral to the nail (Fig 3B) which was the insertion point for the anterolateral incision.9,11

DISCUSSION

Reports of complications of shoulder function following antegrade intramedullary nailing of the humeral diaphysis have been inconsistent. Seidel11 reported no difficulties when utilizing the anterolateral approach (an oblique incision originating from the anterolateral acromion [Fig 2A]). Robinson et al,9 utilizing the same incision, reported a 56% rate of shoulder stiffness and recommended that another entry portal be identified.

In our previous report8 utilizing the Seidel nail, we saw an improvement of shoulder function when abandoning the anterolateral approach (Fig 2A) and utilizing the anterior acromial approach (Fig 3A). Blasier (personal communication), using an oblique incision anterior to the acromion and transecting the coracoacromial ligament, reported excellent shoulder function. Our anatomic dissections document the reason why such a small change in entry portals could seriously affect ultimate shoulder function. The anterior acromial approach split the deltoid muscle fibers over the anterior half of the acromion. With the shoulder extended 30°, an incision was made through the rotator cuff in line with its fibers. We inadvertently were cutting the coracoacromial ligament and decompressing the shoulder (Fig 3).

We initially believed that the improvement in shoulder function when changing from the anterolateral to the anterior acromial approach was due to avoiding an incision in the avascular lateral portion of the rotator cuff. This may still play a role, but we now believe that the most important factor in preventing shoulder stiffness when performing antegrade intramedullary nailing of the humeral diaphysis via an articular entry portal is transection of the coracoacromial ligament with whatever rotator cuff and skin incisions are used. Another alternative is an extraarticular entry portal. Russell et al10 reported excellent shoulder function when entering through the greater tuberosity. This did not allow linear access to the medullary canal, however, adding to the potential risk of comminution.

The reported interval to plateau of shoulder function of 17 weeks is uncomfortably long. The rate of return of shoulder function was the greatest clinical problem seen in this series. This was not only the result of incising the rotator cuff. Hall5 and Russell et al10 reported similar findings using flexible or locked nails without violation of the rotator cuff. A similar analysis has not been performed on shoulder function with functional bracing or plate fixation.13-18

The reason for the variability in the rate of return of shoulder function is unclear. Some patients had a full range of shoulder motion within days of their injury, while others impinged and had discomfort with extremes of motion for up to 29 weeks. Most patients, however, were comfortable through the first 60° of forward flexion and abduction very early in their postoperative course. This is the range of shoulder motion necessary to achieve trauma goals of access to the chest, ambulation on crutches, and bed to chair mobilization.

The anterior acromial incision centers the entry portal into the humeral head in the lateral edge of the articular cartilage. Many patients who underwent intramedullary nailing through this incision lost up to 15° of shoulder motion, but were very comfortable. This may be due to the loss of articular cartilage that would only enter the shoulder joint with full abduction. This minimal loss of motion caused no functional difficulties.

Two humeri in this series became infected. Both were removed through the shoulder joint after undergoing local debridement. When the drainage site was under local control, with persistent drainage but without cellulitis or abscess, the nails were removed through the shoulder, thoroughly debriding the tract. The
bone was subsequently debrided through the sinus after metal removal. A pulse lavage system through the shoulder was not utilized for fear of contaminating the shoulder with infected debris. This is too small a series to be certain that diaphyseal infections will not secondarily infect the shoulder; nails should be used with caution in high risk open diaphyseal fractures.

Five nails were left protruding above the cortex of the humeral head through the substance of the rotator cuff. All impinged until metal removal, after which the patients recovered excellent shoulder function. If patients can tolerate the temporary impingement, we recommend that prominent metal not be exchanged or driven deeper into the humeral head until fracture union has occurred.

When a nail is inserted eccentrically into a round structure, it is possible to obtain an AP radiograph (Fig 5) with the implant in profile, appearing to be within the bone, but in reality being anterior to the horizon of the bone. This is important with the anterior acromial approach. With the shoulder in 30° of extension and the nail potentially anterior to the head of the humerus, the image intensifier must be oblique or the shoulder moved to be certain that the nail is inserted sufficiently deep into the substance of the humeral head and that no portion of the nail will impinge.

We have demonstrated that antegrade intramedullary nailing of the humeral diaphysis can be performed via the anterior acromial approach with an acceptable risk to the shoulder. Humeral nailing can also probably be performed through an incision originating over the acromial acromion, provided the coracoclavicular liga ment is cut. Transection of the coracoclavicular ligament appears to be the major factor in preventing ultimate shoulder stiffness and impingement with an intraarticular entry portal.

Surgical technique does not guarantee excellent shoulder function. At each institution, aggressive physical therapy was begun immediately following surgery and maintained until excellent shoulder function was obtained.

The results of locked humeral nailing must still be considered preliminary. Reported series are small. Indications and techniques have been diverse and results variable. Shoulder motion when nails are inserted via an acceptable approach, however, appears to be less of a concern when aggressive postoperative rehabilitation is employed.

REFERENCES