Is Ulnar Nerve Transposition Beneficial During Open Reduction Internal Fixation of Distal Humerus Fractures?

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Objectives: The purpose of this study was to compare the incidence of ulnar neuritis with and without ulnar nerve transposition during open reduction and internal fixation (ORIF) of distal humerus fractures.

Design: Multicenter retrospective cohort series.

Setting: Two Level I trauma centers.

Patients: Two cohorts were identified: 89 patients (mean age, 48.6 years) who had not undergone an ulnar nerve transposition and 48 patients (mean age, 43.2 years) who had undergone a transposition during ORIF of a distal humerus fracture (Orthopaedic Trauma Association 13A or 13C).

Intervention: All patients underwent ORIF of a distal humerus fracture with or without anterior subcutaneous ulnar nerve transposition based on surgeon preference.

Main Outcome Measure: Presence or absence of ulnar neuritis (ulnar-sided paresthesias, numbness, or intrinsic weakness) or reoperation related to ulnar nerve symptoms.

Results: Average follow up was 9.6 months in the transposition group and 16.0 months in the nontransposition group. Transposition of the ulnar nerve was found to be an independent variable associated with ulnar neuritis ($P < 0.001$). The incidence of ulnar neuritis was 33% (16 of 48) with transposition and 9% (eight of 89) without transposition ($P = 0.0003$). Of the patients with ulnar neuritis, one patient in the nontransposition group (1%) and two patients in the transposition group (4%) required additional surgery specifically related to the ulnar nerve. One patient who had undergone transposition developed chronic motor and sensory denervation.

Conclusion: Patients who underwent ulnar nerve transposition at the time of ORIF of distal humerus fractures had almost four times the incidence of ulnar neuritis than those without transposition. We do not recommend routine transposition of the ulnar nerve at the time of ORIF of distal humerus fractures.

Key Words: distal humerus fracture, ulnar neuritis, transposition

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INTRODUCTION

Ulnar neuritis is a known complication associated with open reduction and internal fixation (ORIF) of bicolumnar distal humerus fractures.[1–30] The development of ulnar neuritis has many potential etiologies.[31] The ulnar nerve may be contused or lacerated at the time of initial trauma or at the time of surgical intervention, particularly from excessive retraction during fracture exposure or fixation. Swelling in the immediate posttraumatic or postoperative setting may also contribute to a neurologic deficit. Postoperatively, soft tissue scar formation, heterotopic ossification, and prominent hardware may represent etiologic factors for ulnar nerve dysfunction.

Anterior transposition of the ulnar nerve theoretically provides a new bed for the nerve away from prominent hardware, posttraumatic scar tissue, or heterotopic bone, limiting potential injury. Conversely, transposition requires further dissection of the nerve with potential for additional trauma and devascularization.[32] Nevertheless, there is no consensus regarding whether ulnar nerve transposition at the time of fracture fixation provides any benefit.

The purpose of this study was to compare the incidence of ulnar neuritis with or without transposition after ORIF of distal humerus fractures. Our null hypothesis was that there would be no difference in the development of ulnar neuritis in patients whether or not ulnar nerve transposition had been performed during ORIF of distal humerus fractures.

PATIENTS AND METHODS

Patients

A retrospective review identified 170 consecutive patients who underwent ORIF of an Orthopaedic Trauma Association (OTA) 13A or 13C distal humerus fracture by one of three orthopaedic trauma surgeons at two institutions between May 1996 and May 2005 (Institutional Review Board-approved). The study groups consisted of those patients

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who did not undergo transposition of the ulnar nerve at the time of fracture fixation and a control group of patients who did undergo ulnar nerve transposition during fracture fixation. The decision for transposition was based on surgeon preference. At one institution, transposition was performed if implants extended past the medial epicondyle and the nerve rubbed against the metal with intraoperative range of motion or if preoperative ulnar nerve symptoms were present (44 of 85 cases). At the second institution, transposition was not routinely performed (four of 52 cases). Patients younger than 18 years of age and those whose fractures were the result of a pathologic bone process were not included. In addition, patients with less than 6 months of follow up were excluded. This left 137 patients who were studied.

Technique

The surgical procedure consisted of careful exposure and protection of the ulnar nerve. Restoration of the medial and lateral columns and articular congruity, if applicable, were performed. In those patients who did not undergo transposition, the ulnar nerve was allowed to return to its native position posterior to the medial epicondyle at the conclusion of the procedure. An anterior subcutaneous ulnar nerve transposition was performed in the remainder of patients. An extensive proximal and distal release of the nerve and soft tissue, including both the Arcade of Struthers as well as the medial intermuscular septum, was performed. The nerve was secured anteriorly in a subcutaneous pouch.

Data Extraction

A chart review determined demographic factors, whether each fracture was open or closed, and the incidence of ulnar neuritis at any time in the postoperative period. We defined ulnar neuritis to represent any subjective symptoms or physical findings that could be attributed to irritation of the ulnar nerve, including ulnar-sided paresthesias, numbness, or intrinsic weakness. Operative reports were reviewed to assess whether an olecranon osteotomy or transposition had been performed. The development of a postoperative infection and any additional surgeries were documented. Preoperative and postoperative radiographs were evaluated to classify each fracture according to the OTA classification and to determine whether implants had been used on the medial column of the elbow.

Statistical Analysis

Dichotomous variables, including sex, open or closed fracture, nonunion, infection, presence of a medial plate, OTA classification, and presence of ulnar neuritis were compared using the chi-squared test and the continuous variable of patient age was compared with the Student *t* test. Regression analysis tested age, sex, OTA fracture classification, olecranon osteotomy, presence of medial hardware, and transposition as independent variables for development of ulnar neuritis. Statistical significance was considered for $P < 0.05$.

RESULTS

Forty-eight patients (mean age, 43.2 years; range, 18.2–89.1 years) underwent ulnar nerve transposition and 89 patients (mean age, 48.6 years; range, 18.2–96.5 years) did not undergo transposition during distal humeral ORIF. Average follow up was 9.6 months (range, 6.0–32.3 months) in the transposition group and 16.0 months (range, 6.0–73.2 months) in the nontransposition group ($P < 0.002$). There was no difference between the groups ($P > 0.05$) with regard to age, sex, olecranon osteotomy, medial plates, nonunion, or infection (Table 1) or OTA classification (Table 2).

Ulnar Neuritis

Symptoms of ulnar neuritis occurred almost four times more frequently in patients with transposition (16 of 48 [33%]) than in those without transposition (eight of 89 [9%]; $P = 0.0003$; Table 3). Transposition of the ulnar nerve was found to be an independent variable associated with ulnar neuritis ($P < 0.001$). Transposition provided no benefit to avoid symptoms of ulnar neuritis even in the presence of medial implants ($P < 0.002$) because 33% of such patients with transposition (15 of 45) and 10% of those without transposition (eight of 80) had symptoms of ulnar neuritis (Table 3). The only patient with ulnar neuritis among those without medial implants (n = 12) had a transposition. One patient who underwent transposition developed chronic motor and sensory ulnar neuropathy. The patient had a closed OTA Type C1 fracture managed with medial and lateral plates without olecranon osteotomy. The medial plate extended to the epicondyle. Electromyography 5 months postoperatively confirmed chronic motor and sensory denervation.

Two of the 48 patients from the transposition group (4%) required secondary surgery related to ulnar neuritis, whereas only one patient in the nontransposition group (1%) required such surgery. The first patient in the transposition group had a closed OTA Type C2 fracture managed with medial and lateral plates, the medial of which extended distal to the medial epicondyle. An olecranon osteotomy had been performed. The

TABLE 1. Patient and Fixation Characteristics

	Transposition Group	No Transposition Group	*P* Value
Sex			
Male	27	48	0.79
Female	21	41	
Olecranon osteotomy			
Yes	26	50	0.82
No	22	39	
Medial plate			
Yes	45	80	0.45
No	3	9	
Fracture			
Open	19	28	0.34
Closed	29	61	
Nonunion			
Yes	4	9	0.73
No	44	80	
Infection			
Yes	2	4	0.93
No	46	85	

TABLE 2. Orthopaedic Trauma Association Classification

Classification	Transposition Group	No Transposition Group
13A2	1	3
13A3	0	4
13C1	5	13
13C2	23	38
13C3	19	31

patient was found to have ulnar nerve symptoms in the acute postoperative period and underwent proximal release of an inadequately released ulnar nerve 15 days after the index procedure. At the 4-month follow up, the patient was asymptomatic. The second patient from the transposition group sustained an open OTA Type C2 fracture treated with a medial plate placed proximal to the epicondyle without an osteotomy. Mild ulnar neuritis developed late in the postoperative period and was associated with a nonunion. A revision transposition was performed at the time of nonunion repair 11 months after the initial surgery. The patient was free of ulnar nerve symptoms 9 months after the second surgery. The patient from the nontransposition group had an open OTA Type C3 fracture treated with medial and posterior lateral plates without olecranon osteotomy. The fracture healed uneventfully. Anterior transposition was performed at 4 months after the index procedure. At the last follow-up visit, 8 months after transposition, the patient was free of ulnar nerve symptoms. One additional patient in the nontransposition group developed ulnar neuritis, but this was only after a secondary capsular release. Two additional patients from the nontransposition group had no ulnar neuritis after the index ORIF and underwent elective transposition during a secondary procedure.

Complications Other Than Ulnar Neuritis

Infection occurred in two patients from the transposition group (all superficial) and in four from the nontransposition group (two superficial and two deep). Nonunion of the distal humerus occurred in four patients from the transposition group and in five from the nontransposition group. Four additional patients from the nontransposition group developed a nonunion of their olecranon osteotomy. Additional unplanned surgery was required for seven patients from the transposition group and for 27 from the nontransposition group (Tables 4 and 5).

TABLE 3. Ulnar Neuritis

	Transposition Group	No Transposition Group	*P*
Ulnar neuritis			
Yes	16 (33%)	8 (9%)	0.0003
No	32	89	
Ulnar neuritis when medial plate present			
Yes	15 (33%)	8 (10%)	<0.002
No	30	72	

TABLE 4. Additional Surgeries Transposition Group

	No. of Patients
Bone grafting	1
Revision open reduction and internal fixation	1
Heterotopic ossification excision	4
Incision/débridement	1

DISCUSSION

The incidence of ulnar nerve symptoms after ORIF of distal humerus fractures has been reported as 0% to 51%.[1–21,23–30,33] Although many surgeons routinely expose the ulnar nerve at the time of surgical fixation of distal humerus fractures, there is controversy about whether the nerve should be transposed anteriorly at the time of surgery. Several authors advocate routine transposition of the ulnar nerve during surgical stabilization of distal humerus fractures to prevent the development of neuritis.[7,28] Other authors recommend transposition for certain indications such as preoperative ulnar nerve symptoms,[8,11,14] a contused ulnar nerve identified intraoperatively,[26] nerve irritation from surgical retraction,[11,14] or the use of implants at the medial epicondyle that could irritate the nerve.[8,11,14,16,26] Other authors feel that anterior transposition is not needed.[3,4,25] These recommendations are without any supportive direct comparative data.

Our results, based on a direct comparison of similar groups with and without transposition, indicate that transposition of the ulnar nerve may not be helpful in preventing the development of ulnar neuritis after these injuries. The percentage of patients who developed ulnar nerve symptoms after surgical fixation was almost four times as high in those patients with transposition as compared with those without transposition (33% versus 9%). The lack of benefit of transposition was also seen in patients with medial implants.

The rate of ulnar nerve symptoms may be higher in those who underwent transposition for several reasons. Additional handling and devascularization of the nerve during transposition may result in nerve irritation. As well, iatrogenic compression may result from an overly tight transposition anteriorly or constriction of the nerve resulting from

TABLE 5. Additional Surgeries in the Nontransposition Group

	No. of Patients
Distal humerus nonunion repair	3
Distal humeral nounion repair, capsular release, hardware removal	1
Olecranon osteotomy nonunion repair	2
Hardware removal	5
Hardware removal, contracture release	4
Heterotopic ossification excision	4
Contracture release	2
Total elbow arthroplasty	2
Carpal tunnel release	1
Radial nerve graft (with subsequent tendon transfers)	1
Radial neurolysis	1
Incision/débridement	2

inadequate release of the medial intermuscular septum. An inadequate proximal release of the Arcade of Struthers can result in nerve compression during an anterior transposition, as was the case in one of our patients who required a neurolysis 2 weeks postoperatively.

There was no difference between the two groups with regard to sex, OTA classification, or whether medial plating or an olecranon osteotomy was performed. One major difference between the two groups was the number of additional surgeries. Twenty-seven (30%) of the nontransposition patients and seven (15%) of the transposition patients required at least one additional procedure. If anything, one would predict that the incidence of ulnar neuritis would be higher in the nontransposition group given the number of secondary surgeries and the accompanying risk for additional injury to the ulnar nerve.

Several limitations of our study deserve discussion. The nature of our review was accompanied by all of the biases inherent to a retrospective analysis. Selection bias may have been introduced by the surgeon's decision to perform a transposition. However, the decision to transpose was based on a best practice scenario. In addition, assessment of ulnar nerve pathology was qualitative, not quantitative. The incidence of ulnar neuritis in our study accounts for ulnar nerve symptoms at any time during the postoperative period but makes no statement about its clinical course. Furthermore, functional outcome was not assessed. Another limitation is the short duration of follow up in our study. However, the authors feel that 6 months would be adequate time to detect ulnar symptoms arising from the initial trauma and surgical intervention. The duration of time that it takes for ulnar neuritis to develop secondary to heterotopic bone, scar tissue, or prominent implants is unclear. In addition, the duration of follow up was significantly shorter for the transposition group.

In conclusion, ulnar nerve transposition at the time of ORIF of distal humerus fractures offered no benefit and in fact may place the patient at greater risk for neuritis. We do not recommend routine transposition of the ulnar nerve at the time of ORIF of distal humerus fractures.

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