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ORIGINAL ARTICLE

Open reduction and internal fixation for nonunion of extra-articular distal humeral fractures in patients 70 years and older

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Hypothesis: The study purpose was to report the clinical and radiologic outcomes of osteosynthesis by open reduction and internal fixation for nonunion of extra-articular distal humeral fractures in patients aged 70 years or older.

Materials and methods: This retrospective study included 28 patients who received osteosynthesis treatment between March 2010 and December 2015. Primary conservative treatment had failed in all patients. All surgical procedures were performed via the posterior approach without olecranon osteotomy and with the use of double-locking plates for each column.

Results: The mean patient age was 72 years, and surgical procedures were performed a mean of 7.6 months after injury. Preoperatively, extension-flexion was 32° to 101° and forearm pronation-supination was 74° to 47°. The mean visual analog scale score was 4; the mean Mayo Elbow Performance Score was 50; and the mean Disabilities of the Arm, Shoulder and Hand score was 58. All cases showed proper union after a mean of 5.2 months. At the final follow-up examination, the extension-flexion and rotation arcs had improved significantly (to 20° to 124° and to 80° to 66°, respectively; both $P < .001$), and all clinical scores were satisfactory (visual analog scale score, 1; Mayo Elbow Performance Score, 65; and Disabilities of the Arm, Shoulder and Hand score, 24; all $P < .001$). Ulnar nerve transposition was performed in 7 patients, and no distinct ulnar nerve symptom was observed in any patient at the final follow-up examination.

Conclusions: We consider osteosynthesis by open reduction and internal fixation as a recommended option for extra-articular distal humeral fractures in elderly patients aged 70 years or older in whom conservative treatment has failed.

Level of evidence: Level IV; Case Series; Treatment Study

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Keywords: Nonunion; osteosynthesis; extra-articular fractures; distal humerus; precontoured locking plate; elderly patients

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Distal humeral fractures in elderly patients range from extra-articular supracondylar or transcondylar fractures to comminuted intra-articular fractures, depending on the energy of the trauma. In this population, comminuted intra-articular fracture is increasingly considered an indication for total elbow

replacement. Since Cobb and Morrey⁶ introduced this approach in 1997, favorable early and midterm outcomes have been reported, and recent reports have confirmed the acceptability of functional outcomes and long-term survival of implants.^{10,11,14,15,21-23} Less comminuted fractures, such as intercondylar fractures, have been treated properly by precontoured anatomic locking, with promising early outcomes.^{12,18}

A few surgeons have attempted to conservatively treat relatively simple extra-articular distal humeral (EADH) fractures, such as those classified as A2 and A3 in the AO/OTA (*Arbeitsgemeinschaft für osteosynthesefragen*/Orthopaedic Trauma Association) system.¹⁹ However, we have encountered patients with nonunion of supracondylar fractures over several decades. Most of these nonunions after conservative treatment presented with the oligotrophic pattern and aggravated displacement. Furthermore, most of these patients experienced consistent pain during basic activities of daily living, as well as substantially reduced range of motion owing to prolonged immobilization with the aim of achieving union.

The common principle of open reduction and internal fixation (ORIF) and early motion exercise has been applied widely to elbow fractures, even those in elderly patients who may have medical comorbidities.^{17,25} Little evidence based on clinical outcomes supports the prioritization of conservative treatment over operative fixation for EADH fractures in elderly patients. In addition, precontoured locking plates have been available for a decade and provide sufficient stability to osteoporotic bone in elderly individuals. We report on the clinical and radiologic outcomes of osteosynthesis performed with double-locking plates for EADH fracture nonunion in patients aged 70 years or older.

Methods

Patient selection

This was a retrospective case series. All patients provided written informed consent before participation. Of 37 patients who had been diagnosed with EADH fracture nonunion at our institution, 31 underwent osteosynthesis between March 2010 and December 2015. Among these, 28 were included in this retrospective study.

The inclusion criteria were (1) age 70 years or older and living independently, (2) unilateral EADH (elbow) fracture, (3) receipt of operative treatment using a precontoured locking system, (4) availability of preoperative clinical and radiologic data, and (5) postoperative follow-up period of 2 years or more. Patients with the following characteristics were excluded: (1) EADH fracture in combination with any other injury in the ipsilateral arm (from finger to shoulder), including fracture and/or ligamentous injury; (2) presence of painful pathology in the ipsilateral upper extremity requiring medication or injection (eg, rotator cuff tear, shoulder stiffness, or arthritis in the hand) prior to elbow fracture; (3) presence of symptomatic neuropathy, confirmed by an electromyography or nerve conduction velocity study, in the ipsilateral upper extremity; (4) history of surgery in the ipsilateral arm; and (5) comorbidity related to neurologic deficiency, such as dementia, Parkinson disease, or stroke sequelae.

Demographic and clinical variables

We evaluated basic demographic and clinical characteristics, including age, sex, period of injury (from fracture to surgery), bone mineral density (BMD), and side of injury (dominant or nondominant arm). BMD was measured during general preoperative evaluation using dual-energy x-ray absorptiometry with Lunar Prodigy enCORE software (version 8.8; GE Medical Systems, Milwaukee, WI, USA). The lowest T score of the proximal femur and lumbar spine, excepting the score for the Ward area of the proximal femur, was recorded. We used the mean value of scores for the hip and spine in the analysis.

Preoperative radiologic evaluation

Traditional simple radiography and computed tomography were performed to assess general bone quality, degree of bone loss, type of nonunion, status of the joint surface, joint motion, and motion at the site of nonunion. According to the location of nonunion, 21 cases were defined as extra-articular extracapsular and 7 as extra-articular intracapsular. Nonunion was also classified according to Weber and Cech²⁶ as oligotrophic, atrophic, or hypertrophic nonunion.

Operative procedures

Sixteen patients underwent surgery while in the prone position under general anesthesia. The other 12 patients were treated while in the lateral decubitus position under a brachial plexus block. The anesthesiologist selected the method of anesthesia with consideration of each patient's medical condition. The posterior triceps-on (Alonso-Llames) approach was used in all patients. A posterior midline incision was made, and subfascial dissection was performed only in the tricipital compartment to reach the intermuscular septum. The inner and outer intermuscular septa were opened by blunt dissection, and the area of exposure between 2 para-olecranon incisions was enlarged to provide a sufficient field of view of the area of fibrous union. After exposure of the distal humerus, debridement of fibrous, inflammatory, and synovial tissue and resection of sclerotic bone surfaces were performed. When necessary, anterior arthrolysis was performed using a posterior approach to release the anterior capsule and retract soft tissues through the nonunion site before reduction and fixation of the lesion. Then, restoration of the length and continuity of both columns was confirmed. After fixation using the locking plate system, an iliac cancellous bone graft was applied in the debrided area. In patients under a brachial plexus block, demineralized bone matrix was infused. Two posterior plates (periarticular elbow locking plate system; Zimmer, Warsaw, IN, USA) were used in each of 12 patients, whereas 2 parallel bicolumn locking plates (3.5-mm LCP distal humerus plate; Synthes, West Chester, PA, USA) were used in each of 16 patients (Figs. 1 and 2). A wedge-shaped strut bone graft was used in 1 case of nonunion of a collapsed column (Fig. 3).

Evaluation of clinical outcomes

The range of elbow motion was checked, and the degree of pain was evaluated using a visual analog scale (VAS). Overall functional status was assessed using the Mayo Elbow Performance Score (MEPS) and the Disabilities of the Arm, Shoulder and Hand (DASH)

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