



# Intra-articular osteotomy for malunited articular fractures of the distal end of the humerus

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**Background:** The precarious anatomy of the articular surface of the distal humerus, as well as its meager subchondral bony support and limited soft-tissue attachments, presents enormous challenges for the operative correction of post-traumatic intra-articular deformities. This study presents 8 patients who underwent articular osteotomy with a mean follow-up period of 10.6 years, with an emphasis on functional, patient-rated, and radiographic outcomes.

**Methods:** Eight patients (mean age, 39 years; range, 17-60 years) were followed up for a mean period of 10.6 years. The original fracture was a type C variant in 4 patients, a type B unicondylar fracture in 2, and a type B articular shearing fracture in 2. The initial injury was treated operatively in 5 patients and non-operatively in 3. The osteotomy and reconstruction were performed on average 8 months after injury (range, 6-11 months). The mean preoperative elbow arc of motion was 37°. Two patients had ulnar nerve dysfunction.

**Results:** All the osteotomies healed after the index procedure without evidence of avascular necrosis. Two patients required a second procedure for stiffness. At follow-up, the mean arc of elbow motion improved to 104° ( $P = .001$ ), with a mean flexion contracture of 26°. The mean Disabilities of the Arm, Shoulder and Hand score at follow-up was 13 (range, 1-37); the mean patient satisfaction rating on a Likert scale (from 0 to 10) was 9.1; and the mean Mayo Elbow Performance Index score was 83 points (range, 70-100 points). Grade II osteoarthritic changes were seen in 3 patients, grade I in 3, and grade 0 in 2.

**Conclusions:** In selected patients with a defined intra-articular malunion, the results of our experience support corrective osteotomy.

**Level of evidence:** Level IV, Case Series, Treatment Study.

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**Keywords:** Distal humeral fracture; malunion; outcomes; fracture fixation; elbow; intra-articular fracture; shear fracture

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The precarious structural anatomy of the articular surface of the distal humerus, as well as its limited soft-tissue attachments, creates a serious technical challenge when one is considering corrective osteotomy of an intra-articular malunion after fracture. The problem may be further compounded by associated soft-tissue contracture, failed

**Table I** Summary of patient data

Patient No.	Age at injury (y)	Pattern of malunion	Preoperative motion (°)		Follow-up (y)	Postoperative motion (°)		Arthritis grade	Mayo score	DASH score	Likert score	Complications
			Extension	Flexion		Extension	Flexion					
1	60	Articular and metaphyseal	45	75	7.5	10	130	I	85	37	8	None
2	17	Articular and metaphyseal	60	65	7.5	15	140	I	85	1	10	Stiffness
3	44	Articular shear	45	80	4	35	120	0	100	3	10	Stiffness
4	33	Partial articular and 1 column	40	135	2	10	140	0	85	3	10	None
5	43	Articular and metaphyseal	60	80	16	70	125	II	70	35	6	Stiffness
6	48	Articular and metaphyseal	50	80	18	35	120	II	80	18	10	None
7	47	Partial articular and 1 column	30	110	12	35	135	II	85	8	9	None
8	18	Articular shear	80	80	18	0	130	I	100	2	10	None

DASH, Disabilities of the Arm, Shoulder and Hand.

internal fixation, and/or ulnar nerve dysfunction.<sup>6,10,12,18,19</sup> Corrective osteotomy carries the risks of avascular necrosis and subsequent arthrosis. Unfortunately, given the uncommon nature of this problem, there is a relative paucity of published surgical experience.<sup>3,5,7,9</sup>

To best address these concerns, we have chosen to review a cohort of 8 patients who underwent corrective osteotomy of a malunited intra-articular fracture with a mean follow-up period of 10.6 years.

## Materials and methods

This is a retrospective case-control study of 8 patients who presented with functional disability associated with a malunited intra-articular fracture of the distal end of the humerus and were treated with corrective osteotomy by 2 surgeons between 1992 and 2011 (Table I). The patients were invited to return for a physical examination and radiographic evaluation under a protocol approved by the human research committees of both authors' institutions. Informed consent was obtained from each patient. Evaluations were performed by independent examiners for the purposes of this study.

The indications for deformity correction included the degree of disability involving the upper limb, a deformity that was well delineated on both standard radiographs and computed tomography, and the absence of advanced articular loss or arthrosis.

The study group included 5 women and 3 men with a mean age at the time of surgery of 39 years (range, 18-60 years). The left arm was involved in 6 patients (5 of whom were right hand dominant) and the right arm in 2 (1 of whom was right hand dominant). The initial injury was the result of a fall from a standing height in 4 patients, a sporting event in 3 patients, and a fall from a horse in 1 patient whose fracture was open and contaminated. The original fracture involved both articular and

metaphyseal bony columns (AO type C) in 4 patients, a partial articular fracture and 1 metaphyseal bony column (AO type B) in 2 patients, and a complete articular shearing fracture (AO subtype B3.3) in 2 patients. Two patients were previously reported on but were included because of the unique opportunity to observe their outcomes 16 and 18 years after osteotomy<sup>10</sup> (cases 5 and 6). The original fracture was treated operatively in 5 patients and non-operatively in 3. The operative treatment included plates and screws in 3 patients, Kirschner wires alone in 1, and external fixation alone in 1. In the one patient with an open fracture, extensive polymicrobial infection developed, necessitating multiple debridements and loss of subchondral and distal metaphyseal-diaphyseal bone, resulting in an intra-articular malunion.

The mean preoperative elbow arc of motion was 37° (range, 0°-95°). Two of the eight patients presented with ulnar nerve dysfunction involving both motor and sensory deficits.

## Operative technique

The location and type of osteotomy and internal fixation were specific to the unique morphologic characteristics of each deformity. The surgical corrections were performed on average 8 months after injury (range, 6-11 months).

In the 2 patients with a malunited articular shearing fracture (cases 3 and 8), the deformity was exposed through an extended lateral approach, which has been described for the management of coronal shear fractures.<sup>11</sup> This approach also permitted excision of the contracted anterior and/or posterior capsules. The osteotomy was created through the original fracture line by use of a thin-bladed osteotome, followed by realignment of the articular fragment to its original anatomic position. Provisional fixation was obtained with smooth Kirschner wires. Stable internal fixation was achieved with headless screws placed from anterior to posterior. A small amount of autogenous bone graft was placed beneath the fragment that had undergone osteotomy to fill incongruities of the joint reconstruction and aid in union (Fig. 1). In case 3, the graft

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