

Distal Humerus Nonunion After Failed Internal Fixation: Reconstruction With Total Elbow Arthroplasty

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ABSTRACT

In nonunion after distal humerus fracture, osteoporosis, devascularized fracture fragments, and periarticular fibrosis limit potential reconstructive options.

We assessed pain relief, functional gains, and complications in 12 patients whose long-standing, painful nonunions after previous treatment with rigid internal fixation were reconstructed with a semiconstrained total elbow arthroplasty, frequently with a triceps-sparing approach and anterior ulnar nerve transposition.

At mean follow-up of 63 months, 11 patients had good pain relief and a good or excellent functional result: mean flexion/extension, 134° to 18°; mean total arc of motion, 117°; mean pronation/supination, 74° to 69°.

Despite the 75% rate of complications (8), semiconstrained total elbow arthroplasty provides a viable treatment for this difficult problem.

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Nonunion occurs in 2% to 5% of distal humerus fractures.¹ The condition is difficult to treat, and no single treatment modality has a high success rate with few complications.²⁻⁶ Without intervention, the patient is left with a painful, unstable, and often flail extremity and with limitations in activities of daily living. Frequently, there is an associated ulnar neuropathy. Osteoporosis, devascularized fracture fragments, and periarticular fibrosis limit potential reconstructive options for long-standing distal humerus nonunions.

Current treatment modalities for distal humerus nonunion include bracing and mobilization, open reduction and internal fixation with bone graft, resection arthroplasty, allograft, arthrodesis, and total elbow arthroplasty (TEA). Each has its disadvantages. In 2 studies,^{2,6} secondary osteosynthesis was associated with an unsatisfactory result more than 50% of the time; in a more recent study, 5 (71%) of 7 patients with nonunion had a good or excellent result with autologous bone graft, stable fixation, and capsulectomy.⁵ Resection arthroplasty leaves the patient with a flail extremity that may still require splinting. For some patients with substantial bone loss, osteoarticular allografts are a salvage option, but the complication rate (infection, instability, graft resorption) is high, and results usually are poor.^{7,8} Elbow arthrodesis is technically difficult, has a high complication rate, and is associated with a low patient satisfaction rate.⁹

Because of such high complication rates, prosthetic replacement of the elbow provides a more appeal-

ing treatment option. In the 1980s, TEA for nonunion with tightly constrained or custom prostheses had fair to moderately good results but high complication rates (4/7, 57%; 5/14, 36%¹⁰). According to a recent review,¹¹ however, 31 (86%) of 36 patients had a satisfactory result with a semiconstrained prosthesis, and only 7 (19%) of the 36 patients had complications.

In the current study, we assessed outcomes (complications, symptoms, function) after semiconstrained TEA for long-standing distal humerus nonunions.

MATERIALS AND METHODS

Patient Population

With the approval of the institutional review board, we retrospectively reviewed one institution's patient database to identify patients who, between 1989 and 1997, had been treated with a semiconstrained TEA for painful, long-standing (>14 months) distal humerus fracture nonunion. We excluded patients with painless nonunion, patients with nonunions treated initially with arthroplasty, and patients treated with arthroplasty for an indication other than nonunion.

We identified 12 consecutive patients who met the study criteria. All 12 distal humerus fractures had been treated initially with rigid internal fixation. Mean age of the 4 male and 8 female patients at the time of arthroplasty was 61 years (range, 36-81 years), mean duration of nonunion was 28 months (range, 14-96 months), and mean number of additional surgeries after the initial intervention was 2 (range, 1-5).

Table. Patient Data

Patient No.	Age at Surgery (y)	Follow-Up (mo)	Arc of Motion (°)					Elbow		Repeat Surgery
			Flexion	Extension	Total	Pronation	Supination	Score	Complication	
1	51	94	150	0	150	80	80	100	None	No
2	36	83	130	-15	115	75	75	80	Ulnar neuropathy	No
3	71	40	140	0	140	75	75	90	None	No
4	59	64	130	-20	110	75	60	75	Olecranon fracture	No
5	61	61	140	-10	130	76	75	90	Superficial infection	No
6	63	56	130	-25	105	70	65	75	Triceps weakness	No
7	62	43	120	-40	80	60	55	57	Deep infection	No
8	59	86	145	-10	135	78	80	90	None	No
9	62	70	133	-18	115	75	70	80	Ulnar neuropathy	Ulnar nerve transposition
10	64	62	130	-30	100	70	60	70	Triceps avulsion	Triceps repair
11	81	36	135	-15	120	78	70	85	Triceps weakness	No
12	60	63	130	-30	100	70	68	70	Ulnar neuropathy	No
Means	61	63	134	-18	117	74	69	80		

Procedures

The TEA technique was well described by Morrey and Adams¹¹ and Morrey and colleagues¹² and is addressed only briefly here. We used a standard posterior exposure, exploiting old incisions when possible, and the Bryan-Morrey triceps-sparing exposure¹³ in 8 cases. Complex skeletal deformities, often encountered, necessitated minor modifications. In 9 cases, release with anterior transposition of the ulnar nerve was performed. Cultures were obtained to rule out infected nonunion.

Patients were assessed for subjective pain relief and functional gains at 6 weeks, 3 months, 6 months, and yearly thereafter. Postoperative ROM was quantified, and in all cases radiographs were reviewed for evidence of loosening. For each patient, a postoperative performance index, or elbow score, was calculated using the method described by Morrey and Adams.¹¹

Mean follow-up after TEA was 63 months (range, 36-94 months). ROM and performance index were determined at 2-year follow-up.

The 9 postoperative complications were ulnar neuropathy (3 cases), triceps weakness (2), triceps avulsion (1), olecranon fracture (1), superficial infection (1), and deep infection (1). All extensor mechanism complications (triceps weakness, triceps avulsion) occurred in patients with previous olecranon osteotomies. Two patients required additional surgery (1 triceps repair and 1 ulnar nerve transposition). The other 2 patients with ulnar neuropathy had resolution of their paresthesias in less than 6 months. The patient with deep infection elected to use suppressive antibiotics.

“...we agree that a complete release and transposition of the ulnar nerve should be considered in the treatment of any distal humerus nonunion.”

In all patients, a semiconstrained Coonrad-Morrey prosthesis (Zimmer, Warsaw, Ind) was set in place with third-generation cement, often containing antibiotics. Care was taken to achieve a good cement mantle. Wounds were closed over suction drains, and long-arm splints positioned over the extremity in 90° of flexion remained in place for 10 days.

Postoperative Care and Assessment

Patients were discharged home between postoperative days 2 and 4. Active range of motion (ROM) was initiated 1 week after surgery in patients treated with a triceps-sparing approach. Supervised therapy was not required.

RESULTS

After semiconstrained TEA for long-standing distal humerus nonunions in these 12 patients, flexion averaged 134° (range, 120°-150°) to 18° (range, 0°-40°) of extension, and pronation averaged 74° (range, 60°-80°) to 69° (range, 55°-80°) of supination. Mean total arc of motion was 117°; 11 of 12 patients had a functional total arc of motion (≥100°). Mean performance index (elbow score) was 80 points (range, 57-100 points; Table). Based on joint function and pain, this index has 100 points assigned to the areas of motion (40), pain (35), strength (20), and stability (5).

There was evidence of radiographic lucency around the humeral implants in 3 patients at 36-month follow-up. One implant was clearly infected (same patient just described). The other 2 had asymptomatic lucency around the cement mantle on the humeral and ulnar sides and continued to be monitored radiographically each year.

At final follow-up, 7 of the 12 patients reported no pain (Figure), 4 had occasional pain with activity, and 1 had a painful, infected arthroplasty. All but the patient with the infected arthroplasty believed the procedure had provided excellent pain relief and substantial functional gains.

DISCUSSION

Nonunion of a distal humerus fracture is uncommon and difficult to manage. The condition is compounded by the presence of poor bone stock, osteoporotic bone, or both, as often is found in the elderly. In our study, 92% of patients achieved satisfactory pain resolution and functional ROM after reconstruction with semiconstrained TEA for a long-standing distal humerus nonunion.

Several case series and treatment modalities have been reported.^{2-6,11,14,15} In 2 early studies^{2,6} on the use of osteosynthesis for nonunion, less than 50% of patients had a satisfactory result. Of the 25 patients reviewed by Mitsunaga and colleagues,⁶ 27% required 1 and sometimes 2 additional procedures to achieve union, and 25% had complications; ROM at final follow-up was 71°, an increase of only 9° in arc of motion. Ackerman and Jupiter² reported that, of 20 patients with nonunion, only 7 (35%) had a good or excellent result, whereas 13 (65%) had a fair or poor result.

In 1994, McKee and Jupiter⁵ reported on 13 patients (5 with distal humerus nonunion, 2 with nonunion and malunion, 6 with malunion only)

treated with extensile exposure, mobilization and transposition of the ulnar nerve, external neurolysis of the ulnar nerve, anterior and posterior capsulectomy, reconstruction of intra-articular defects, rigid internal fixation, iliac crest bone grafting, and postoperative early motion. Mean increase in arc of motion was 45°, and all patients achieved union. Of the 7 patients who originally had nonunion, 5 (71%) had good to excellent results, and 2 (29%) had fair results. Because all 9 patients with ulnar neuropathy showed some improvement after surgery, the need to expose and protect the ulnar nerve is clear. None of the patients experienced early complications; late complications were not addressed.

Jupiter and Goodman⁴ and McKee and Jupiter⁵ emphasized the importance and vulnerability of the ulnar nerve in distal humerus nonunion. Our results were similar to theirs, and we agree that a complete release and transposition of the ulnar nerve should be considered in the treatment of any distal humerus nonunion.^{3,11}

The poor to moderate results seen with osteosynthesis—persistent pain, limited motion, need for additional surgery—make TEA an appealing

option, especially for low-demand elderly patients with or without sufficient bone stock.¹¹ For the 36-year-old patient included in the current study, the decision to proceed with TEA was based on poor bone stock and the patient's vocational/avocational interests, which did not require lifting. Mitsunaga and colleagues⁶ used first-generation constrained TEA for 7 patients with nonunion and indicated that all had good pain relief and increased ROM. Two patients, 1 with heterotopic ossification and 1 with radial nerve palsy, had component loosening and required revision. In the series of 14 TEAs for distal humerus nonunion reported by Figgie and colleagues,¹⁰ 8 (57%) of 14 patients had excellent pain relief, and their mean ROM was 100°. However, 5 (36%) of the 14 patients had 7 major complications, the infection rate was 7% (1/14), and the failure rate was 21% (3/14).

Morrey and Adams¹¹ reviewed, at 50-month follow-up, 36 patients treated with semiconstrained TEA for distal humerus nonunion, 31 (86%) of whom had satisfactory results. Arc of motion improved from 72° before surgery to 111° after surgery. Seven

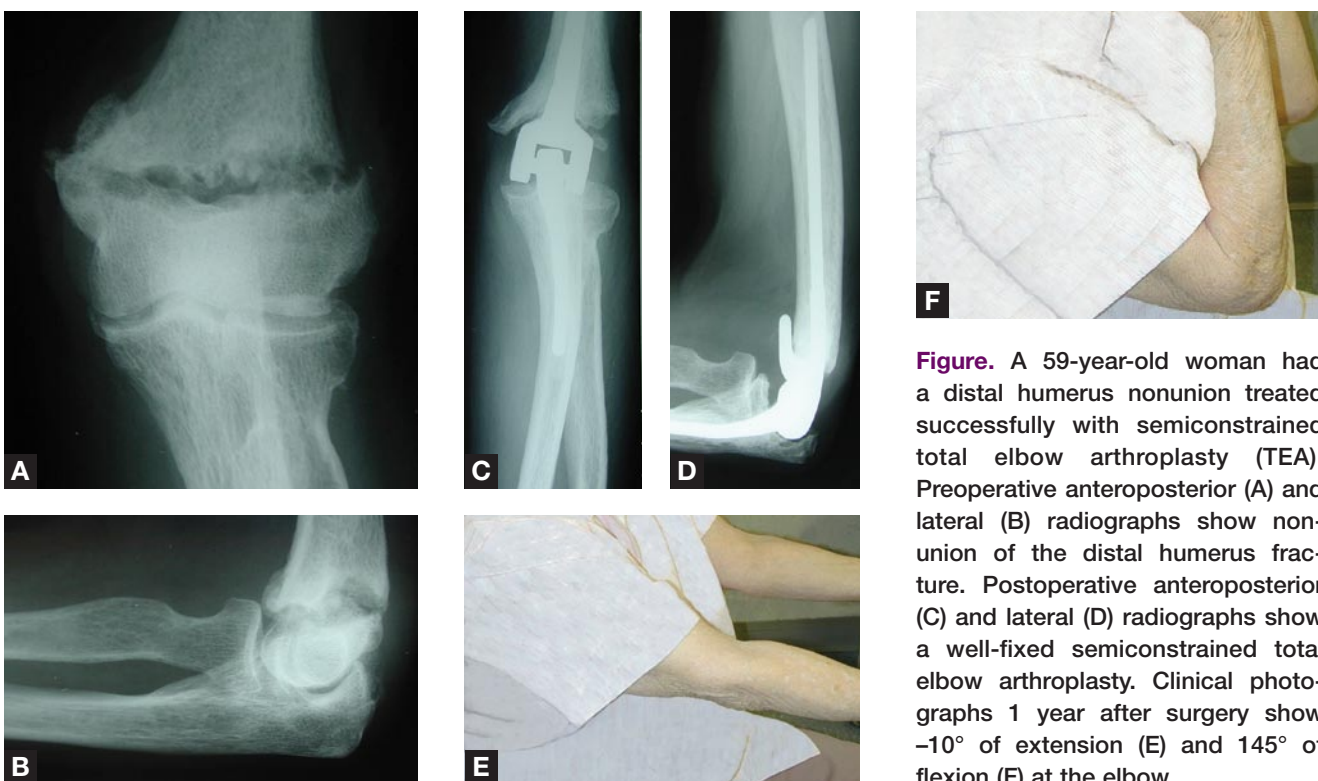


Figure. A 59-year-old woman had a distal humerus nonunion treated successfully with semiconstrained total elbow arthroplasty (TEA). Preoperative anteroposterior (A) and lateral (B) radiographs show nonunion of the distal humerus fracture. Postoperative anteroposterior (C) and lateral (D) radiographs show a well-fixed semiconstrained total elbow arthroplasty. Clinical photographs 1 year after surgery show -10° of extension (E) and 145° of flexion (F) at the elbow.

(19%) of the 36 patients had complications: deep infection (2), particulate synovitis (2), transient ulnar neuropathy (2), and worn polyethylene bushing (1). Five (71%) of those 7 (or 14% of the total group) required another operation.

In our series, 11 (92%) of 12 patients had satisfactory results and regained functional ROM. However, the complication rate was high (75%, 9/12), and 3 complications affected the extensor mechanism after olecranon osteotomy. Two (17%) of the 12 patients required additional surgery. Our findings may indicate a need to release and transpose the ulnar nerve, and they support using a triceps-sparing exposure during initial osteosynthesis.

TEA is usually reserved for patients older than 60 but can be appropriate in low-demand younger patients.¹⁶ Rapid recovery after TEA, especially with a triceps-sparing approach that allows immediate active joint motion, is of particular benefit to elderly patients. Despite the relatively high complication rate, relief from nonunion pain appears to be more reliable after TEA than after osteosynthesis.^{3-5,8} Because

of concerns about mechanical loosening and prosthesis durability and longevity, osteosynthesis with capsular release is still recommended for most patients younger than 60.⁴ For patients older than 60, we recommend TEA with a triceps-sparing approach and particular care in releasing and transposing the ulnar nerve.

AUTHORS' DISCLOSURE STATEMENT

The authors report no actual or potential conflict of interest in relation to this article.

REFERENCES

1. Sim FH, Morrey BF. Nonunion and delayed union of distal humeral fractures. In: Morrey BF, ed. *The Elbow and Its Disorders*. 2nd ed. Philadelphia, PA: Saunders; 1993:367-382.
2. Ackerman G, Jupiter JB. Non-union of fractures of the distal end of the humerus. *J Bone Joint Surg Am*. 1988;70(1):75-83.
3. Gallay SH, McKee MD. Operative treatment of nonunions about the elbow. *Clin Orthop Relat Res*. 2000;(370):87-101.
4. Jupiter JB, Goodman LJ. The management of complex distal humerus nonunion in the elderly by elbow capsulectomy, triple plating, and ulnar nerve neurolysis. *J Shoulder Elbow Surg*. 1992;1(1):37-46.
5. McKee MD, Jupiter JB. A contemporary approach to the management of complex fractures of the distal humerus and their

6. Mitsunaga MM, Bryan RS, Linscheid RL. Condylar nonunions of the elbow. *J Trauma*. 1982;22(9):787-791.
7. Dean GS, Holliger EH 4th, Urbaniak JR. Elbow allograft for reconstruction of the elbow with massive bone loss. Long term results. *Clin Orthop Relat Res*. 1997;(341):12-22.
8. Urbaniak JR, Aitken M. Clinical use of bone allografts in the elbow. *Orthop Clin North Am*. 1987;18(2):311-321.
9. Koch M, Lipscomb PR. Arthrodesis of the elbow. *Clin Orthop Relat Res*. 1967;(50):151-157.
10. Figgie MP, Inglis AE, Mow CS, Figgie HE 3rd. Salvage of non-union of supracondylar fracture of the humerus by total elbow arthroplasty. *J Bone Joint Surg Am*. 1989;71(7):1058-1065.
11. Morrey BF, Adams RA. Semiconstrained elbow replacement for distal humeral nonunion. *J Bone Joint Surg Br*. 1995;77(1):67-72.
12. Morrey BF, Bryan RS, Dobyms JH, Linscheid RL. Total elbow arthroplasty. A five-year experience at the Mayo Clinic. *J Bone Joint Surg Am*. 1981;63(7):1050-1063.
13. Bryan RS, Morrey BF. Extensive posterior exposure of the elbow. A triceps-sparing approach. *Clin Orthop Relat Res*. 1982;(166):188-192.
14. Graham TJ, Jacobson PA. Total elbow arthroplasty: a solution for complex nonunions and malunions about the elbow. *Semin Arthroplasty*. 1998;9(1):56-67.
15. Obrebskey WT, Bhandari M, Dirschl DR, Shemitsch E. Internal fixation versus arthroplasty of comminuted fractures of the distal humerus. *J Orthop Trauma*. 2003;17(6):463-465.
16. Morrey BF, Adams RA, Bryan RS. Total replacement for post-traumatic arthritis of the elbow. *J Bone Joint Surg Br*. 1991;73(4):607-612.

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