



## Linked total elbow arthroplasty as treatment of distal humerus nonunions in patients older than 70 years

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**Treatment of distal humerus nonunions may be challenging, especially in the elderly patient. Total elbow replacement has been proposed as an option in selected patients, but a high index of complications has been reported. We present the results of a linked elbow replacement in six patients older than 70 years with a symptomatic nonunion of the distal humerus. At a mean follow-up of 40 months, average range of motion was from 15° to 125° of flexion-extension. Only one patient had moderate pain in the elbow, but all six were satisfied with the results of the operation. The arthroplasty allowed all patients to do basic tasks of daily living activities. Our results are encouraging, and show that linked elbow replacement is a good option in elderly patients with symptomatic nonunions of the distal humerus. Appropriate selection of ideal candidates for this procedure is a key factor in reducing the risk of complications.**

**Keywords :** elbow arthroplasty ; nonunion ; distal humerus.

### INTRODUCTION

Non-union of a fracture of the distal end of the humerus is one of the most challenging complications in elbow trauma. The reported incidence of non-union after the treatment of distal humerus fractures ranges between 2 and 10% (1). Although some patients can be pain free and may not require treatment, the majority present with marked instability, pain and profound functional disability.

Good results have been reported with rigid internal fixation, iliac crest bone graft and capsular release in young patients (5-8,13). However, these fractures often occur in elderly patients with osteopenic bone with poor osteogenic potential and small bony fragments difficult to stabilize. Moreover, there is always some degree of soft tissue damage and fibrosis, increasing the stress at the site of the nonunion. Under these circumstances, the results of internal fixation have been disappointing (1,6,8).

Although satisfactory results have been reported by several authors with the use of an elbow replacement as a salvage procedure for distal humerus nonunions, a high rate of complications has been documented (3,4,9,10).

The purpose of this study is to present the results and complication rate of a linked elbow replacement

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in a selected group of patients older than 70 years with nonunion of the distal humerus.

## MATERIAL AND METHODS

### Patient Data

We studied 6 patients older than 70 years with a nonunion of the distal humerus treated by joint replacement. All patients had a complete preoperative clinical evaluation, operative records, and a minimum follow-up of 2 years (mean, 40 months; range, 24-63 months) (Table I).

There were five women and one man, whose ages ranged from 71 to 84 years (mean, 80 years). The dominant extremity was involved in four of the six cases. The mechanism of the initial injury was a fall from standing height in all patients. Three patients had been treated conservatively at the time of the initial injury, two patients had undergone a previous failed attempt to reconstruct the fracture, and one patient had two previous operations. According to the classification system described by Mitsunaga *et al* (9), five nonunions were intercondylar and one was supracondylar.

The patients had various presenting symptoms but the most common were pain associated with instability or with loss of motion. The average time from the initial injury to the time the patient underwent elbow replacement was 22 months (range, 6-60 months).

### Operative Technique

With the patient supine on the operating table, a tourniquet was applied and the arm was brought across the chest. A posterior skin incision is preferred but if an incision was previously used to fix the fracture, this scar was reopened. The ulnar nerve was identified, dissected, and protected throughout the operation.

According to the technique previously described by Morrey and Adams (10), the triceps tendon was left intact in all cases (Fig. 1). The fractured fragments and hardware were removed from the medial and lateral aspect of the distal humerus through the paratricipital approach described by Alonso Llamas (2). Once the distal humerus was removed, excellent exposure of the humeral canal could be obtained through either side of the triceps. The ulnar notch was exposed by rotating the forearm, usually from a lateral to a medial direction.

In all patients a cemented linked elbow implant was used (Coonrad-Morrey total elbow prosthesis, Zimmer,



**Fig. 1.** — The Alonso Llamas approach allows preservation of the triceps attachment and favors prompt recovery of active elbow extension.

Warsaw, Ind., USA) (Fig. 2). Four patients underwent subcutaneous transposition of the ulnar nerve. In the two patients with a previous transposition at the time of initial fracture fixation, the nerve was identified at the triceps and its path followed, but no further dissection was carried out distally because there were no preoperative symptoms of nerve irritation.

Postoperatively, the arm was placed in a plaster with the elbow extended and elevated for 24-48 hours. Once the immobilization was removed, the patients were allowed to use their arms freely, with the only limitation of avoiding heavy weight lifting with the operated arm.

### Clinical Review

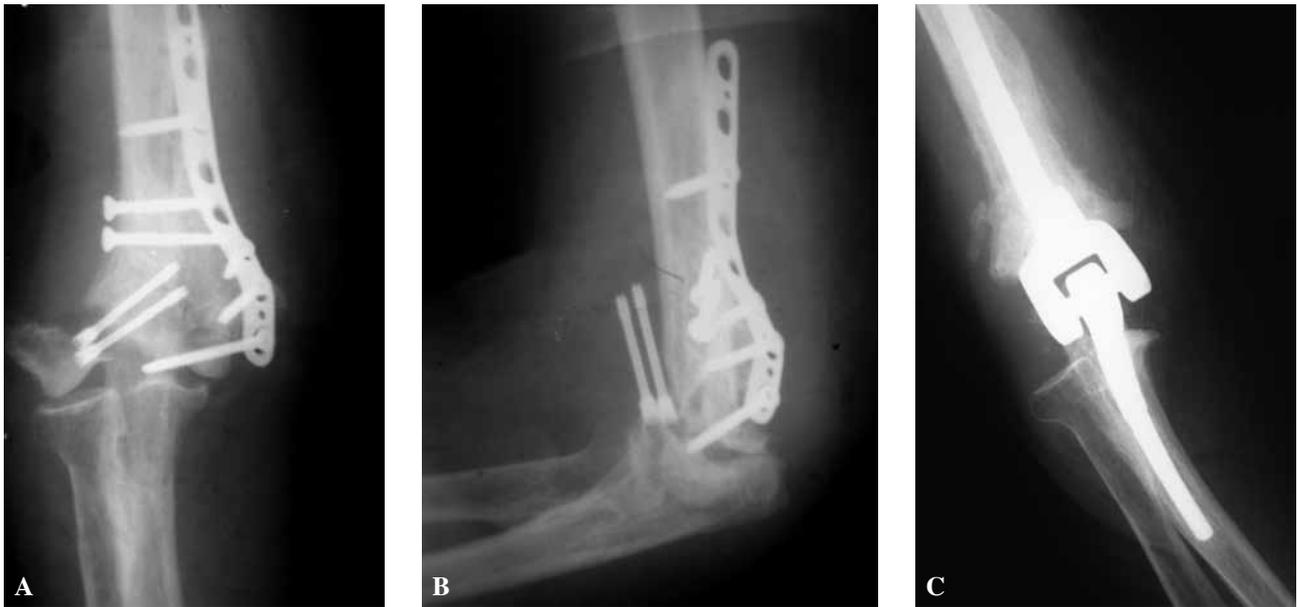
Our Institutional Review Boards approved a review of the medical records and an invitation to patients to return for evaluation. All patients were contacted and returned to our hospitals for an interview, physical examination, and radiographic evaluation.

The outcome assessment included the Disabilities of the Arm, Shoulder, and Hand questionnaire (DASH) which is a validated thirty item self-reported outcome instrument which assesses symptoms and physical function in patients with upper extremity musculoskeletal disorders. The score is scaled between 0 and 100, with higher scores indicating worse upper-extremity disability.

Elbow pain was graded as absent, mild (only with activity, no need for medication), moderate (with and after any activity), or severe (pain at rest, need of constant medication). Additional information was collected

Table I. — Clinical and radiographic outcome of the patients

Case	Age (yrs.)	Nonunion Type	Treatment of acute Fx	Follow up (months)	Flexion Preop-Postop. (degrees)	Extension Preop-Postop (degrees)	Elbow Pain	Ulnar nerve symptoms	Rx Lucent lines	Patient Satisfaction	DASH.	MEPS.	Complications
1	82	Intercondylar	ORIF	36.00	50/130	15 /20	None	0	none	Very Satisfied	18	100	
2	74	Intercondylar	Conservative	36.00	115/130	25/0	None	0	Type-1 humerus	Very Satisfied	40	100	Skin Necrosis
3	71	Intercondylar	2 ORIF	63.00	110/120	90/30	None	0	None	Very Satisfied	7	95	
4	84	Intercondylar	ORIF	56.00	105/120	60/20	Moderate	0	None	Satisfied	68	50	
5	84	Intercondylar	Conservative	24.00	120/130	35/10	Mild	0	Type-1 humerus	Satisfied	69	70	
6	84	Supracondylar	Conservative	24.00	125/120	35/10	Mild	Mild	None	Satisfied	69	75	



**Fig. 2.** — A-B. Preoperative anteroposterior and lateral radiographs of case 3. This patient had been operated two times before the elbow replacement ; C-D. 5 years after the procedure, the implant was stable, without lucent lines and good healing of the bone graft.



regarding the presence of ulnar nerve symptoms. A visual analogue scale (VAS) was used for the assessment of patient satisfaction. Patients were also asked to give a verbal categorical rating of their degree of satisfaction as very satisfied, satisfied, and unsatisfied.

Physical examination included measurement of the range of motion of the elbow and forearm. Flexion and extension were measured with the forearm in neutral rotation, and pronation and supination with the elbow at 90°.

With the information collected from the interview and the physical examination, a physician-based scoring system was used to define the results. The elbows were evaluated with the Mayo Elbow Performance Score (10) for pain (maximum score, 45 points), motion (maximum score, 20 points), stability (maximum score, 10 points), and daily functional activities (maximum score, 25 points). A score of 90 to 100 points was defined as an excellent result ; 75 to 89 points, as a good result ; 60 to 74 points, as a fair result ; and less than 60 points, as a poor result. A result was considered satisfactory if an excellent or good rating was attained.

### Radiographic Review

At the time of the most recent follow-up examination, plain anteroposterior and lateral radiographs of the elbow were taken in all patients. They were evaluated for evidence of radiolucent lines, migration of components, and incorporation of the anterior bone graft.

Implant loosening was assessed on radiographs and was graded on a scale of 0 to 4, as previously described (12). Type 0 indicates a radiolucent line that is < 1 mm thick and involves < 50% of the interface ; type 1 is a radiolucent line that is 1 mm thick and involves < 50% of the interface ; type 2 is a radiolucent line that

is > 1 mm thick and involves > 50% of the interface ; type 3 is a radiolucent line that is > 2 mm thick and involves the whole interface ; and type 4 is gross loosening with migration of components.

## RESULTS

### Subjective outcome

All six patients had moderate or severe pain in the elbow before surgery. At the most recent follow up, 3 patients had no pain, 2 had mild pain only after unusual activities, and 1 had moderate pain (Table I). One patient complained of ulnar nerve irritation which was only occasional and mild. None of the six patients sought further treatment for neurological problems.

The mean satisfaction score on the VAS was 8.4 (range, 10 to 6). According to patients' own assessments, 3 patients (50 percent) said that they were very satisfied with the result of the operation and 3 (50 percent) were satisfied. The DASH score at the time of the latest examination averaged 45 points (range, 7 to 69).

### Objective outcome

One patient had a problem with wound healing two months after the operation, when a necrotic ulcer of the thin skin over the olecranon process developed. She was treated with debridement and a fasciocutaneous flap to cover the skin defect. The flap healed uneventfully and no further treatment was required.

The average arc of motion prior to the arthroplasty was 43° (range, 15 to 90°) of extension to 104° (range, 50 to 125°) of flexion. At the latest follow-up examination, the mean range of motion was from 15° of extension (range, 0 to 30°) to 125° of flexion (range, 120 to 130°), with a mean total arc of 110° (range, 90 to 130°) (Fig. 3). Five elbows had a functional arc of flexion-extension (30 to 130°) at the time of the latest follow-up (11). At the latest follow-up evaluation, they had a mean of 77° of pronation (range, 70 to 90) and 80° of supination (range, 70 to 90).



**Fig. 3.** — A-B. Flexion-extension arc of case 3. This patient had a MEPS of 95, and was very satisfied with the results of the operation.

The mean MEPS was 82 points (range, 50-100). The result was excellent for three elbows, good for one, and fair for two. Thus, based on the objective score, four elbows (67%) had a satisfactory result and two (33%) had an unsatisfactory result.

### Radiographic Analysis

None of the six elbows had radiographic evidence of loosening. Type-1 radiolucent lines were evident only in two humeral components. Incorporation of the bone graft between the anterior prosthetic flange and the distal humeral cortex was seen radiographically in all elbows.

## DISCUSSION

Distal humerus nonunions represent one of the most difficult problems in elbow surgery. When they present in young patients, rigid internal fixation with new techniques and bone grafting is the procedure of choice and good results have been reported when the joint surface is not severely damaged (6,7). However, bone healing is more difficult to achieve in the elderly patient with poor bone quality and small fragments.

The use of a highly constrained elbow replacement as a salvage procedure in complex distal humerus nonunions was first reported by Mitsunaga *et al* (9) in seven patients. Two patients in this series developed aseptic loosening and the authors discouraged the use of this type of arthroplasty for this specific indication. Figgie *et al* (4) reported the results of several different implants in 14 distal humerus nonunions. Overall, the majority of patients were satisfied, but there was a high index of complications, many of them requiring further surgery.

Surprisingly, there are only two previous reports available in the literature of distal humerus nonunions treated with a linked semiconstrained arthroplasty, and both studies were performed at the same institution. Cil *et al* (3) recently reported the results of the Coonrad-Morrey elbow replacement in 92 elbows (91 patients) with a symptomatic distal humerus nonunion treated over a period of 21 years. Although 74% of their patients had no pain or mild pain in the elbow after a mean follow up of 6.5 years, almost half of them (40 elbows) had a complication, 32 requiring a reoperation. Only 39 of the 91 patients included in the study were older than seventy years at the time of surgery. The results were significantly worse in young patients, with aseptic loosening, component fracture and infection being the most common reasons for failure. From the data available in this study, one could conclude that elbow replacement should probably not be used in patients younger than 70 years, especially if the fracture had been treated operatively with an increased risk for infection.

Our approach for distal humerus nonunions is based on patient's age, quality of bone and history of previous infection. It is our preference to pursue

bone healing with parallel plating, supracondylar compression and bone grafting in the great majority of elbows when they have acceptable bone quality despite patient's age (14). Likewise, if there is a history of infection after previous surgical treatment of the fracture or we suspect that there is an increased risk for infection due to poor soft tissue coverage, we tend to perform rigid internal fixation after debridement and medical treatment of the infection or after achieving adequate tissue coverage. We reserve elbow replacement for elderly patients with osteopenic bone, severely damaged joint surface or bone loss. Under these circumstances, achieving a functionally mobile and painless elbow with internal fixation is very unpredictable.

The results of elbow arthroplasty in our selected group of patients with distal humerus nonunions are encouraging. Our patients were highly satisfied with the outcome of the operation and the majority achieved a functional range of motion. We did not find any major complication and none of our patients had evidence of radiographic loosening. Our results compare favorably with previous reports and support the idea of limiting the indication of this procedure to elderly patients with no history of infection.

Several factors may be involved in the success of this procedure. Preservation of the extensor mechanism is one key factor in regaining early range of motion and avoiding postoperative weakness of the triceps. The Alonso Llamas approach allows implantation of both components with limited dissection, reducing the risk of infection. Elderly patients require limited use of the arm and do not place the elbow at high risk for mechanical loosening or bushing wear. Finally, implantation of an elbow replacement in the setting of a distal humerus nonunion is technically easier and faster than any reconstructive procedure aimed at achieving bone healing with joint preservation.

In conclusion, elderly patients with distal humerus nonunions and extensive articular comminution benefit from a linked semiconstrained joint replacement. Younger patients, patients with adequate bone quality and patients with a history of infection may be better treated with a joint preserving procedure.

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