Citations Classics Shoulder & Elbow

Total Elbow Arthroplasty

Samuel Fuller, MD PGY2
Bradley Hawayek, MD PGY4
Teja Polisetty, MD PGY1
Matthew Corsi, MS4
Jalen Warren, MS4
Alex MacFarlane, MD PGY6

OHIO UNIVERSITY Heritage College of Osteopathic Medicine
WAYNE STATE School of Medicine
HARVARD MEDICAL SCHOOL
UB MD ORTHOPAEDICS & SPORTS MEDICINE

Elbow Arthroplasty Indications have changed drastically.....

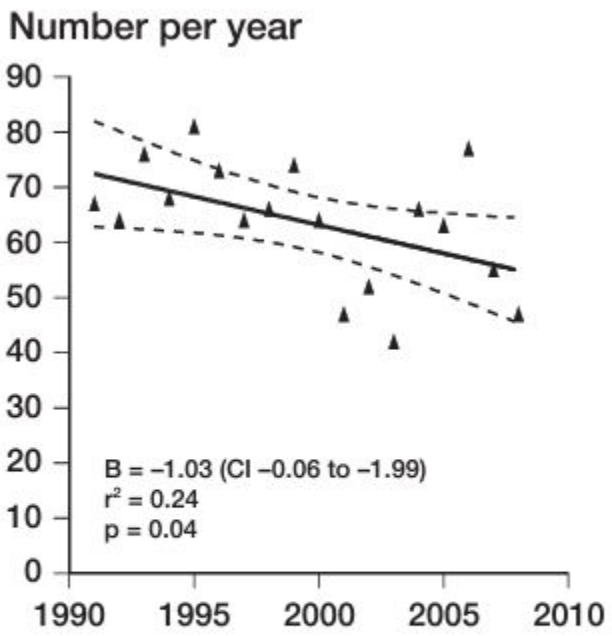


Figure 1. Annual number of TERs over time.

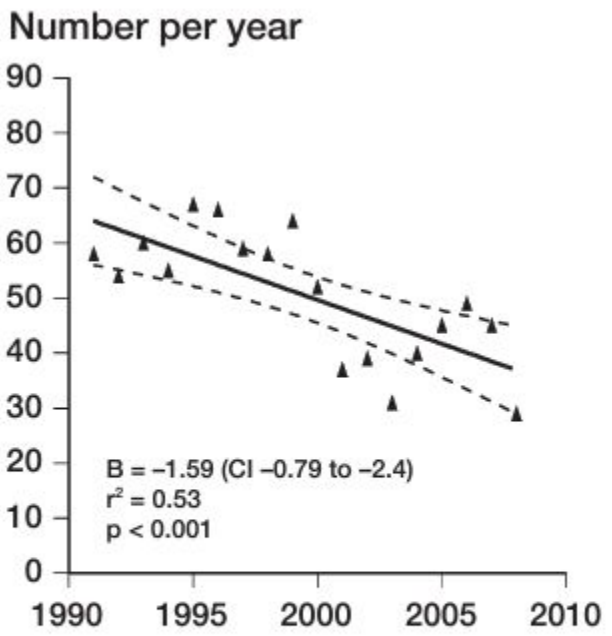


Figure 2. Change in incidence over time for TERs carried out for rheumatoid arthritis.

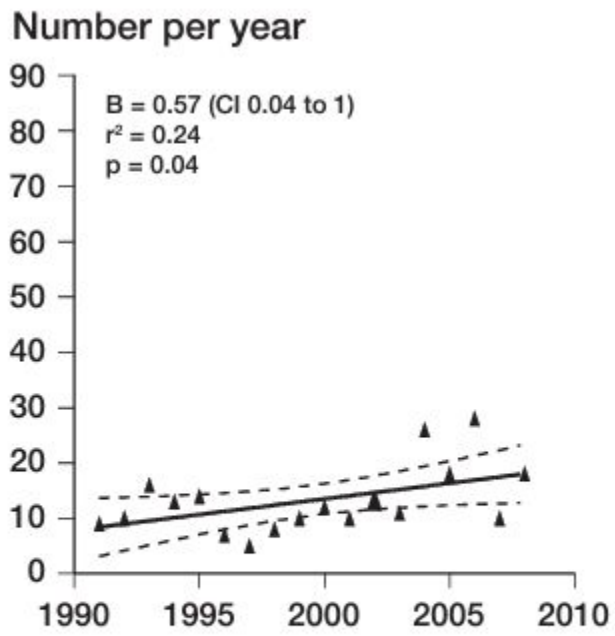


Figure 3. Change in prevalence versus time for TER performed for non-inflammatory conditions

Acta Orthopaedica 2013; 84 (2): 119–123

Total elbow replacement: outcome of 1,146 arthroplasties from the Scottish Arthroplasty Project

Paul J Jenkins[1], Adam C Watts[1], Tim Norwood[2], Andrew D Duckworth[1], Lech A Rymaszewski[3], and Jane E McEachan[1]

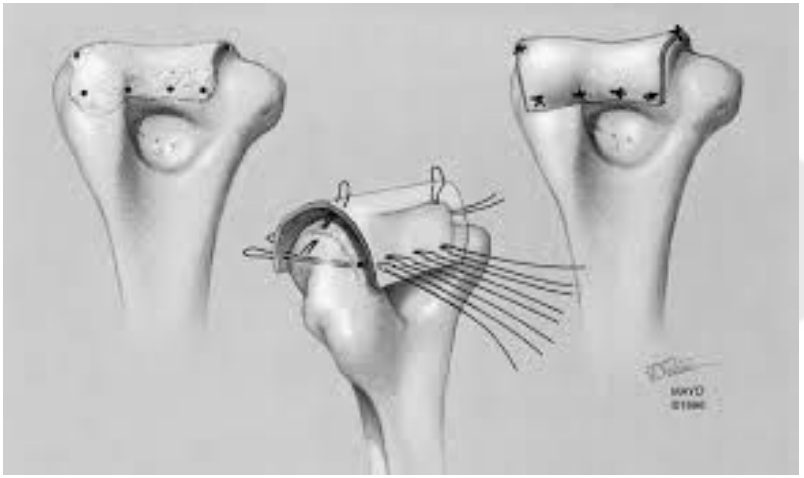
Elbow Arthroplasty

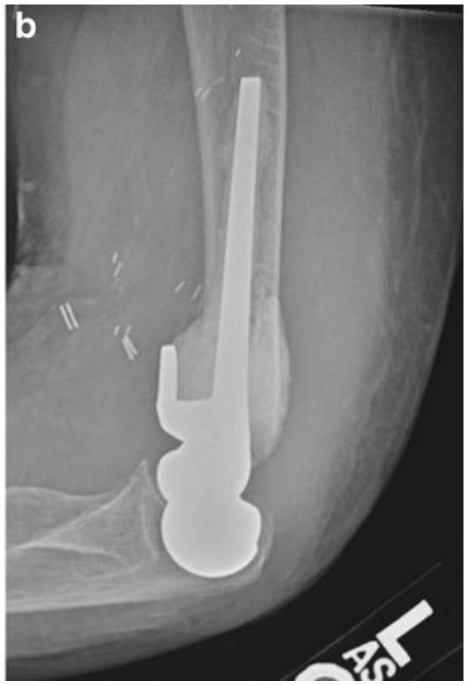
Complications

- Soft tissue complications, infection
- Instability - higher constraint
- Aseptic loosening, bone loss
- Bushing wear
- Triceps insufficiency
  - triceps-on approach, complication more common in RA, but still readily present in FX

Alternatives

- Arthritic
  - Open or arthroscopic capsular release and synovectomy
  - Interposition graft
- Fracture
  - ORIF
  - Distal humeral replacement (not available in US)



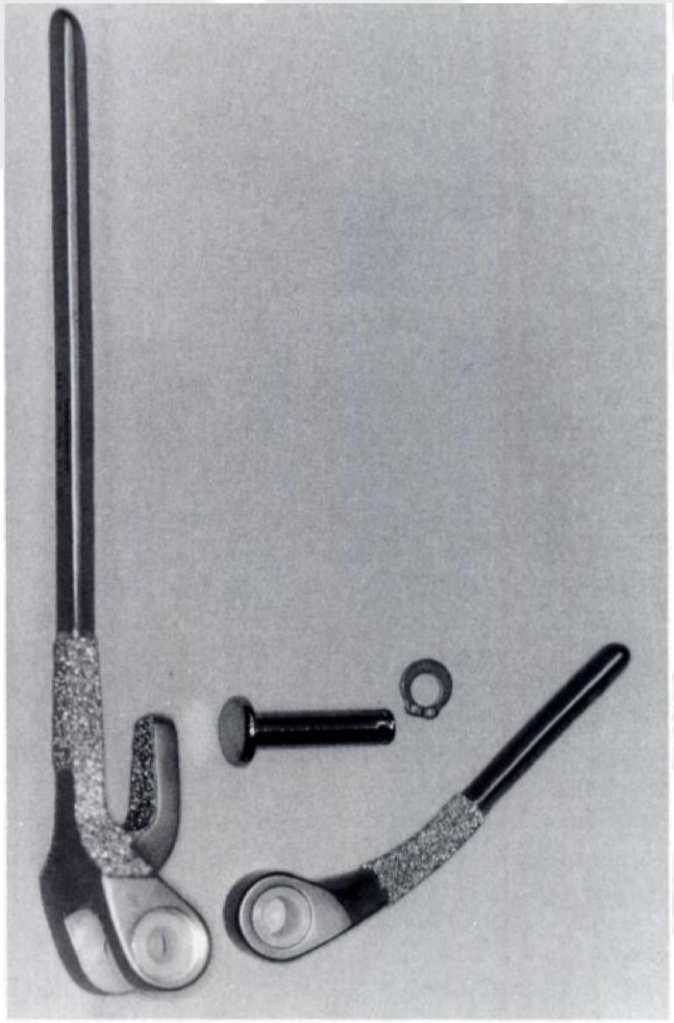


Semiconstrained Arthroplasty for the Treatment of Rheumatoid Arthritis of the Elbow*†

BY BERNARD F. MORREY, M.D.‡, AND ROBERT A. ADAMS, O.P.A.‡, ROCHESTER, MINNESOTA

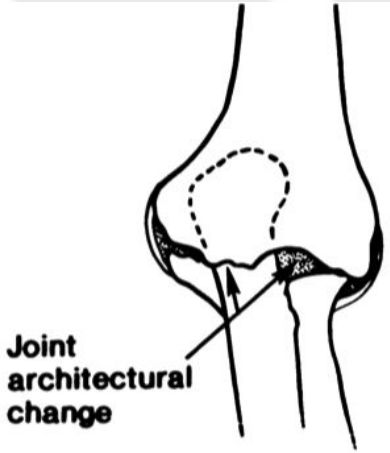
Investigation performed at the Department of Orthopedics, Mayo Clinic and Mayo Foundation, Rochester

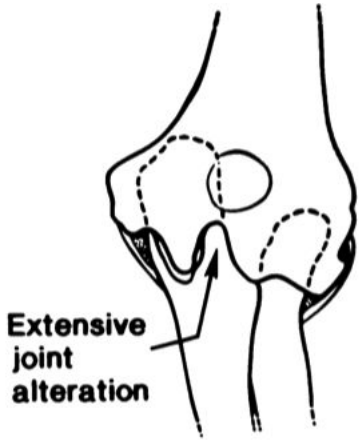
Background



- Fully constrained with metal-metal hinge rarely used due to high rates of loosenings
- 1st gen semiconstrained prosthesis modified to allow for greater articulation, 8 degrees of varus-valgus laxity and 8 deg IR/ER consistent with normal elbow ROM
  - Pin placed across distal humerus component through polyethylene bushings
  - Anterior extension added to humeral component for posterior stability
- Purpose - report long-term results of 2nd-gen semiconstrained elbow arthroplasty design in patients with rheumatoid arthritis

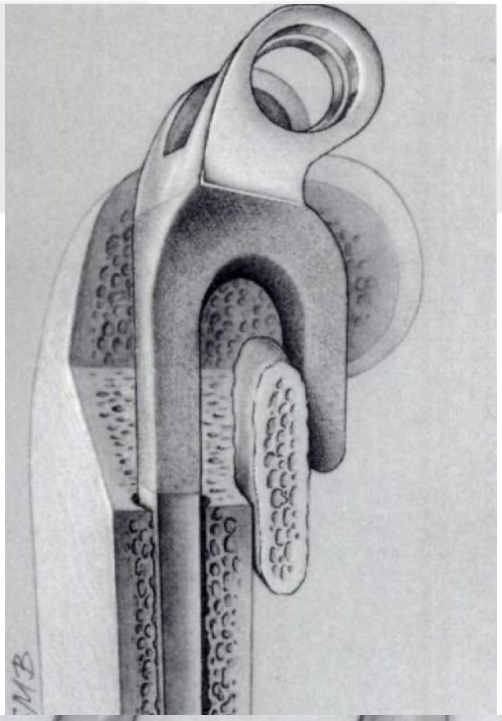
Study Design

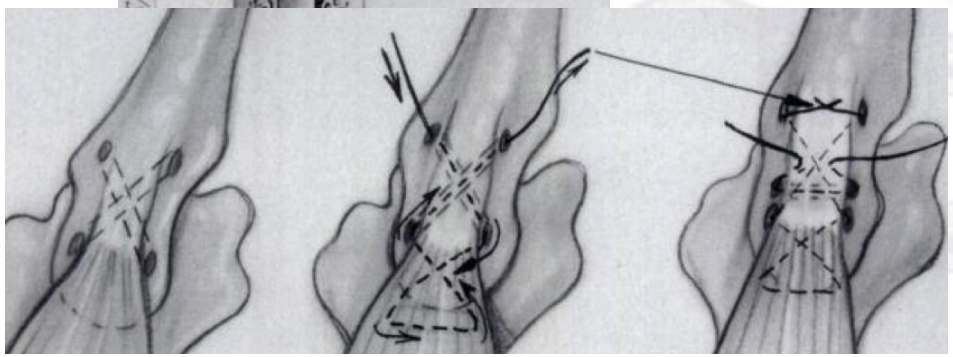




- Retrospective review between 1982-1988 of 68 elbows of 64 patients with RA and refractory pain (91%) or limited motion
- Implant: Semiconstrained modified Coonrad implant (Zimmer).
  - Exception: resurfacing device Pritchard Mark II (DePuy) in patient <35yrs with good bone stock
- Performance index measured preop and postop
  - Pain (max 45 pts), Motion (20 pts), Stability (10 pts), Daily function (25 pts)
- Radiographs classified as follows
  - I - no changes, osteoporosis
  - II - articular narrowing
  - III - joint alteration
  - IV - gross destruction

Results





- Soft Tissue and Nerve Management
  - Release triceps from olecranon along with anconeus.
  - Translate the ulnar nerve anteriorly.
- Implant and Fixation Technique
  - Use intramedullary injecting system for cement insertion in both components.
  - Place a bone graft between the anterior extension of the implant and the distal humerus.
  - Secure pin between two-part device with a splint ring.
  - Reattach the triceps through crisscrossed and transverse drill channels with the elbow at 90 degrees.

Results (mean follow-up 3.8yrs)

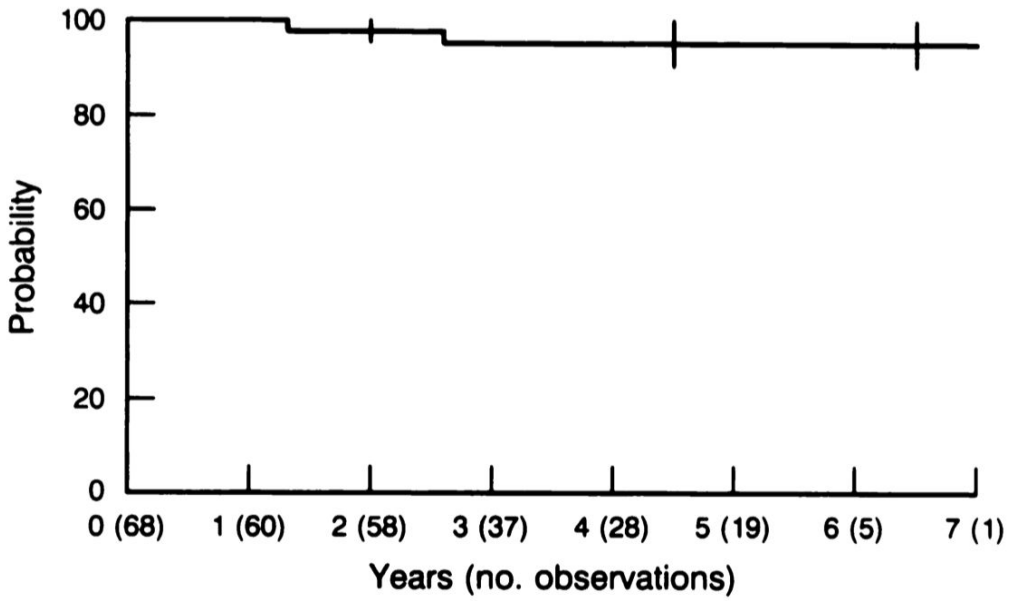
TABLE II

DATA ON THE FIFTY-EIGHT ELBOW REPLACEMENTS

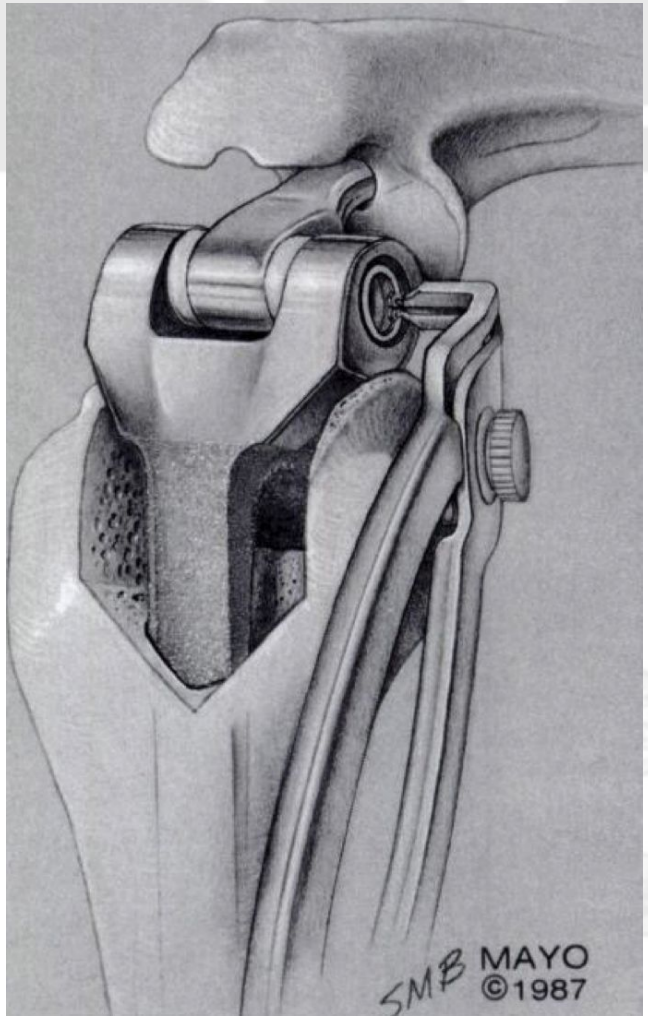
	Preop.	Postop.
Pain* (*per cent*)		
None	0	85
Mild	5	7
Moderate	35	9
Severe	60	0
Motion (*degrees*)		
Extension from flexion of:	32	20
Further flexion to:	118	129
Pronation	64	78
Supination	59	77
Stability* (*no.*)		
Stable	38	58
Moderately unstable	13	—
Grossly unstable	7	—
Daily function* (mean) (*points*) (maximum, 25 points)	8	23
Mean performance-index score* (*points*)	38	94

- Complications: 15 pts (22%) and 6 reoperations

Infection (4), intraop condylar fx (4), Ulna fx distal to prosthesis after fall (2), Supracondylar fx (2), persistent ulnar paresthesia (2), avulsion of triceps insertion (1)



Conclusions



- Semiconstrained TEA for rheumatoid arthritis offers excellent long-term results
- Selection of pts for semiconstrained elbow arthroplasty limited by bone stock and stability present
- Loose articulation of semi-constrained design provides stability and allows muscles and ligaments to absorb valgus-varus and axial forces, reducing stress on the bone-cement interface.

The Coonrad-Morrey Total Elbow Arthroplasty in Patients Who Have Rheumatoid Arthritis

A Ten to Fifteen-Year Follow-up Study*

BY DAVID R. J. GILL, M.B., CH.B., F.R.A.C.S.†, AND BERNARD F. MORREY, M.D.‡, ROCHESTER, MINNESOTA

Investigation performed at the Department of Orthopedics, Mayo Clinic, Rochester

Background

- Early total elbow prostheses with disappointing results
  - High rates of loosening with fully constrained prostheses
  - High rates of instability with resurfacing implants
- Semi-constrained prosthesis design developed to help address this
- Prior short to mid-term follow up for TEA in patients with RA show good results

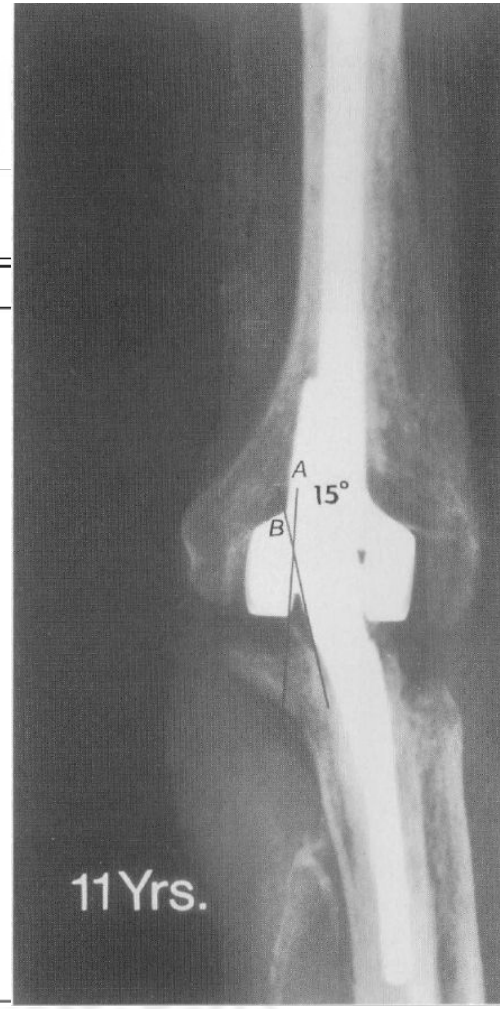
- Purpose: To describe the 10-15 year results of the Coonrad-Moorey semi-constrained total elbow prosthesis in patients with RA

Study Design

- Retrospective review of patients with RA treated with the Coonrad-Moorey total elbow prosthesis (1981-1986)
  - 78 elbows in 68 patients
    - 17 had prior operation (12 TEA with other implant, 4 ORIF, 1 resection of fx fragments)
  - 68 Mayo approach, 10 Triceps split
  - 68 subq translocation of ulnar nerve, 10 without
  - 75 cemented, 3 uncemented
  - Divided into Group 1 (> 10 year follow-up) and Group 2 (< 10 year follow-up)
- Outcomes
  - Implant survival
  - Mayo elbow performance tool
  - Radiographic evaluation (loosening, bushing wear)
  - Complications

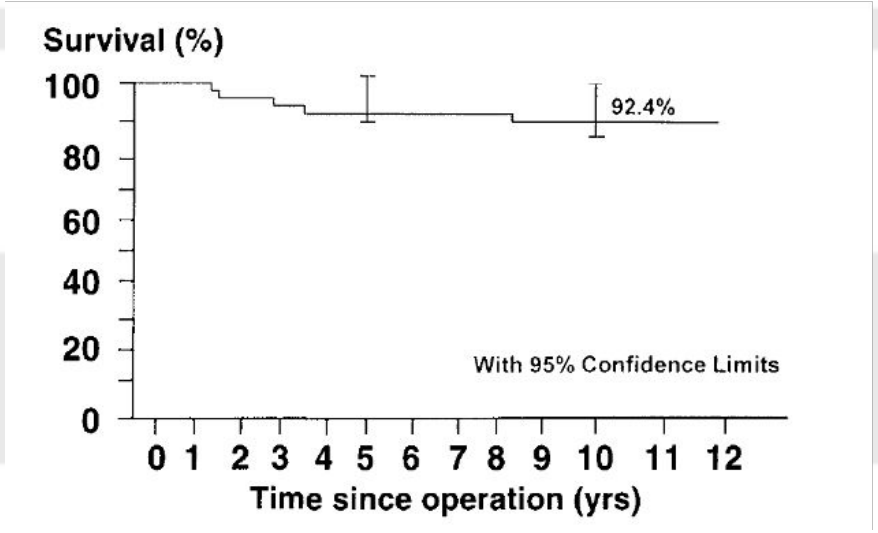
TABLE I
THE MAYO ELBOW PERFORMANCE SCORE[13,17,19]

	No. of Points*
Pain (45 points)	
None	45
Mild	30
Moderate	15
Severe	0
Range of motion (20 points)	
>100 degrees	20
50-100 degrees	15
<50 degrees	5
Stability† (10 points)	
Stable	10
Moderate instability	5
Gross instability	0
Daily function (25 points)	
Combing hair	5
Feeding oneself	5
Hygiene	5
Putting on shirt	5
Putting on shoes	5
Maximum possible total	100



Results

- Implant survival: 94.4% at 5 years, 92.4% at 10 years
- 74/78 (95%) of elbows had satisfactory result
- Pain: 97% of elbows not painful or mildly painful
- ROM: Significant increase in flexion, extension, pronation, supination compared to pre-op
- Stability: No patients with intact prostheses had any subjective or objective instability
- Daily Function: Significant increase from pre-op evaluation



RESULTS FOR THE SEVENTY-EIGHT ELBOWS AT THE LATEST FOLLOW-UP EVALUATION

	Group 1* (N = 46)		Group 2* (N = 32)		Overall Series (N = 78)	
	Preop.	Postop.	Preop.	Postop.	Preop.	Postop.
Pain† *(no. of elbows)*						
None	0 (0%)	29 (63%)	1 (3%)	18 (56%)	1 (1%)	47 (60%)
Mild	6 (13%)	16 (35%)	3 (9%)	13 (41%)	9 (12%)	29 (37%)
Moderate	15 (33%)	1 (2%)	6 (19%)	0 (0%)	21 (27%)	1 (1%)
Severe	25 (54%)	0 (0%)	22 (69%)	1 (3%)	47 (60%)	1 (1%)
Mean range of motion† *(degrees)*						
Extension	33	31	34	25	34	28
Flexion	121	134	128	126	124	131
Pronation	53	68	61	68	56	68
Supination	54	65	53	60	53	62
Stability‡ *(no. of elbows)*						
Stable	13 (28%)	46 (100%)	4 (13%)	30 (94%)	17 (22%)	76 (97%)
Moderately stable	10 (22%)	0 (0%)	16 (50%)	0 (0%)	26 (33%)	0 (0%)
Grossly unstable	23 (50%)	0 (0%)	12 (38%)	2 (6%)	35 (45%)	2 (3%)
Mean score for daily function‡§ *(points)*	18	22	14	20	16	21
Mean elbow performance score‡ *(points)*	46	90	38	84	42	87

*Group 1 = elbows that were followed for at least ten years and Group 2 = elbows that were followed for less than ten years.
†Extension refers to the flexed position from which the patient extends the upper extremity. Flexion refers to the amount of additional flexion that is possible from the original flexed position.
‡See text and Table I for definitions.
§The maximum possible score is 25 points.

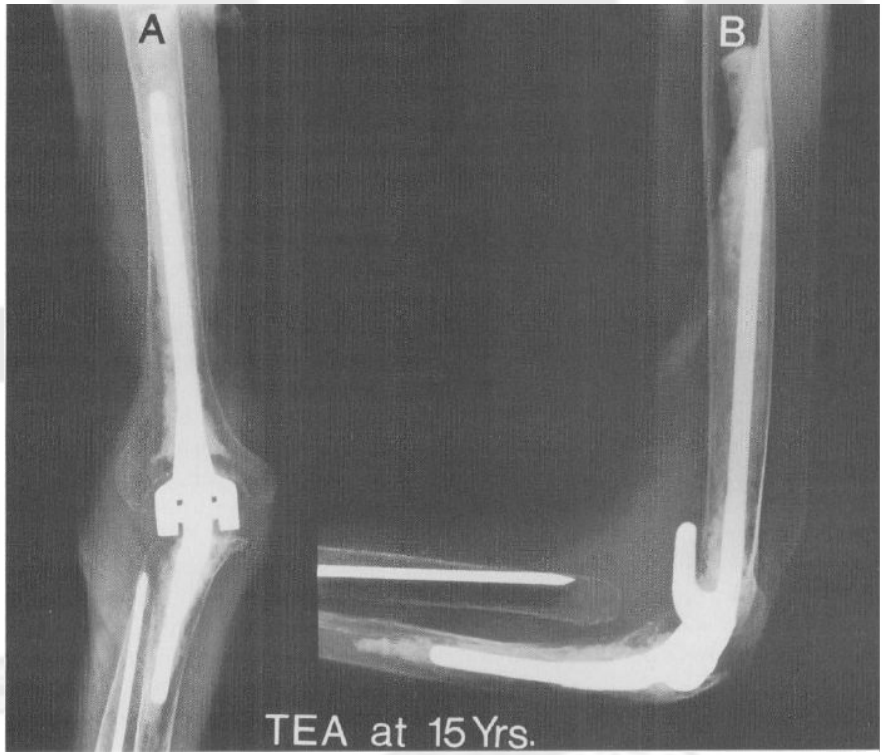
Results ctd.

- Radiographic Loosening – 2 loose ulnar components (1 infection, 1 asymptomatic)
- 11 patients had bushing wear (5 partial, 6 complete)

- Complications 11 total (14%)
- 3 triceps avulsions
- 2 deep infections
- 2 ulnar fractures
- 2 revised for aseptic loosening

Conclusions

- Total elbow arthroplasty with the Coonrad-Moorey implant for patients with rheumatoid arthritis can provide reliable pain relief, improved range of motion, and good to excellent outcomes at 10-15 year follow-up
- Still limited by weight-lifting restrictions post-operatively
- Complications such as infection, while rare, can result in unsatisfactory results and potentially devastating outcomes



J Bone Joint Surg Am. 1997 Jun;79(6):826-32. doi: 10.2106/00004623-199706000-00004.

Total elbow arthroplasty as primary treatment for distal humeral fractures in elderly patients

T K Cobb [1], B F Morrey

Background

- Distal humerus ORIF complication rates high with approximately 25% of patients unsatisfied
- TEA has not been considered as an option for the treatment of comminuted fractures of the distal humerus, primarily because the outcome is unpredictable
- Long-term follow-up of TEA for an acute fracture of the distal humerus are not available
- TEA shown to be viable option for post-traumatic deformities of the elbow in some patients > 60 years old

Study Design

- Retrospective review Nov 1982-October 1992
- 20 carefully selected patients (21 elbows) with distal humerus fractures of 125 patients (129 elbows)
- Only performed in the absence of any suitable alternative treatment
  - Indications: extensively comminuted acute fracture of the distal aspect of the humerus (9 patients, 10 elbows) with destruction of the articular surface due to RA, and comminuted intra-articular fracture in patients older than 65 years old (11 patients)
- Having RA did influence treatment choice (RA is a disease of joints that usually is treated with replacement arthroplasty)
- Average age: 72 (48-92); Average age of all 125 patients: 49
- Average time to surgical fixation was 7 days
- Average follow-up 3.3 years

Results

- All implants intact at last follow-up
- All implants were cemented
- All patients has a flexion contracture ranging from 5-45 degrees
- 15 elbows with excellent results, 5 with good results, 1 inadequate data for Mayo elbow performance score (45 for pain, 25 for function, 20 for motion, 10 for stability - excellent > 90, good 75-90)
- Average post-op ROM 25-130
- Complications: 1 revision, 3 ulnar neuropraxia, 1 reflex sympathetic dystrophy, 1 PE POD1, 1 CVA intraop, 1 MI intraop, 1 superficial wound infection, 1 fibrous non-union
- 1 revision TEA 20 months post-op for fracture of ulnar component during a new fall

Conclusions

- TEA can be alternative form of treatment for severely comminuted fracture of distal humerus in older patients even in the presence of RA
- However, experience with TEA should be considered a prerequisite for a surgeon performing the operation
- 21 procedures were performed during an 11-year period emphasizes the strict criteria for selection

A Comparison of Open Reduction and Internal Fixation and Primary Total Elbow Arthroplasty in the Treatment of Intraarticular Distal Humerus Fractures in Women Older Than Age 65

Mark A. Frankle, Dolfi Herscovici, Jr., Thomas G. DiPasquale, Matthew B. Vasey, and Roy W. Sanders

Florida Orthopaedic Institute, Tampa, Florida

Background

- At the time distal humerus fractures accounted for 2% of adult fractures
- Treatment options including Osteosynthesis, ORIF, and nonoperative all provided **suboptimal outcomes and complications**
  - secondary to poor fracture patterns, patient characteristics, and postoperative therapy programs
  - Complications included hardware failure, heterotopic ossification, nerve entrapment, posttraumatic arthritis and non/malunion were common in all ages
- Previous studies demonstrated that **women > 65 y/o** with intraarticular distal humerus fractures have **suffered the worse postoperatively**
- **Purpose:** To compare ORIF with TEA for intraarticular distal humerus fractures in women older than 65 y/o

Study Design

- Retrospective study at a single Level 1 Trauma center
- **24 Females (24 elbows)** > 65 y/o with distal humerus fractures were selected from the trauma and total joint registry
  - **12** elbows in the ORIF group, **12** elbows in the TEA group
  - All fractures were identified as a **13.C2 or 13.C3** OTA classification
  - No fractures were open or had neurovascular compromise
- ORIF elbows were treated by a traumatologist, TEA elbows were treated by a shoulder & elbow surgeon
- **At least 24 months of follow-up**

Study Design

ORIF Group

- Average age of 74 y/o (65-86)
- Four 13C2 and Eight 13C3 fractures
- Time to surgery: 2 days (1-5)
- 3 patients had osteoporosis
- 10/12 elbows required olecranon osteotomy
- The remaining 2 utilized triceps-sparing approach

TEA Group

- Average age of 72 y/o (65-88)
- Four 13C3 and eight 13C with rheumatoid destruction that prevented further classification
- All patients had osteoporosis
- Time to surgery: 8 days (2-30)
- All used semiconstrained, cemented Total elbow implant by Zimmer

Outcomes:

Mayo elbow performance score, pain, patient satisfaction, Arc of flex/ext, and complications

Results

ORIF Group

- Average follow-up: **57 months** (2-78)
- Operative time: **150 mins**
- Mayo elbow performance score: **4 excellent, 4 good, 1 fair, 3 poor**
  - Fair: secondary to postoperative infection that required I&D
  - Poor: all 3 were from fixation failure that required revision to TEA
    - these patients were removed from follow up as they were not considered in the primary TEA group
- Avg ext: 30 deg (10-50), avg flex: 110 deg (80-120), **avg arc: 100 deg** (90-120)
- **Avg Mayo score: 87.7 points**
  - excluding revision patients

TEA Group

- Average follow-up: **45 months** (24-72)
- Operative time: **90 minutes**
- Mayo elbow performance score: **11 excellent, 1 good**
  - No revisions of implant
  - Complications: uncoupled prosthesis, hematoma, I&D for superficial infection
- Avg ext: 15 deg (0-30), avg flex: 125 deg (110-130), **avg arc: 113 deg** (100-130)
- **Avg Mayo score: 95.0 points**
  - no exclusions

TABLE 1. *Distal humerus fractures in women older that age 65 treated by open reduction and internal fixation*

Case no.	Age	Affected side (dominant ext)	Comor-bidities*	Time to surgery	Complication	Duration of follow-up	Duration of hospitalization	Tourniquet time	Arc of flex/ext	Arc of pro/sup	Patient satisfied	Pain	Mayo elbow performance (rating)
1	68	L (R)	A/C	2 days	Fixation	8 wk	2 days	150 min	0	0	No	Severe	50 (P)
2	79	L (R)	A/B/C	2 days	Fixation	12 wk	2 days	150 min	0	0	No	Severe	50 (P)
3	80	R (R)		1 day		6.5 yr	4 days	150 min	95	80/80	Yes	None	85 (G)
4	68	L (R)	E	1 day		6 yr	3 days	150 min	110	80/80	Yes	None	85 (G)
5	73	L (R)		1 day		2.5 yr	2 days	140 min	90	80/80	Yes	Mild	95 (E)
6	86	R (R)		1 day		6.5 yr	4 days	155 min	110	80/80	Yes	None	100 (E)
7	73	R (L)		2 days		6.5 yr	4 days	135 min	110	80/80	Yes	None	85 (G)
8	65	L (R)		2 days		5 yr	3 days	155 min	90	80/80	Yes	Mild	90 (E)
9	66	L (R)	D	3 days	Infection	5 yr	5 days	145 min	95	80/80	Yes	Mild	70 (F)
10	83	R (R)	A/C	5 days	Fixation	n/a	4 days	155 min	n/a	n/a	n/a	n/a	n/a (P)†
11	65	L (L)		3 days		2.5 yr	2 days	150 min	120	80/80	Yes	None	80 (G)
12	77	L (R)		2 days		2.5 yr	2 days	120 min	100	80/80	Yes	None	100 (E)
Mean	74			2 days		57 months†	3 days	146 min	100‡				81

TABLE 2. *Distal humerus fractures in women older than age 65 treated by primary total elbow arthroplasty*

Case no.	Age	Affected side (dominant ext)	Comor-bidities*	Time to surgery	Complication	Duration of follow-up	Duration of hospitalization	Tourniquet time	Arc of flex/ext	Arc of pro/sup	Patient satisfied	Pain	Mayo elbow performance (rating)
1	66	L (R)	A/C	10 days	Uncoupling prosthesis/ radiolucency-ulnar component	5 yr	3 days	90 min	100	80/90	Yes	Mild	85 (G)
2	72	R (R)	C/F	4 days		6 yr	3 days	60 min	120	80/90	Yes	None	100 (E)
3	74	R (R)	C/F	7 days		4 yr	2 days	90 min	105	80/90	Yes	None	95 (E)
4	74	R (R)	C/F	5 days		4 yr	2 days	100 min	110	80/90	Yes	None	95 (E)
5	88	R (R)	C	2 days		3 yr	2 days	55 min	130	80/90	Yes	None	100 (E)
6	65	R (R)	C/F	6 days		3 yr	2 days	80 min	130	80/80	Yes	None	100 (E)
7	65	R (R)	C/F	30 days		3 yr	2 days	80 min	110	80/80	Yes	None	95 (E)
8	79	L (R)	B/C	4 days		4 yr	2 days	80 min	120	80/80	Yes	None	95 (E)
9	71	R (R)	C/F	3 days	Hematoma	3 yr	2 days	100 min	100	80/80	Yes	Mild	90 (E)
10	67	L (R)	C	5 days		2 yr	2 days	70 min	110	80/80	Yes	None	95 (E)
11	76	L (R)	C/F	15 days		2.5 yr	2 days	70 min	115	80/80	Yes	None	95 (E)
12	71	R (R)	C/F	2 days	Infection	5 yr	2 days	60 min	110	80/80	Yes	None	95 (E)
Mean	72			8 days		45 mo	2 days	78 min					95

Conclusions

- Patients treated with **TEA scored higher on the Mayo score** than the patients successfully treated with ORIF
- However, outcomes of distal humerus fractures in patients treated by ORIF and TEA demonstrated **either can restore function** and provide pain relief
- **TEA** was preferred for **comminuted and displaced intra articular fractures** in older women with comorbidities
- **ORIF** was preferred for patients with **adequate bone stock and without comorbidities**
    - Conclusions of this study were limited due to the small sample size and to 67% of TEA patients having RA

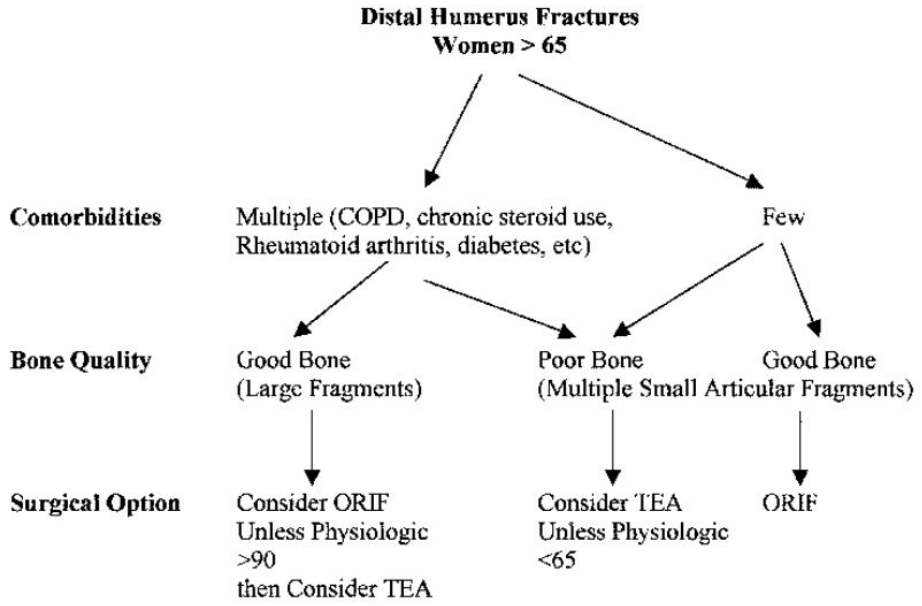


FIGURE 3. Algorithm for ORIF versus TEA in distal humerus fractures of the elderly.

Randomized Controlled Trial > J Shoulder Elbow Surg. 2009 Jan-Feb;18(1):3-12.
doi: 10.1016/j.jse.2008.06.005. Epub 2008 Sep 26.

A multicenter, prospective, randomized, controlled trial of open reduction--internal fixation versus total elbow arthroplasty for displaced intra-articular distal humeral fractures in elderly patients

Michael D McKee [1], Christian J H Veillette, Jeremy A Hall, Emil H Schemitsch, Lisa M Wild, Robert McCormack, Bertrand Perey, Thomas Goetz, Mauri Zomar, Karyn Moon, Scott Mandel, Shirlet Petit, Pierre Guy, Irene Leung

Affiliations + expand

PMID: 18823799 DOI: 10.1016/j.jse.2008.06.005

Background

- ORIF w/ plate fixation gold standard for displaced intra-articular distal humerus fx. in young pts.
  - Elderly pts. had less predictable outcomes d/t numerous factors
- Primary TEA showed to be a viable tx opt. for older patients but recommendations were based only on retrospective reviews from single institutions.
- Prospective RCT comparing functional outcomes, complications and reoperation rates
- Purpose: Compare effectiveness of ORIF w/ primary TEA for the treatment of displaced, comminuted intra-articular distal humerus fractures in elderly pts. (>65yrs.)
- Primary outcome measures - reoperation rate
- Secondary outcome measures - pt. function using the Mayo elbow performance score (MEPS) and the Disabilities of the arm, shoulder and hand instrument (DASH)

Study Design

- Prospective, randomized, double blinded RCT - 4 academic centers
- Inclusion criteria: age > 65, displaced comminuted, intra-articular fracture of the distal humerus and closed or gustilo grade I open fractures tx. w/in 12 hrs of injury.
- 42 pts. randomized
  - 2 died before f/u, were excluded
    - 5 pts in ORIF were converted to TEA d/t extensive comminution
    - 15 pts (3 men 12 women) w/ mean age of 77 in ORIF
    - 25 pts (2 men 23 women) w/ mean age of 78 in TEA

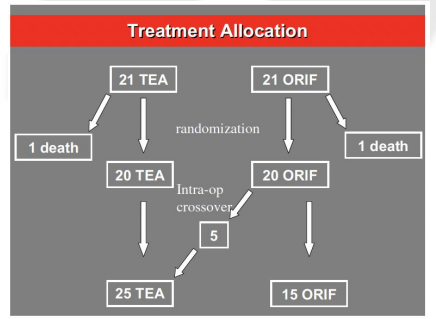


Figure 1 Randomization scheme. *intra-op*, Intraoperative.

- Baseline demographics for mechanism, classification, comorbidities, fracture type, activity level and ipsilateral injury were similar between the two groups.
- Metrics studied:
  - Primary outcome - reoperation rate
  - Secondary outcome - pt. outcome
    - MEPS and DASH scores taken at 6 wks. 3 mths. 6 mths. 12 mths. and 2 yrs.
    - Complication type, duration, management and treatment requiring reoperation were recorded.
- Intention to treat analysis and on-treatment analysis were used on pts who were randomized to ORIF but converted to TEA intraoperatively.

Results

- Operation time averaged 32 minutes less in TEA group in comparison to ORIF (p=.001).
- Patients who underwent TEA had better MEPS at 3 mths., 6 mths., 12 mths., and 2 yrs, which was statistically significant.
- Patients who underwent TEA had better DASH at 6 wks. and 6 mths. but not at 12 mths. and 2 yrs.
- Mean flexion-extension arch
  - 107 for TEA and 95 for ORIF (p =0.19)
- Reoperation rates (not sig)
  - 3/25 (12%) for TEA and 5/15 (27%) for ORIF

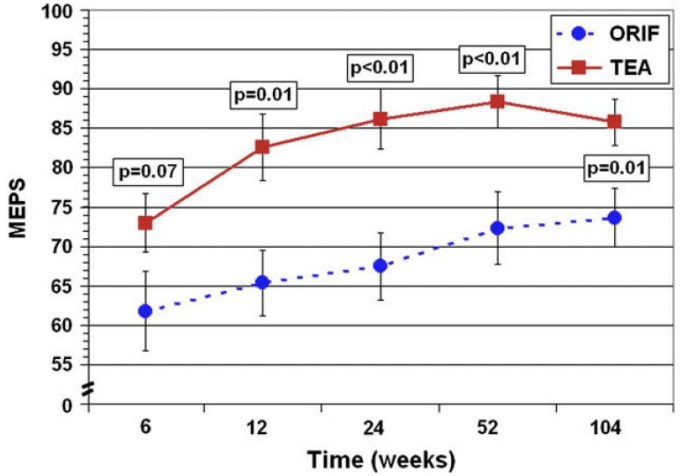


Figure 2 MEPS was significantly improved at 3 months (83 vs 65, $P = .01$), 6 months (86 vs 68, $P = .003$), 12 months (88 vs 72, $P = .007$), and 2 years (86 vs 73, $P = .015$) in patients with TEA (*solid line*) compared with ORIF (*dashed line*). *Error bars* represent SE.

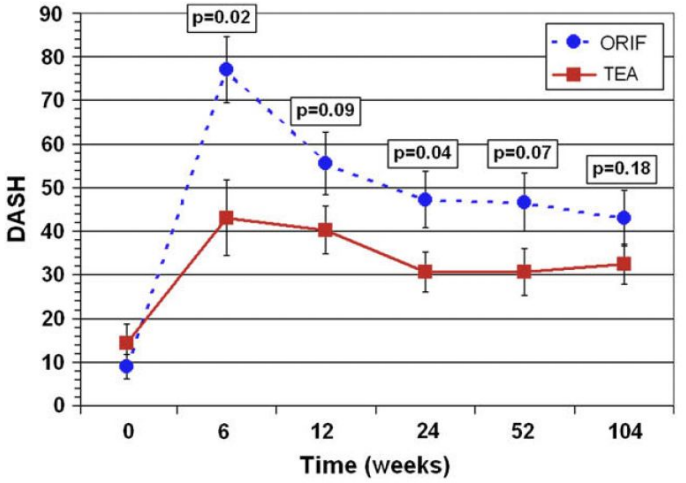


Figure 3 DASH scores showed a significant improvement for TEA (*solid line*) compared with ORIF (*dashed line*) between 6 weeks (43 vs 77, $P = .02$) and 6 months (31 vs 47, $P = .04$) but not at 12 months (31 vs 47, $P = .07$) and 2 years (32 vs 43, $P = .18$). *Error bars* represent SE.

Conclusions

- TEA for treatment of comminuted intra-articular distal humerus fractures showed more predictable and improved 2 yr. function outcomes compared to ORIF based on MEPS.
- DASH scores were better in the TEA in the short term, but not statistically different at 2 yrs f/u.
- Trends showed that TEA may result in decreased reoperation rates and improved ROM, but did not show to be statistically significant in the study.
- Weakness: Smaller sample size and only a 2 year f/u.
- Elderly pts. have an increased baseline DASH and appear to accommodate to objective limitations in function with time.
- TEA is a preferred alternative for ORIF in elderly pts. w/ complex distal humerus fractures that are not amenable to stable fixation w/ ORIF.

Citations Classics Shoulder & Elbow

Total Elbow Arthroplasty

Samuel Fuller, MD PGY2
Bradley Hawayek, MD PGY4
Teja Polisetty, MD PGY1
Matthew Corsi, MS4
Jalen Warren, MS4
Alex MacFarlane, MD PGY6

OHIO UNIVERSITY Heritage College of Osteopathic Medicine
WAYNE STATE School of Medicine
HARVARD MEDICAL SCHOOL
UB MD ORTHOPAEDICS & SPORTS MEDICINE