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Study of functional outcome of total elbow replacement using semi-constrained elbow prosthesis in non inflamatory elbow arthritis

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Abstract
Background: Total Elbow Replacement is considered when there is disabling arthritis of the elbow. Various eteologies are responsible for this arthritis, commonest being Rheumatoid Arthritis. Other causes include, post traumatic arthritis, tumor affection of elbow, rarely haemophilic arthritis. Indications also include distal humerus fractures/ nonunion in select elderly patients.
Materials and Methods: 7 patients of Elbow arthritis were operated for Total Elbow Arthroplasty at our institute between, 2013-2015. There were 4 males and 3 females in our study. Baksi sloppy hinge prosthesis was implanted in all our patients.
Results: Evaluation of patients was done at 6, 12, 18 months and final evaluation was done at 24 months in all our patients. Significant improvement in functional score, stability and range of movement was documented. Total Elbow Replacement is not a routinely performed surgery as such and has a steep learning curve which is a technical challenge. No major complication was noted in our study.
Conclusion: Total Elbow Replacement provides stable, painfree elbow with functional range of movement and negligible complications if performed with technical expertise.

Keywords: Study of functional outcome, elbow replacement, elbow prosthesis. non inflammatory, elbow arthritis

Introduction
In the past four decades total elbow replacement (TER) has emerged as a viable surgical option for advanced elbow disease.
Elbow arthoplasty is less commonly performed as knee arthroplasty or hip arthoplasty, due to higher incidence of complications. However in the last 15 years rate of complications has decreased due to better available prosthesis [1]. Proper selection of patients is important in elbow arthoplasty.
In 1972 Dee introduced the first 'Modern' constrained total elbow prosthesis using cement. Despite good initial clinical outcomes, loosening rates were extremely high due to high stress levels at the bone-cement interface. Non-constrained (Resurfacing) and semiconstrained prostheses were then developed to overcome the problem.
The original Baksi's rigid hinge prosthesis was designed in 1977 (Indian Patent No.146175, dated 11.8.1978) and has been used in clinical practice since 1977 [50]. Its physical properties were extensively studied with the help of a newly designed Elbow Joint Simulator during the period from 1978 to 1983. This study concluded that if 7^0-10^0 laxity is added in the hinge section, that will reduce the metal dust liberation and hinder the strain of loosening in the bone cement interface [51, 52]. On the basis of these facts, the original rigid hinge prosthesis was redesigned into sloppy hinge elbow prosthesis in 1983 (Indian registered design no 161541).

Material and Methods
Between 2013-2015, SEVEN patients of Elbow arthritis underwent TER
104 patients with posttraumatic arthritis were evaluated in the orthopaedic opd. 11 patients having posttraumatic arthritis of elbow who fit in the inclusion criteria were advised for surgery. Out of 11 patients with POST Traumatic Arthritis, 5 patients finally consented for surgery.

5 cases of comminuted Distal Humerus Fractures in the Elderly were advised for replacement, however only *1 patient* agreed for total elbow replacement.
3 cases of Distal Humerus Nonunion were advised replacement out of which *1 patient* agreed.
Thus, 7 patients were operated and reviewed over a period of 24 mths.

Small sample size for total elbow replacement can be attributed to the following
Elbow dysfunction sometimes is tolerated by the patient since it does not directly interfere with locomotion. Only when the morbidity becomes worse so as to adversely affect the activities of daily living, the patients tend to acquiesce for surgical treatment.
Kumar *et al.* reviewed 11 cases operated over a period of ten years [14].
Hildebrand *et al.* reviewed 47 cases operated over a period of 7 years [15].
This is not a routinely performed procedure and the incidence of elbow arthritis is not very frequent.
Elbow replacement is not a routine surgery. Given the small sample size and steep learning curve, makes this surgery a technical challenge.

Inclusion criteria were
- *Complex fracture* of the elbow, even in the elderly.
- *Severely damaged* or torn soft tissues in the elbow, resulting in *instability.*
- *Osteoarthritis*.
- Poor results from previous elbow surgery

Although inflammatory arthritis constitutes the major chunk of elbow arthritis, we wanted to study the effect of elbow arthritis in a purely mechanical group of subsets of patients.

Baksi sloppy hinge prosthesis was used in all our cases.
All preoperative workup was done prior to subjecting them for surgery.
All patients were operated in supine position which is the preferred position of the senior author. General anesthesia was administered and Bryan Morrey approach was used for exposure. Depending on the involvement radial head was excised or left intact. Bony cuts were identified and taken. After appropriate broaching the humeral and ulnar components were fixed with cement to the humerus and ulna respectively. Link pin was fixed and the coupling screw was tightened.
Thorough lavage was done and meticulous closure of the extensor apparatus was done after keeping romovac closed suction drain no. 14.
Post operative limb was kept in extension with back slab. First check dress was done on day-2 of surgery (not counting day of surgery), along with drain removal. Second check dressing was done on day -5 post operative. Further sutures were removed around 13-15 days post operative. Gentle passive flexion was begun around day-8 post op, which was increased as tolerated by the patient. By end of 4-6 weeks target of 90 degrees flexion was achieved in most of the patients. Slab was removed after 4 weeks. Patients were discharged on day 15 after suture removal and called for further opd evaluation after 6, 12, 18 and 24 months.
Antibiotic policy of the senior author is as follows. Vancomycin 1gm infusion iv one hour prior to surgery. Cefuroxime 1.5 gm iv at the start of procedure and given twice daily for 5 days. amikacin 500mg twice and metrogyl 500mg twice for 5 days.

Results
Results were analysed on basis of
Functional outcome.
Radiographic analysis.
Complications.
Overall patient satisfaction with postoperative results

There was a significant improvement in the functional scores six months post-operatively. The mean scores for stability six months post-operatively were significantly improved. No specific criteria were used for radiographic analysis but radiolucent lines and region of lucency were noted. Progression of the lucent lines was also recorded.
A total of 2 patients were not satisfied with the outcome six months post-operatively; all of these patients subsequently became satisfied after eight months post-operatively.
There were no dislocations reported in this study.
No patient presented with any infection postoperatively.

Discussion
The biomechanical properties of the total elbow prosthesis are well documented [1, 2]. In up to 65% of the early papers describing the outcome after TER Rheumatoid Arthritis (RhA) was the indication for surgery[3]. In present study RhA was not included as the major indication for surgery.
The elbow is affected in approximately half of the patients suffering from rheumatoid arthritis [46, 47].
The indications have since changed [4, 5-9]. Advances in the medical management of RhA have led to a decrease in joint destruction and, together with advances in implant design, TER is now often used in post-traumatic conditions and in patients with primary OA [4, 7].
Gill and Morrey reported prosthesis survival at 10 years as 92%, with 86% having good or excellent results in 78 elbows with the Coonrad-Morrey prosthesis [13]. Shi *et al.* reported a post-operative mean MEPS of 84 for primary implants [16]. In a long-term study by Aldredge *et al.* with a follow-up duration of 10-31 years, the mean MEPS for the Coonrad-Morrey prosthesis was 91 in 41 elbows [12].
The most important finding in our study was that no specific factor had an impact on loosening and failure of the prosthesis. Loosening can be caused by a variety of factors including biomechanical instability, deep infection and peri-prosthetic fracture. The rate of deep infection in literature ranges from 0% to 9% [37] and the incidence of intraoperative condylar fracture from 0% to 4% [37, 38, 39]. The peculiar bone cut required during the preparation of the humerus and the sub-optimal quality of bone in inflammatory arthritis are probably responsible for this complication. Deep infection and fractures are common in elderly patients with rheumatoid arthritis [40]. This is probably because such patients have immune system dysfunction and a compromised soft tissue cover.
Ulnar nerve palsy is a well recognised complication of TER and the reported incidence varies from 1.7% to 28% [17]. Transient median nerve palsy has also been reported [10] but was not observed in our study.
Nerve palsy is the most common complication in TER. The incidence of ulnar nerve palsy in literature ranges from 0% to 26% [37, 39, 40, 41, 42]. A Bryan-Morrey approach was used in all our cases. Meticulous dissection and isolation of the ulnar nerve is required to minimize the occurrence of ulnar nerve

palsy.

Literature suggests that despite these precautions nerve palsies can occur in stiff elbows that regain a considerable range of motion after surgery [43]. Anterior transposition of the nerve may be considered in such elbows based on the intraoperative increase in range of movement achieved.

A minimum of 100° of range of movement is required in the flexion extension axis (range 30-130° of flexion) and the pronation/supination axis (pronation 50° and supination 50°) to perform most activities of daily living [44].

This functionally useful range of movement was achieved in all cases in our series.

This puts forward the view that the biomechanics and functional result of the TER is conducive to the performance of most activities of daily living. This is also the case in other series in literature [37, 38, 42].

The failure rate of primary TER in literature has ranged from 0% to 31.7% [37, 39, 41]. The 5-year survivorship of primary TER ranges from 68% to 100% in the literature [38, 45, 48]. The survivorship of our primary TER series was at the higher end of this spectrum at 24 months.

The original Coonrad prosthesis (Type I), introduced in 1973, had high molecular weight polyethylene bushings and a varus-valgus laxity of 2-3°. It was associated with an unacceptable rate of aseptic loosening in rheumatoid arthritis [48].

Our findings confirm that TER improves the function of the elbow and reduces pain, and overall patient satisfaction is high.

The mean range of movement obtained was similar to that with other commonly used TERs, *Acclaim* (DePuy Orthopedics Inc, Warsaw, Indiana) [34] *Souter-Strathclyde* (Stryker Howmedica Osteonics, Limerick, Ireland) [35, 36] and *Kudo* (Biomet Inc, Warsaw, Indiana) [14-15].

Table 1: Age wise distribution of cases in study group

Age	Frequency	Percent
50 to 60	2	28.6
60 to 70	4	57
70 to 80	1	14
Total	7	100.0

Table 2: Sex wise distribution of cases in stydy group

Sex	Frequency	Percent
Female	3	43
Male	4	57
Total	7	100.0

Table 3: Comparison of flexion between pre op baseline and post op 6mths, 12mths, 18mths, 24mths in study group

Parameter	Flexion		t Value	P Value
	Mean	SD		
Pre op baseline	109.64	6.805	-	-
Post op 6 months	125.76	6.638	8.912	<0.0001
Post op 12 months	126.47	6.071	12.172	<0.0001
Post op 18 months	128.47	5.864	12.789	<0.0001
Post op 24 months	130.94	5.717	14.342	<0.0001

Table 4: Comparison of extension deficient between pre op baseline and post op 6mths, 12mths, 18mths, 24mths in study group

Parameter	Extension deficit		t Value	P Value
	Mean	SD		
Pre op baseline	38.88	10.295	-	-
Post op 6 months	25.53	5.524	7.748	<0.0001
Post op 12 months	16.18	3.877	10.209	<0.0001
Post op 18 months	12.94	3.561	10.985	<0.0001
Post op 24 months	9.71	3.293	12.381	<0.0001

Table 5: Comparison of range of motion between pre op baseline and post op 6mths, 12mths, 18mths, 24mths in study group

Parameter	Rangeo f motion		t Value	P Value
	Mean	SD		
Pre op baseline	80.00	14.093	-	-
Post op 6 months	97.65	9.539	8.531	0.001
Post op 12 months	108.24	7.894	10.505	<0.0001
Post op 18 months	113.82	8.575	10.629	<0.0001
Post op 24 months	117.94	8.849	11.578	<0.0001

Table 6: Comparison of pronation between pre op baseline and post op 6mths, 12mths, 18mths, 24mths in study group

Parameter	Pronation		t Value	P Value
	Mean	SD		
Pre op baseline	64.29	11.450	-	-
Post op 6 months	72.94	11.866	13.605	<0.0001
Post op 12 months	79.65	10.068	12.890	<0.0001
Post op 18 months	82.06	8.671	11.950	<0.0001
Post op 24 months	84.71	5.987	10.819	<0.0001

Table 7: Comparison of supination between pre op baseline and post op 6mths, 12mths, 18mths, 24mths in study group

Parameter	Supination		t Value	P Value
	Mean	SD		
Pre op baseline	52.35	11.629	-	-
Post op 6 months	63.53	11.069	8.823	<0.0001
Post op 12 months	70.24	11.278	12.718	<0.0001
Post op 18 months	75.00	12.119	13.340	<0.0001
Post op 24 months	78.24	11.982	13.568	<0.0001

Table 8: Comparison of stability between pre op baseline and post op 6mths, 12mths, 18mths, 24mths in study group

Parameter	Stability		t Value	P Value
	Mean	SD		
Pre op baseline	0.24	0.437	-	-
Post op 6 months	1.35	0.493	9.50	<0.0001
Post op 12 months	1.65	0.493	9.414	<0.0001
Post op 18 months	1.76	0.437	12.257	<0.0001
Post op 24 months	1.88	0.332	13.786	<0.0001

Table 9: Improvement at 24 months followup

	Preoperative baseline	Post op 24months
Flexion	109.64	130.94
Extension deficient	38.88	9.71
Rom	80	117.94
Pronation	64.29	84.71
supination	52.35	78.24

Pre and Post Op Mayo Score

	Preop	postop
Pain (no.ofelbows)		
None	03	03
Mild	03	03
Moderate	04	01
Severe	03	0
Mean range of motion (degrees)		
Extension	33	31
Flexion	115	134
Pronation	50	65
Supination	49	64
Stability (no.of elbows)		
Stable	2	7
Moderately stable	3	0
Grossly unstable	5	0
Mean score for daily function (points)	15	20
Mean elbow performance scored (points)	46	90

Fig 1

Fig 2

Fig 3

Fig 4

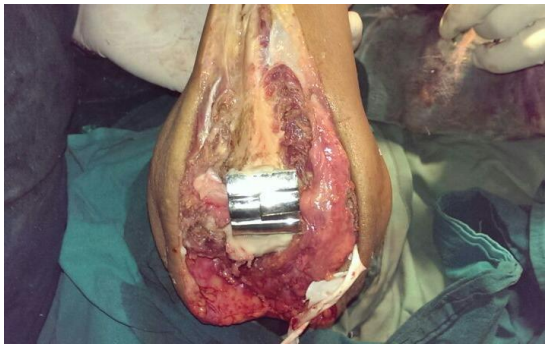

Fig 5

Fig 6

Fig 7

Fig 8

Fig 9

Conclusion

To conclude, Total Elbow Replacement surgery provides significant pain relief, stability and a functionally useful range of movement in elbows affected by non inflammatory arthritis.

The surgery accomplishes all the aims of elbow reconstruction with good functional outcome and survivorship and significantly reduces the disability of the patient.

Total elbow Replacement is an effective procedure for the treatment of patients with non inflamatory arthritis.

Surgery in longterm is cheaper and better and is associated with less complications than going for other modalities of treatment.

As such, the information regarding TEA utilization, demographics, cost and complications are limited. The average hospital stay is 15 days with a total cost of 30,000-40,000 /- per case.

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