Original Article

Evaluation of Functional Outcome of Elbows after Resection Arthroplasty of Failed Total Elbow Replacement

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Abstract

Background: Recovery of elbow function is a challenging problem following resection arthroplasty after failure of total elbow prosthesis. The objective of this study is to evaluate long term functional outcome in a series of such patients. **Materials and Methods:** Nineteen patients with twenty elbows who had failed total elbow arthroplasty (TEA) following the use of Baksi total elbow prosthesis needed removal of prosthesis during the period from 1978 to 2003. As two patients were lost to followup, 17 patients with 18 elbows (bilateral in one) were included in this study with a mean age of 44.3 years. Nine cases had uncontrolled infection, seven cases of aseptic loosening including one occurred after TEA for bilateral postburns ankylosis, and two had broken humeral stems. After removal of the prosthesis and its adjacent surrounding bone cement, the cut ends of humerus and ulna were approximated with number 5 Ethibond suture. Postoperatively, the elbow was immobilized in a plaster slab in 110° elbow flexion for 6 weeks followed by physiotherapy. The patients were evaluated for 15–19.4 (mean 16.3) years where functional results were compared at 10 years and 15 years following resection arthroplasty. **Results:** The resected elbow initially remained flail but gradually regained stability, especially in the sagittal plane. Both the groups showed overall improvement from preoperative Mayo Elbow Performance Score (MEPS) 26.5 to postoperative mean MEPS at 10 years (69.6) and at 15 years (70) (P = 0.001). Postoperative mean DASH score was 36.62 at 10 years' and 36.38 at 15 years' followup, suggesting persistence of function of resected elbow in the passage of time. The results were good in 9 (50%), fair in 7 (38.8%), and poor in 2 (11.1%) patients. None had recurrence of infection. Transient ulnar nerve palsy was seen in three patients. Postoperatively, power of Biceps recovered up to Medical Research Council grade 4 and Triceps 2–3. **Conclusion:** Resection arthroplasty of elbow provided acceptable functional recovery in our series of patients with failed elbow prosthesis.

Keywords: *Outcome, resection, arthroplasty*

Introduction

The functional outcome of resected elbow after failure of total elbow arthroplasty remain a matter of great concern. Failure of total elbow arthroplasty (TEA) may result from infection, aseptic loosening, or breakage of prosthetic stems and rarely due to accidental disassembling of prosthetic components. An average 6% failure rate after TEA was experienced by different workers.[1] However, the mode of failure changes in due course of time as infection is the primary mode of early failure in the first 5 years, bushing wear of Coonrad–Morrey prosthesis in 5–10 years, and its component failure or loosening is seen in more than 10 years following the operation.[2] Overall, infection is the serious and most common cause of failure, with its incidence ranging from 1% to 12%.[3-6] Management of such elbows is done by revision or resection arthroplasty, arthrodesis, and rarely amputation.[3,6-8] However, in some infected cases, two-stage reimplantation is advised by some workers,[3,5,7,8] but it has become impractical and unsuccessful in most patients with failed TEA because of coexisting medical comorbidities with poor bone quality or resistant or flaring up of dormant infection.[5]

Therefore, removal of prosthesis is a salvage option and should be considered in patients with refractory infection when all attempts to eradicate the infection fail.[5,9,10] Following resection arthroplasty of elbow, functional outcome was reported to improve from preoperative Mayo Elbow Performance Score (MEPS) 49[5] to postoperative 60.[10] Subjective clinical improvement after resection arthroplasty

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was in terms of relief of pain with compromised stability in majority of the cases.[5,10] In this study, the mode and pattern of failure as well as the functional outcome of resection arthroplasty of failed first-generation (original Baksi rigid hinge[11]) and second-generation (original Baksi sloppy hinge[6]) TEA were studied and reported in a series of patients resulting from different causes and variable period after TEA. In this study, the aim was to find out the functional status of those elbows where prosthesis was taken out. The objective was to find out the causes of failure, pattern (the frequency of stems failed with duration from index procedure), functional status of failed first- and second-generation Baksi's prosthesis (whatever difference of clinical outcome related to the design of prosthesis used) as well as to find out the difference of clinical outcome of resected elbows with the passage of time after removal of prosthesis. Here, the clear research question of this study was to find out the clinical outcome of functional status of elbows during the passage of time where the prosthesis was removed due to different reasons.

Materials and Methods

Baksi's original first-generation, all-metal hinge elbow prosthesis having 2° to 3° laxity at the hinge section, has been used in different clinical conditions since 1978.[11] This prosthesis was redesigned into second-generation sloppy design on the basis of studies of its physical properties with the help of a newly designed elbow joint simulator.[12,13] The second-generation, all-metal sloppy hinge elbow had 7°–10° side-to-side laxity but limited rotation at its hinge section and was being used in clinical practice since 1984. This design had limited motion-bearing contact areas due to potential gap between the motion-bearing components, and hence resulted in minimal metal dust liberation. Two hundred and fifty nine index elbow arthroplasties using first- and second-generation Baksi elbow prosthesis had been performed, of which 20 prosthesis in 19 patients (one bilateral) needed removal between 1978 and 2003, of which two patients were lost to followup. The initial diagnosis leading to index elbow arthroplasty included posttraumatic bony ankylosis/arthritis in 209 elbows,[6,11,14] advanced rheumatoid arthritis in 14 elbows,[14] postburns bony ankylosis in 17 elbows,[15] osteoarthritis in 3 elbows, and unstable elbow following trauma or failed osteosynthesis in intercondylar fracture of distal humerus in 16 elbows.[6,11,14] The causes of resection arthroplasty and duration after index procedure are mentioned in Table 1. The institutional ethical board approved this study. In this retrospective study, the functional status of the resected elbows of the patients was evaluated following resection arthroplasty during schedule followup or by contact either via telephone or using letters sent by post. Resected elbows of all patients who were willing to participate in the study were included. Only one patient who did not agree to participate in the study was excluded.

We studied the functional outcome of 18 resected elbows in 17 patients (one bilateral) between 1978 and 2017. Nine deep infection out of 18 elbows, resistant to all treatment modalities, remained the major cause of resection arthroplasty, and seven aseptic loosening (one following bilateral postburn ankylosis) and two broken humeral stem with loosening were included, when they were associated with painful elbow motions with instability. All these patients were thoroughly counseled regarding the advantages and disadvantages of resection arthroplasty as well as other options. The procedures of resection arthroplasty were undertaken only after explaining the postoperative outcome regarding this procedure and accordingly, their written consent was obtained. Here, resection arthroplasty following removal of prosthesis was a rescue operation from a complicated condition of index arthroplasty. Still, ethical clearance was taken from standard and statutory ethical board of the concerned institution where the rescue operation was undertaken.

Operation technique

Under general anesthesia and tourniquet application in the upper arm, skin incision is made through the original scar of posteromedial incision over the elbow of index arthroplasty. Special care is taken to dissect the ulnar nerve, embedded in fibrous tissues and shifted medially during exploration of the prosthesis. Soft-tissue dissection is carried out just over the medial side of the hinge component of the prosthesis, and dissection was extended both proximally over the distal part of humerus and distally to the upper part of ulna. The discolored reactionary tissues wherever present around the prosthesis are meticulously excised till the healthy soft tissues are visible. If both the stems of the prosthesis are loose, it is possible to remove the prosthesis in an assembled form by the distraction forces applied gently by hammering over the hinge section with the help of a special impactor by keeping the elbow flexed at 100°. When only one prosthetic stem is loose and the other is firmly fixed, the dissembling of the prosthetic components is mandatory for their removal. Disassembling is done by removal of the lock screw through the main surgical wound followed by removal of the main screw through a small skin incision, made over the lateral aspect of the elbow overlying the head of the main screw. Then, the humeral stem is removed which is found loose commonly. However, whenever the stem is not loose, then a longitudinal slit over the anterior humeral shaft is cut overlying the distal half of the stem of the prosthesis to make it free from the cement mantle with the help of thin osteotome or bone gouge carefully to avoid fracture of the shaft of humerus. For the removal of ulnar stem which usually remains firmly seated, a longitudinal musculo-osteoperiosteal flap is cut with an electric saw after making drill holes over the medial surface of the proximal shaft of the ulna extending from the upper cut end distally till the distal part of the ulnar stem is separated from the cement mantle. All the bone cement along with

Table 1: Details of resected elbow

Age (years)	Sex	Sides	Causes of primary TEA	Date of primary TEA	Type of prosthesis used	Causes of removal	Date of resection
20	Female	Right	RA ankylosis	January 30, 1978	I	Primary infection	April 15, 1978
52	Male	Left	Posttraumatic ankylosis	April 25, 1979	I	Broken humeral stem	June 25, 1983
46	Female	Right	Postburns ankylosis	May 5, 1982	I	Aseptic loosening	May 7, 1993
46	Female	Left	Postburns ankylosis	August 9, 1982	I	Aseptic loosening	February 11, 1993
34	Male	Left	Posttraumatic ankylosis	March 11, 1983	I	Aseptic loosening	August 12, 1998
51	Male	Right	Posttraumatic ankylosis	June 23, 1983	I	Delayed infection	June 25, 1989
62	Female	Left	RA ankylosis	October 29, 1983	I	Primary infection	September15, 1989
40	Female	Left	Postburns ankylosis	March 17, 1984	I	Delayed infection	December 2, 1995
65	Male	Right	Posttraumatic instability	July 29, 1984	II	delayed infection	December 15, 1997
49	Male	Left	Posttraumatic instability	January 3, 1985	II	Delayed infection	July 17, 1991
58	Male	Left	RA ankylosis	May 9, 1986	II	Aseptic loosening	August 12, 2000
29	Female	Right	Failed ORIF with instability	November 15, 1986	II	Aseptic loosening	December 15, 1998
46	Female	Right	RA ankylosis	May 25, 1988	II	Delayed infection	February 1, 1999
42	Male	Left	Posttraumatic ankylosis	November 29, 1989	II	Aseptic loosening	December 15, 1996
32	Male	Right	Posttraumatic instability	February 7, 1990	II	Broken humeral stem	January 15, 2002
59	Female	Left	RA ankylosis	June 15, 1990	II	Delayed infection	December 29, 1992
42	Female	Left	Failed ORIF instability	August 25, 1999	II	Delayed infection	June 14, 2002
36	Female	Left	Failed ORIF	November 11, 1991	II	Aseptic loosening	December 03, 2002

Duration of TER at resection	Duration of FU after resection	MEPS score			Post Operative DASH score		Complication	Gradation of results
		Preoperative	Postoperative (10 years)	Postoperative (15 years)	At 10 years	At 15 years		
2 and ½ months	15 years	20	49	50	36.3	45.7	Delayed wound healing	Poor
4 and ½ years	16 and 5/12 years	30	70	70	34	38.6	Transient ulnar nerve palsy	Fair
11 years and 3 months	15 and 5/12 years	20	56	55	40	45.7	Delayed wound healing	Poor
10 and ½ years	16 and 2/12 years	35	75	75	31.8	25	Nil	Good
15 and 5/12 years	19 and 4/12 years	30	75	75	36.3	31.8	Nil	Good
6 years	19 and 2/12 years	35	66	65	40	43.1	Transient ulnar nerve palsy	Fair
5 and 11/12 years	17 and 9/12 years	25	64	65	40	45.7	Nil	Fair
11 and 9/12 years	15 and 6/12 years	30	75	75	38.6	34	Nil	Good
13 and 5/12 years	16 and 6/12 years	25	81	80	43.1	38.6	Nil	Good

Contd...

Table 1: Contd...

Duration of TER at resection	Duration of FU after resection	MEPS score			Post Operative DASH score		Complication	Gradation of results
		Preoperative	Postoperative (10 years)	Postoperative (15 years)	At 10 years	At 15 years		
6 and 6/12 years	15 and 11/12 years	25	69	70	31.8	34	Nil	Fair
14 and 3/12 years	17 and 10/12 years	30	74	75	34	31.8	Nil	Good
12 and 1/12 years	16 years	25	79	80	36.3	31.8	Nil	Good
10 and 9/12 years	15 years	25	65	65	31.8	36.3	Nil	Fair
7 and 1/12 years	16 and 7/12 years	25	74	75	38.6	31.8	Nil	Good
12 years	15 years	30	69	70	40	45.7	Nil	Fair
2 and 6/12 years	15 and 6/12 years	25	64	65	34	31.8	Transient ulnar nerve palsy	Fair
2 and 10/12 years	15 and 6/12 years	25	74	75	34	31.8	Nil	Good
11 and 4 years	15 years	25	75	75	38.6	31.8	Nil	Good

TEA=Total elbow arthroplasty, I=Baksi original relatively rigid hinge prosthesis, RA=Rheumatoid arthritis, II=Baksi original sloppy hinge prosthesis, ORIF=Open reduction and internal fixation, FU=Followup, MEPS=Mayo Elbow Performance Score, DASH=Disabilities of the arm, shoulder and hand, TER=Total elbow replacement

unhealthy granulation tissues were removed from humeral and ulnar medullary canals. Sample for microbiological test was prepared from the operating field during the removal of prosthesis.

Wound is thoroughly irrigated with normal saline mixed with povidone-iodine solution. Then, the tourniquet is removed, and hemostasis is well secured. For anchorage of adjacent bone ends of humerus and ulna, drill holes are made transversely across the approximated humeral and ulnar bone ends for the passage of number 5 Ethibond sutures (braided nonabsorbable polyester suture manufactured by Johnson and Johnson Company, San Juan, Puerto Rico, America). The suture ends are tied in front of adjacent bone ends in the fashion of figure of eight. Two suction drains, each one placed in the respective medullary canals of humerus and ulna, are usually removed 3–4 days after the drainage ceases.

After removal of stitches at 2 weeks, the elbow is then immobilized in a plaster slab at 110° flexion for a period of 6 weeks to facilitate the maturation of scar tissues connecting the adjacent ends of humerus and ulna to ensure stability of the resected elbow. On removal of plaster slab, vigorous elbow-mobilizing exercises taking 500 mg to 1 kg weight in hand are continued till elbow flexion is stable at least in sagittal plane. An elbow brace is used for initial 3–6 months till the recovery of relatively stable elbow flexion, when the elbow brace may be discarded.

Results

All the 17 patients of age 20–65 (mean 44.8) years were evaluated for 15–19 years, 4 months (mean 16 years and 3 months), till December 2017, and their results were recorded [Table 1]. After 15 years of followup, most of the patients either refused to come on request or lost to followup. Therefore, those patients who completed at least 15 years' followup were included in this study. The date of resection arthroplasty, its postoperative complications, and its followup period were also recorded [Table 1]. Tests for checking normality before parametric test were used with the help of "*t*"– test to assess difference between the two groups where type I and type II Baksi's prostheses were used [Table 2]. There was no significant difference between the two groups. It suggests that the groups were similar. Unpaired "*t*-" test was done in the two groups using the prosthesis type I and type II which showed df (2) at 0.05 table value is 1.03. Therefore, the obtained value between the two groups was not different. For functional outcome of preoperative and postoperative status of resection arthroplasty, we used MEPS[16] having four components, each weighed with a maximum number of points for a total score of 100. In that score, pain got a maximum of 45 points, range of motion 20, stability 10, and function 25 points. Outcome was assessed based on the total number of points achieved with 90 points or more indicating excellent, 75–89 points indicating good,

60–74 points indicating fair, and <60 points indicating poor results. Subjective evaluation of functional status was also assessed by DASH score[17] where a questionnaire carrying 30 questions was served to the patients and asked to respond in at least 27 questions out of the 30. Then, a formula was used to calculate the score out of 100.[17] Here, the higher the DASH score, the greater the disability was considered.[17] For statistical analysis, paired *t*-test was used to compare preoperative and postoperative changes of MEPS, its individual components, as well as DASH score at 10 years' and 15 years' followup.

Results of the patients after resection arthroplasty during the course of 10 years' and 15 years postoperative followup to evaluate the functional outcome including the quality of stability of elbow motions whether they are improving or deteriorating with the passage of time in the long term followup are reported in Table 3. Mean MEPS score improved significantly from preoperative mean 26. 5 to postoperative mean 70 in both the groups [Table 3]. According to the table using the paired *t* test, we find that the table value of *P* of 0.05 level of significance at *df* (17) is 3.96. As our calculated *t* value (25.01) in this study [Table 4] was high than the table value (3.96), we conclude that our results are significant, rejecting null hypothesis**.** The mean MEPS of all elbows at 10-year followup was 69.6 and at 15 years 70 [Table 5]. As the difference between the mean values of the above two durations of followup proved to be statistically insignificant ($P > 0.05$), it suggests that no significant changes took place in these years of followup. As the difference between the mean MEPS at 10 and 15 years was only 0.34, the *t* value came out to be 1.85 [Table 5], which is not significant at 0.05 level of significance (*df* 17). The mean DASH score of all elbows at 10-year followup was 36.62 and at 15 years was 36.38 [Table 3]. As the difference between the mean values of the above two durations of followup proved to be statistically insignificant ($P > 0.05$), it suggests that no significant changes took place in these years of followup. As the difference between the mean DASH score at 10 and 15 years was only 0.3, the *t* value came out to be 0.18 [Table 6], which is not significant at 0.05 level of significance at df 17. It means that there was no significant change in DASH score in 10- and 15-year postoperative functional status, suggesting the consistency of the functional outcome of resected elbows during the passage of time.

Here, the resected elbows regained functional stability especially in sagittal plane, whereas variable instability persisted during elbow motions with abducted shoulder with overall satisfactory functional status maintained in 10–15 years following the operation [Table 2]. Majority (16 out of 18) of our patients were using their elbows with their level of satisfactions by relatively stable elbow motions in sagittal plane (with the arm by the side of the body). However, they had relatively unstable elbow motions when they attempted to use their elbow with shoulder abducted. The patients who regained satisfactory stable elbow motions in sagittal plane with the arm by the side of the body but were satisfied with relatively unstable motions in coronal plane were awarded 5 or 10 points for stability in MEPS score and were considered to have good results. The patients who were unsatisfied with their instability of elbow with shoulder abducted were awarded either 0 or 5 marks for stability depending on their level of satisfaction and achieved fair results. The patients who were unsatisfied for unstable elbow motions both in the sagittal plane with the arm by the side of the body and with the abducted shoulder were awarded 0 marks and were considered to have poor results.

Overall, the results were good [Figures 1-6] in 9 (50%), fair in 7 (38.8%), and poor in 2 (11.1%) patients. Both the groups showed significant improvement of MEPS from

Table 2: *t*-test to assess the difference between two groups/homogeneity of the groups using type I and II prostheses (n_1=8, n_2=10, total *n*=18)

Groups	Mean preoperative MEPS	SEMD	*t*	Remarks
Used prosthesis type I (*n*=8)	28.13	2.06	1.03	Not significant
Used prosthesis type II (*n*=10)	26			

P>0.05 at df (16) at 0.05 level of significance. There was no significant difference between the two groups. It suggests that groups were similar. MEPS=Mayo Elbow Performance Score, SE_{MD}=Standard error of mean difference

Table 3: Overall results of resected elbows after removal of prosthesis

Group of elbow	Mean MEPS pain score Preoperative/ postoperative	Mean postoperative elbow motions extension/ flexion (°)	Mean postoperative forearm motions supination/ pronation (°)	Mean postoperative MEPS ROM score	Mean postoperative MEPS stability score preoperative/ postoperative	Mean postoperative MEPS function score	Mean MEPS score preoperative/ postoperative	DASH score
Elbows of 10-year FU	11.25/37.5	36.25-99.4	52.5/58.7	15	8.5/5	11.8	26.5/69.66	36.62
Elbows of 15-year FU	11.25/36	43-103.5	49/60	15	8.5/5	15	26.5/70	36.38

FU=Followup, ROM=Range of motion, *n*=Number of patients, MEPS=Mayo Elbow Performance Score, G=Good, F=Fair, P=Poor

their preoperative value and achieved almost similar score irrespective of the duration of followup. After resection, the level of satisfaction in the daily activities was assessed clinicoradiologically by different workers and subjectively by using questionnaire with the options for management. The patients were thoroughly counseled regarding the advantages and disadvantages of further reimplantation and only after having their consent, resection of elbow was considered. Two patients who had poor results were rehabilitated with the use of adjustable turn buckle elbow brace only during some particular work on demand.

Complications

Two patients needed prolonged use of antibiotics and dressing for delayed wound healing (case no. 1 and case no. 3), but surprisingly none had recurrence of infection. Among the nine patients, where infection (either primary in two or delayed infection in seven) was the indication for resection arthroplasty, two had *Staphylococcus aureus* for primary infection and four had *Staphylococcus epidermidis* resistant to multiple antibiotics for delayed infection. No organism was found in three patients of delayed infection. Postoperative transient ulnar nerve palsy was seen in three (case nos. 2, 6, and 16) patients, which recovered completely in the subsequent followup.

Table 4: Paired *t*-test showing difference in preoperative and postoperative Mayo Elbow Performance Score among the patients of resection arthroplasty

State	Mean	Mean difference	*t*	Remarks
Preoperative	26.94	43.06	25.01	Significant
Postoperative	70			

Total number of patients=18. $P<0.05$ at df (17). It means a significant functional outcome was achieved

Table 5: Paired *t*-test showing difference in Mayo Elbow Performance Score at 10 years and 15 years after resection arthroplasty

Client assessed at (years)	Mean MEPS score	Mean difference	*t*	Remarks
10	69.6	0.34	1.85	Not
15	70			significant

Here, the total number of patients was 18. $P>0.05$ at df (17) at 0.05 level of significance. It means that there was no significant change in MEPS of resected elbows during passage of 10 years and 15 years. MEPS=Mayo Elbow Performance Score

Table 6: Paired *t*-test showing difference in Disabilities of the Arm, Shoulder and Hand Score at 10 years and 15 years after resection arthroplasty

Client assessed at (years)	Mean DASH score	Mean difference	*t*	Remarks
10	36.62	0.24	0.18	Not
15	36.38			significant

$P>0.05$ At df (17). It means that there was no significant change in DASH score of resected elbows during passage of 10 years and 15 years. DASH=Disabilities of the Arm, Shoulder and Hand

Discussion

Resection arthroplasty is a treatment option following failed TEA when other options are not feasible.[5,9,10,18] Among 18 elbows who required resection arthroplasty in our series, infection was the most common indication in 9 (50%), followed by aseptic loosening in 7 (38.8%) and breakage of prosthetic stem in 2 (11.1%) elbows.

The main advantage of resection arthroplasty in this series is eradication of infection and improvement of pain score from 10.12 (preoperative) to 36.7 (postoperative) which did not deteriorate even in long term followup. Overall MEPS improved from preoperative 26.4 to postoperative 69.4 in our series, comparable to other workers' experience.[10] The superior results in terms of MEPS score of our series compared to that of Yamaguchi *et al*.[5] and Figgie *et al*.,[19] may be explained by several factors. Because the hinge section of our prosthesis is smaller, the resulting gap after removal of prosthesis between the humerus and ulnar bone ends is relatively smaller. Moreover, the subsidence of the prosthetic stem in the presence of loosening leads to further approximation of bone ends [Figure 1]. In addition, the nonabsorbable suture connecting them improved the stability of the resected elbow in the presence of adjacent mature periprosthetic fibrous tissues and reorientation of muscle balance after vigorous postoperative exercise. Majority (88.8%, 16 out of 18) of our patients achieved good functional elbow stability in sagittal plane, whereas moderate degree functional elbow stability in coronal plane was achieved only in 9 (50%) patients and marked as good results [Table 1]. The periprosthetic tissue studied histologically showed either matured fibroblast in noninfected cases or incompletely matured fibroblast with inflammatory cells in cases of infection along with generalized features of patchy areas of woven bone and calcification in all. The formation of incompletely matured fibrous tissue in cases of infection explained the presence of clinically unstable elbow motions for relatively longer period. All patients were able to discard the elbow brace, when they achieved reasonable stability of elbow at least in sagittal plane after 3 to 4 months' postoperative period. Two patients with poor results are using the elbow brace intermittently during the use of elbow with abducted shoulder.

The bone ends remain approximated after removal of prosthesis due to fibrosis connecting the adjacent bone ends, contrary to primary excision arthroplasty of elbow, where the free bone ends are seen to diverge from the beginning of motions resulting in gross laxity with instability. The presence of prosthesis *in situ* following TEA allowed approximation of the bone ends of humerus and ulna which remained apposed [Figure 1] after the

Figure 1: 15.5-year postoperative skiagraph of index total elbow arthroplasty done in a 34-year-old male patient with posttraumatic bony ankylosis of the left elbow treated with original first-generation Baksi all-metal total elbow hinge prosthesis fixed with bone cement showing gross loosening with subsidence of humeral stem and approximation of adjacent bone ends [case no. 5 vide Table 1]

Figure 2: One-year postoperative skiagraph of the above patient after removal of the elbow prosthesis showing approximation of the adjacent humeral and ulnar bone ends

Figure 3: One-year postoperative clinical photograph of the above patient showing full elbow flexion

Figure 4: One-year postoperative clinical photograph of the above patient showing full elbow extension against gravity

passage of time, with the periprosthetic fibrous tissues anchoring them. On this background, the matured periprosthetic fibrous tissues around the resected elbows, especially on the anterior aspect and reorientation of muscle balance, explained the long-lasting stability achieved after resection arthroplasty in failed TEA which appeared superior to primary interposition arthroplasty as experienced by several workers, where the occurrence of early postoperative stability gradually deteriorates with the passage of time.[20,21] After postoperative rehabilitation program, the biceps recovered up to power Medical Research Council grade 4 and triceps 2–3. This series showed lower rate of complications and no flare up of postoperative infection after removal of prosthesis and the surrounding bone cement. The use of the MEPS in this study may be misleading as stability in this scoring system was only allocated a maximum of 10 points of possible 100 points of MEPS. The improvement in outcome following resection is attributed largely to a relief of pain (maximum score of 45) and not necessarily stability. A flail elbow, for example, may in fact score reasonably well with the system of the MEPS on the basis of pain score, range of motion, and function even though the elbow is completely unstable. Here, DASH score was not used preoperatively as there was symptomatic functional limitation of elbow in the presence of failed prosthesis *in situ*. Whereas, our aim was to evaluate the functional status of resected elbow without prosthesis and to evaluate the consistency of the functional status of resected elbow in due course of time for which DASH was very much appropriate. Hence, DASH score[17] is useful in this situation to estimate the actual performance of routine different daily activities in the presence of instability. Here, the resected elbows regained functional stability especially in sagittal plane, whereas variable instability persisted during elbow motions with abducted shoulder, with overall satisfactory

Figure 5: 19.4-year postoperative skiagraph of the above patient after removal of elbow prosthesis showing little gaping (remain approximated) of the humerus and ulnar bone ends

Figure 6: 19.4-year postoperative clinical photograph of the above patient showing his left elbow extension against gravity

functional status maintained in 10–15 years following the operation [Table 2]. In our series, the mean postoperative DASH score in the final followup was 35.86, which is comparable to the score reported by other workers.[10]

The misconception that resection arthroplasty of elbow leads invariably to a flail elbow with poor functions is not supported by this study. Although the sample size is small, which is a limitation of the study, the long period of the study provided valuable information regarding the efficacy of resection arthroplasty. Thus, this series showed that resection arthroplasty can provide painless, reasonably satisfactory stable elbow motions in majority of cases with some limitation of daily activities without recurrence of infection. Hence, this can be recommended as a treatment option for failed TEA of the patients when no other surgical option is available to provide reasonable functional elbow.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

References

1. Little CP, Graham AJ, Carr AJ. Total elbow arthroplasty: A systematic review of the literature in the English language until the end of 2003. J Bone Joint Surg Br 2005;87:437-44.
2. Throckmorton T, Zarkadas P, Sanchez-Sotelo J, Morrey B. Failure patterns after linked semiconstrained total elbow arthroplasty for posttraumatic arthritis. J Bone Joint Surg Am 2010;92:1432-41.
3. Morrey BF, Bryan RS. Infection after total elbow arthroplasty. J Bone Joint Surg Am 1983;65:330-8.
4. Wolfe SW, Figgie MP, Inglis AE, Bohn WW, Ranawat CS. Management of infection about total elbow prostheses. J Bone Joint Surg Am 1990;72:198-212.
5. Yamaguchi K, Adams RA, Morrey BF. Infection after total elbow arthroplasty. J Bone Joint Surg Am 1998;80:481-91.
6. Baksi DP. Sloppy hinge prosthetic elbow replacement for posttraumatic ankylosis or instability. J Bone Joint Surg Br 1998;80:614-9.
7. Morrey BF, Bryan RS. Revision total elbow arthroplasty. J Bone Joint Surg Am 1987;69:523-32.
8. Morrey BF, editor. The Elbow and Its Disorders. 3rd ed. Philadelphia: W. B. Saunders; 2000. p. 685-700.
9. Razza F, Peretti GM, Macias G, Lastroni G. Resection arthroplasty as alternative procedure for the stiff elbow. Minerva Orthop Traumatol 2001;52:73-80.
10. Zarkadas PC, Cass B, Throckmorton T, Adams R, Sanchez-Sotelo J, Morrey BF. Long term outcome of resection arthroplasty for the failed total elbow arthroplasty. J Bone Joint Surg Am 2010;92:2576-82.
11. Baksi DP. Total replacement of the elbow joint. Indian J Orthop 1980;14:129-42.
12. Baksi DP. Studies on Physical Properties of a Newly Designed Elbow Prosthesis and Clinical Evaluation After Its Transplantation. Ph D Thesis. 1984 University of Calcutta; 1984. p. 1-186.
13. Baksi DP. Evaluation of physical properties of author's elbow prosthesis with the help of a newly designed elbow joint simulator. Indian J Orthop 1989;23:61-9.
14. Baksi DP. Result of Baksi sloppy hinge compared to rigid hinge elbow arthoplasty. Indian J Orthop 1995;30:1-11.
15. Baksi DP, Pal AK, Chatterjee ND, Baksi D. Prosthetic replacement of elbow in postburn bony ankylosis: Long term results. Int Orthop 2009;33:1001-7.
16. Morrey BF, An KN. Functional evaluation of the elbow. In: Morrey BF, editor. The Elbow and Its Disorder. 2nd ed. Philadelphia: W. B. Saunders; 1993. p. 74-83.
17. Hudak PL, Amadio PC, Bombardier C. Development of an

upper extremity outcome measure: The DASH (disabilities of the arm, shoulder and hand) [corrected]. The upper extremity collaborative group (UECG) Am J Ind Med 1996;29:602-8.
18. Dee R. Reconstructive surgery following total elbow endoprosthesis. Clin Orthop Relat Res 1982;(170):196-203.
19. Figgie MP, Inglis AE, Mow CS, Wolfe SW, Sculco TP, Figgie HE 3rd. Results of reconstruction for failed total elbow arthroplasty. Clin Orthop Relat Res 1990;(253):123-32.
20. Kita M. Arthroplasty of the elbow using J-K membrane. An analysis of 31 cases. Acta Orthop Scand 1977;48:450-5.
21. Knight RA, Van zandt IL. Arthroplasty of the elbow; an end-result study. J Bone Joint Surg Am 1952;24 A: 610-8.