Original Article

Sloppy Hinge Prosthetic Replacement in Old Healed Side Swipe Injuries of Elbow – Long term Results

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Abstract

Background: Sideswipe injuries of elbow often poses significant functional loss resulting from devastating injuries involving osseoligamentous structures as well as multilevel soft tissue injuries around the elbow. Inspite of treatment, no conscientious treatment opinion is available in the literature to provide optimum functional outcome. The objective of this study is to evaluate the results of prosthetic replacement of old healed sideswipe injuries of elbow with gross dysfunctional disabilities resulting from loss of bones and muscles around the joint. **Materials and Methods:** Fourteen patients of 2–3 years old healed sideswipe injuries of the elbow, treated by Baksi sloppy hinge (original version in seven and recent version in seven) prosthetic replacement were evaluated. All had normal neurovascular status except two; one having ulnar nerve deficit the other median nerve in another. The mean age was 42.7 years (range 32-61 years). **Results:** The average followup period was 13.5 years (range 5.11-23.11 years). Ten patients regained stable 0° to 130° elbow flexion, and four had restricted terminal flexion with arc 10°–115° following V-Y plasty of contracted triceps. Mean supination was 22° and mean pronation was 35°. According to Mayo Elbow Performance Score (MEPS), excellent results were in five (35.7%), good in six (42.8%), and fair in one (7.1%). Two patients (14.2%) needed removal of prosthesis due to intractable delayed infection and considered failure. Following removal, the resected elbow retained relatively stable motions due to mature fibrous tissues connecting the adjacent bone ends and reorientation of muscle balance. Postoperative improvement of MEPS (mean 84) was significant (P = 0.0037) compared to preoperative value (mean 41.7). Two patients had superficial wound infection and five aseptic loosening of which one was symptomatic. **Conclusion:** Prosthetic replacement of elbow is an effective salvage procedure in old healed sideswipe injuries.

Keywords: *Elbow, side swipe injuries, total elbow arthroplasty*
MeSH terms: *Prosthesis, arthroplasty, replacement, elbow joint*

Introduction

The massive injuries of elbow like sideswipe injury or baby car injury were introduced into the orthopedic literature since 1940.[1,2] The findings usually included an open comminuted fracture of proximal ulna, dislocation of the elbow, and fracture of the distal humerus. The devastating nature of the injury is obvious by its association of 50% amputation rate.[3] The massive trauma to the elbow is characterized by involvement of all the major tissues including bones, joints, vessels, nerves, muscles, and skin which require demanding surgical management with high level of expertise.[4-8] After primary repair, secondary reconstruction of elbow is often required due to loss of bone and muscles around the elbow resulting in instability with functional loss, associated with or without pain, provided the neurovascular status of the limb is reasonably preserved. To ensure the stability of the elbow either arthrodesis or its prosthetic replacement may be contemplated. Arthrodesis is extremely difficult because of deficient bone stock in this situation.[3]

Other options like interposition arthroplasties are also difficult to contemplate around the deficient bone ends. Except sporadic case report of prosthetic replacement of elbow in side swipe injuries,[8-11] no report on a series of such cases and their functional results have been published in the literature within our knowledge. The object of this paper is to report the long term functional results of Baksi sloppy hinge elbow arthroplasty in a series of such patients.

Materials and Methods

Seventeen patients of 2- 3 year-old healed sideswipe injuries of elbows who had functional disabilities were selected for the

How to cite this article: Baksi D, Pal AK, Baksi DP. Sloppy hinge prosthetic replacement in old healed side swipe injuries of elbow – long term results. Indian J Orthop 2018;52:177-83.

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Access this article online

Website: www.ijoonline.com

DOI: 10.4103/ortho.IJOrtho_179_17

Quick Response Code:

study. Original Baksi sloppy hinge[11] prosthetic replacement was done in ten during the period from January 1993 to December 2003 and recent version of sloppy hinge[12] replacement was done in seven during the period from August 2004 to January 2011 [Table 1]. The adults and elderly patients having completely unstable elbow with painful or painless nonfunctional arc of elbow motion for at least 2-3 years healed side swipe injuries were selected. Two patients had partial ulnar nerve injury (case no. 6) and medial nerve injury (case no. 10). There should not be any evidence of infection clinically as well as from investigational parameters such as ESR and CRP which should be within normal limit without radiographic features of infection. On the other hand, skeletally immature patients with unstable elbows, those with evidence of neuro vascular deficit or established chronic infection of bones around the elbow were excluded from the study.

The mean duration between time of injury and total elbow arthroplasty was 35.2 months. This study was done after consent and permission of the ethical board. Three patients treated initially by original Baksi Sloppy Hinge Elbow Prosthesis were lost in follow up. The patients were assessed clinically by Mayo Elbow Performance Score [MEPS] of which an excellent result was considered when scored between 90 and 100, good between 75 to 89, fair between 60 to 74, and poor below 60 points. Preoperatively, all patients presented with completely unstable elbow MEPS with active range of elbow motions below 50° (MEPS range of motion score five). Patients had either painless (MEPS pain score 45) or minimal painful (MEPS pain score 30 or 15) active elbow flexion before operation, resulting in inability to perform activities of daily living (MEPS activity score zero).

Accordingly, preoperative mean MEPS score was 41.7 (SD 6.80). All had normal neurovascular status except two having partial ulnar nerve deficit with clawing of little and ring fingers (Case 6) and partial weakness of muscles of forearm and hand from median nerve neural deficit (Case 10). The mean age was 42.7 years (range 32-61 years). There were nine males and five females. The right side was involved in six cases and left side in 8 cases. Pronation and supination of forearm were restricted due to ineffective rotators of forearm and contracture of interosseous membrane. ESR and CRP were within normal limits and there was no radiographic evidence of infection before we considered for total elbow arthroplasty (TEA).

Prosthesis

The original design of Baksi sloppy hinge elbow[11] was redesigned into recent version[12] [Figure l] and is in use since 2003 (Indian registered design number 20075). It is a semiconstrained design with 7° to 10° varus valgus laxity with limited rotation at its hinge section. The hinge components have metal on metal articulation with a potential gap at the motion bearing surfaces resulting in limited contact during elbow motions, hence minimal metal dust liberation.[11,12] The improved recent version[12] [Figure l] differs from the previous design by its provision of two flanges, each of 13 mm. height, 10 mm. breadth and 2.5 mm thickness incorporated on each side of the shank of humeral stem of sloppy hinge prosthesis in its coronal plane [Figure l]. The flanges are seated in the corresponding longitudinal slot made on each side of the humeral shaft [Figure 1, Inset] extending from its transverse cut end to be seated in corresponding slot to act as single prosthesis-bone assembly, thereby overcome the windshield wiper effect of the humeral stem.

Operative procedure

The elbow is placed in front of the chest with the patient lying in supine position on the operation table. Through the posterior midline incision, the ulnar nerve is isolated and the posterior surface, of distal humerus, the margins and lower attachment of triceps are delineated while the comminuted loose, fractured olecranon fragments with attached soft tissues are seen. The distal end of triceps is isolated and separated from the posterior surface of distal humerus whose condyles are often missing. The healthy part of lower part of humerus just proximal to its fractured segment is sectioned transversely for exposure of its

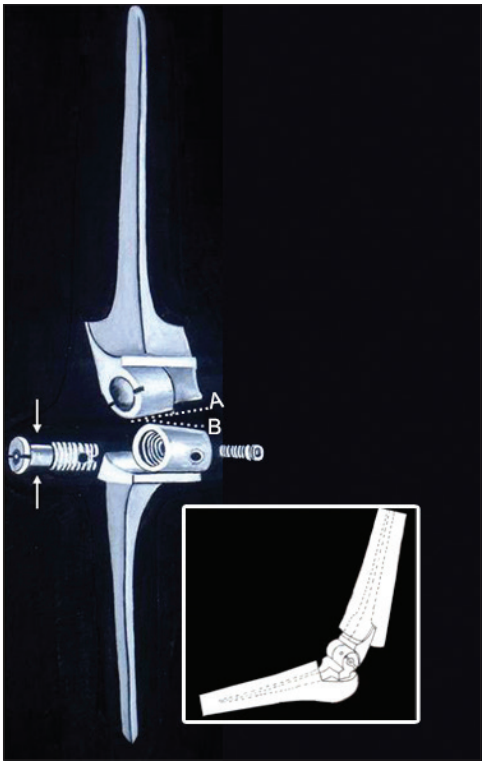

Figure 1: A photograph of disassembled components of the prosthesis. Its humeral hinge section (A) is shorter than the ulnar one (B) and has a larger hole than the diameter of the smooth part of the main hinge screw (arrow) to allow 7 –10 degree side to side laxity. Two flanges are incorporated on each side of the shank of humeral prosthesis stem. Inset - Flanges are seated in the longitudinal slots made on each side of lower cut end of the humerus in it's coronal plane

Table 1: Functional outcome of prosthetic replacement of elbows in old healed sideswipe injuries

Case number	Age (years)/ sex/side	Date of injury	Presence of nerve palsy/ infection	Primary treatment	TEA (OV/RV)	Date of TEA	Duration of follow up	Preoperative/ postoperative		Complications	Functional results
								Results (MEPS)	Results (DASH)		
1	33/male/ right	June 10, 1990	Nil	Debridement	OV	January 02, 1993	23 years, 11 months	35/85	82.5/32.5	2 mm aseptic loosening around humeral stem asymptomatic	Good
2	34/male/ right	April 28, 1993	Nil	Ilizarov external fixation	OV	May 11, 1995	21 years, 7 months	50/70	85/49.1	Delayed infective loosening at 17 months (removal of prosthesis on November 96)	Fair
3	37/female/ left	May 03, 1995	Nil	Debridement	OV	February 02, 1998	18 years, 11 months	40/90	79.1/27.5	2 mm aseptic loosening around humeral stem (asymptomatic)	Good
4	41/male/ left	February 02, 1997	Nil	AO external fixation	OV	April 09, 1999	17 years	35/65	85/53.3	Delayed infective loosening at 3.5 years (removal of prosthesis on October 2002)	Fair
5	32/male/ left	August 08, 1999	Infection	Debridement	OV	February 02, 2002	14 years, 11 months	35/80	81.6/33.3	2 mm aseptic loosening around humeral stem (asymptomatic)	Good
6	56/male/ right	February 01, 2000	Ulnar nerve palsy with claw hand	AO external fixation	OV	March 04, 2003	13 years 11 months	50/70	83.3/45	Permanent ulnar motor deficit. 3 mm aseptic loosening with clinical instability	Fair
7	44/female/ left	February 02, 2001	Infection	Debridement	OV	December 12, 2003	13 years, 1 months	35/90	80.8/20.8	1 mm aseptic loosening around humeral stem (asymptomatic)	Excellent
8	46/female/ right	June 05, 2001	Infection	Debridement with pedicle skin graft	RV	August 08, 2004	12 years, 7 months	40/90	87.5/22.5	Superficial infection controlled with dressing	Excellent
9	39/male/ right	March 02, 2003	Nil	Debridement with AO external fixation	RV	September 06, 2005	11 years	50/95	85.8/24.1	Erosion around the flanges of humeral stem asymptomatic	Excellent
10	48/male/ left	August 03, 2003	Median nerve Paresis	Debridement with secondary suture	RV	August 02, 2006	10 years, 7 months	35/85	86.6/34.1	Superficial infection, grip power weak (MRC Grade 4)	Good

Contd...

Table 1: Contd...

Case number	Age (years)/ sex/side	Date of injury	Presence of nerve palsy/ infection	Primary treatment	TEA (OV/RV)	Date of TEA	Duration of follow up	Preoperative/ postoperative		Complications	Functional results
								Results (MEPS)	Results (DASH)		
11	34/female/ right	February 08, 2004	Nil	Debridement + AO external fixation	RV	February 03, 2007	9 years, 6 months	50/95	83.3/23.3	Transient ulnar nerve neuropraxis recovered in 3 months postoperatively	Excellent
12	49/male/ left	February 02, 2005	Nil	Debridement with secondary suture	RV	March 03, 2008	8 years, 8 months	35/85	84.1/31.6	Erosion around the flanges of humeral stem asymptomatic	Good
13	45/male/ left	July 29, 2005	Nil	Debridement with secondary suture	RV	August 25, 2009	7 years, 3 months	55/85	85.8/33.3	Superficial excoriation of skin around stitch line, healed with conservative treatment	Good
14	61/female/ left	December 13, 2006	Nil	Debridement + AO external fixation	RV	January 16, 2011	5 years, 11 months	40/90	84.1/19.1	Nil	Excellent

OV=Original version, RV=Recent version, TEA=Total elbow arthroplasty, MEPS=Mayo elbow performance score, DASH=Disabilities of the Arm Shoulder and Hand, MRC=Medical Research Council, AO=Arbeitsgemeinschaft für Osteosynthesefragen

medullary canal for insertion of the humeral stem of the prosthesis.[11,12] Longitudinal cut is made on each side of the lower cut end of humerus in its coronal plane for insertion of flanges of recent version of Baksi sloppy hinge elbow prosthesis [Figure 1, Inset].

The radial head and neck are often fractured and may be displaced where the radial neck was sectioned transversely along with excision of loose fragments. The upper end of ulna including olecranon process is exposed, and whenever it is intact, L shaped subarticular cut is made in the upper end of ulna.[11] In the absence of olecranon process which is common in such injuries, the upper end of ulna is cleared of soft tissues, and its medullary canal is delineated with the help of an awl or harpoon-shaped reamer. For anchorage of triceps to the upper end of ulna, a no 5 Ethibond, polyester white braided nonabsorbable suture (manufactured by Johnson and Johnson company) or a stainless steel wire is passed transversely through a drill hole made to the upper end of ulna. Then after cementing the medullary canal of ulna and humerus, the corresponding stems of elbow prosthesis are inserted. Assembling of hinge components with the help of main linking and locking screws are completed. For anchorage of triceps to the upper end of ulna, the proximally retracted triceps is mobilized down in four such cases with additional V-Y plasty of triceps, needed for its anchorage to the upper end of ulna with the preinserted stainless steel wire or Ethibond suture. The wound is washed with normal saline and closed around a suction drain encircled around the prosthesis. Compression bandage followed by plaster slab is applied around the elbow in the position of 30° flexion.

Postoperative care

The drain is removed after 3–4 days while the discharge is reduced to almost nil. The wound is reviewed in eight to tenth postoperative day for active discharge or signs of inflammation. Stitches are removed 2 weeks later, and the elbow is retained in a turnbuckle splint and maintained for 6–8 weeks alternatively in maximum flexion and extension for 5–6 hours until the triceps attachment is firm enough to allow active flexion and extension of the elbow. The antibiotic coverage is maintained for 6 weeks.

Results

The follow up period of patients [Table 1] varied from 5 years 11 months to 23 years 11 months (average 13.5 years; SD 5.025). Ten patients (71.4%) regained stable 0° to 130° elbow flexion, and four (28.6%) had limited terminal range of elbow motion with arc of 10° to 115° following V-Y plasty of contracted triceps. The forearm motions were restricted in all with average supination 22° and pronation 35°. Postoperatively, all patients had painless stable elbow motions except three, of which two (Case 2 and 4) had delayed infection needed removal of prosthesis and another (Case 6) had 3 mm aseptic loosening around the humeral stem with instability. Elbow flexors recovered up to MRC Grade 4–5 in 4–6 months postoperative period, whereas triceps recovered up to MRC Grade 3–4 within 6 months to

1 year period. However, the patients were satisfied with their improved function after the operation, compared to almost no activity of the involved extremity before TEA. Mayo elbow performance score (MEPS)[13] for functional evaluation of replaced elbow and Disabilities of the Arm Shoulder and Hand (DASH) score[14] for disabilities of arm, shoulder, and hand were used [Table 1]. In this study, excellent MEPS score were obtained in five (35.7%) [Figure 2a-g] good in 6 (43%), fair in one (7.1%), poor nil and failure in two (14.3%). Postoperative improvement of MEPS mean 84 (SD 6.80) mainly in terms of regaining stability, ability to perform daily activities, and retaining painless satisfactory range of elbow motions. This also was supported by significant improvement of postoperative DASH score mean 32.1 (SD 10.6), compared to preoperative DASH score value mean 83.8 (SD 2.28) vide [Table 1]. We used the paired *t*-test to compare the preoperative and postoperative MEPS score and found that the postoperative score was significantly higher ($P = 0.0037$).

Complications

Superficial skin breakdown occurred in two patients; one (Case 8) healed up with dressing and antibiotics and another (Case 10) needed secondary sutures. Case 11 developed transient ulnar neuropraxia during early postoperative period which recovered spontaneously. Radiolucency at bone cement interface commonly around the humeral stem of about 1.2 mm occurred in four (28.6%) patients, all were treated by original sloppy hinge prosthesis replacement. One such patient (Case 6) having 3 mm aseptic loosening around humeral stem, experienced clinical instability and occasional pain during elbow motion was considered as symptomatic aseptic loosening with MEPS 70, rated as fair result. Three patients (Cases 1, 3, 5) had asymptomatic 2 mm aseptic loosening around humeral stem were rated as good result. During postoperative follow up visit, it was seen 6–8 years postoperatively, the radiolucent line started to appear at bone cement interface commonly around humeral stem. With passage of time the radiolucency extends in variable amount, but till up to 2–3 mm line, without evidence of infection they remain asymptomatic clinically. Failure due to deep infection with loosening in two patients (Case 2 and 4) needed removal of the prosthesis. The patients having preoperative median nerve neuropathy (Case 10) with muscular weakness improved significantly during the postoperative period due to improved lever arm

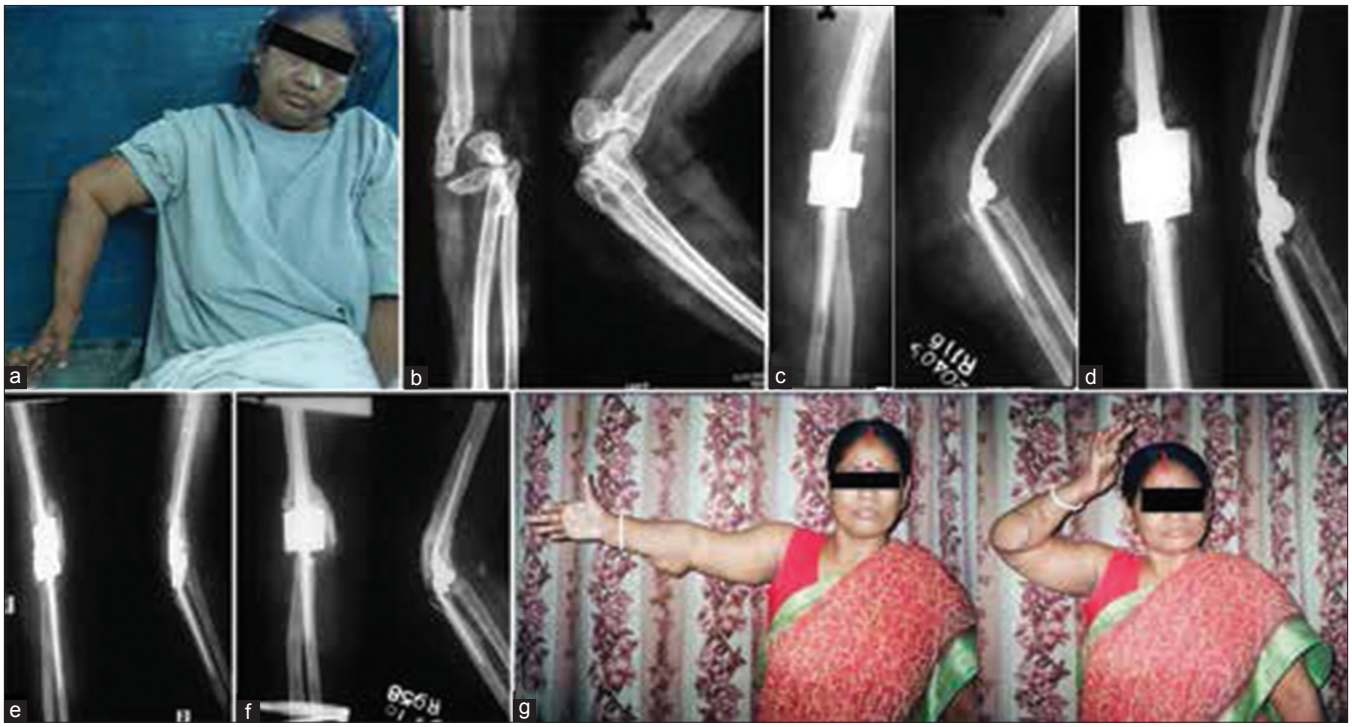

Figure 2: (a) Clinical photograph of a 45 years old female (Case 8) sustained side swipe injuries on right elbow treated by wound debridement and pedicle skin grafting, showing healed wound with unstable joint. (b) Radiograph of the above patient 3 years and 2 months after initial injury anteroposterior and lateral views showing ununited condyles of humerus with ununited loose piece of olecranon process and loss of radial head. (c) Three weeks postoperative radiograph anteroposterior and lateral views of the above patient showing third generation elbow prosthetic replacement. The flanges of the humeral stem is seen outside the humeral shaft due to its segmental loss, a loop of S.S wire is seen at upper end of ulna used for anchorage of triceps. (d) Radiograph at 3 months postoperative period anteroposterior and lateral views showing patchy new bones formation around the bare lower part of humeral stem and around the posteromedial aspect of hinge components. (e) Radiograph of 9 months anteroposterior and lateral views showing consolidated sheets of new bone around the shank and flanges of humeral stem of prosthesis, sparing the prosthetic joint. (f) Radiograph at 12 years and 7 months follow up of same patient showing consolidated new bone formation around posteromedial aspect of shank and flanges of humeral stem of prosthesis, sparing the prosthetic joint No evidence of radiolucency noted around the prosthetic stem. (g) Clinical photograph of the above patient at 12 years and 7 months follow up showing right elbow flexion arc 0° to 135°. No deterioration of motions of elbow is noted even after posteromedial new bone formation due to sparing the prosthetic joint

of elbow motions after TEA., The patient with ulnar nerve neuropathy (Case 6) regained improved sensory recovery but ulnar clawing remained unchanged.

Discussion

Old healed sideswipe injuries of elbow pose a challenging problem because of dysfunctional disability of elbow, possibility of flaring of dormant infection and difficulty to identify the anatomical structures clearly because of loss of bones and soft tissues resulting in distortion. Two to three years should have elapsed for TEA after healing of the primary wound when the infection was likely to be burnt out. Majority of the patients are relatively young [Table 1] and regained functional benefit after their prosthetic replacement with 78.5% satisfactory (excellent and good) results during the mean 13.5. years follow up period. However, they were advised to avoid strenuous use of the replaced elbows permanently.

Encouraging results associated with the original[11] and recent version[12] of Baksi Sloppy hinge prosthesis [Figure 1] can be explained by its inherent properties. Varus valgus stability is provided by inbuilt 7°–10° side to side laxity in the hinge section, for which any strain occurring in the hinge section is dissipated to the surrounding soft tissues, and less strain occurs at bone cement prosthesis interfaces.[15] Axial stability is provided by the main linking and locking screw fixation of the hinge components. Rotational stability is provided by the intramedullary snugly fitting triangular shaped shank of the humeral stem along with its flanges impacted into the longitudinal slot in each side of humeral cut end of recent version [Figure 1, Inset]. This minimizes the stress at the humeral prosthesis-bone cement interface. The anterposterior stability is provided by the broadened shank of the humeral stem which distributes the cyclical compression and distraction forces during flexion and extension over the larger bony surface of the lower end of humerus where the flanges of the humeral prosthetic stems are seated. As the flanges increased the transverse diameters of the shank of humeral stem, stress per unit area is greatly reduced over broad lower end of humerus. In side swipe injury even, in the absence of humeral condyles, this design allowed secure fixation by impaction of triangular shaped humeral stem in the corresponding medullary canal fixed with bone cement along with snugly fitting flanges into the longitudinal slot over each side of humeral cut end [Figure 1, Inset], thereby functioning as a single prosthesis bone assembly to overcome the wind shield wiper effect of the humeral stem. Hence, the prosthesis needs only humeral diaphysis to obtain secure fixation in the absence of humeral condyles. Condylar reconstruction is not mandatory.[16] The linked semi constrained prosthesis must have a stem for stable anchorage in the humeral shaft. In the presence of loss of elbow joint motion and dysfunctional disabilities, forearm rotations were likely become restricted. The muscle functions around the elbow were poor in absence of lever arm.

Postoperatively, the forearm rotations did not recover possibly due to fibrotic contracture of interroseous membrane. The patients recovered satisfactory painless stable elbow motion with gradual improvement of function of muscle around the elbow which met the satisfaction of patients. The radiolucency up to 2 mm commonly around humeral stem remained asymptomatic without clinical instability in majority was the reason of satisfactory clinical result. Only one patient has symptomatic loosening of 3 mm. was considered as fair result. Perhaps, he reduced activities of the replaced elbow with subnormal power of elbow flexors and extensors in such cases are the main reasons of limited (1–2.mm) aseptic loosening of prosthesis in four (28.5%) even in long term followup. The radiolucency may be related to poor cementing technique, overstraining of the replaced elbow, obese overweight patients and an individual variation. In spite of radilolucency at bone cement-prosthesis interface, the fibrosis around the prosthesis joint and reorientation of muscle balance may be the reasons of elbow remained asymptomatic. Furthermore, the elbow is a nonweight bearing joint except during flexion against gravity and weightlifting. Moreover, from 8th case onward, the recent version Baksi Sloppy Hinge with improved implant design as well as improved surgical technique, the results improved accordingly. Two patients (Case 2 and 4) who needed removal of prosthesis retained relatively stable elbow motion due to fibrosis connecting the adjacent bone ends and reorientation of muscle balance after physical exercise as was recorded in similar instances,[11,17] and rated as fair functional outcome. The bone ends remained stable for more than 19.5 years with adequate function,[11,17] and little deterioration was noticed in comparison to that reported after fascia lata or other interposition arthroplasties.[18,19] To promote fibrosis around the bone ends after removal of the prosthesis, drill holes are made transversely close to the approximated humeral and ulnar bone ends for passage of number 5 Ethibond suture for their anchorage in a fashion of figure of 8, in front of adjacent bone ends. The elbow is then immobilized in plaster slab at 100°–110° flexion for a period of 6 weeks to facilitate mature scar formation between the distal end of humerus and proximal end of ulna. On removal of plaster slab vigorous, elbow mobilizing exercises are encouraged till recovery of reasonable stable elbow flexion is noted particularly in sagittal plane.

Recent version of prosthesis showed no incidence of loosening around the prosthetic stem till date. However, there are several compromised factors in our selected elbows like previous old open injury with possibility of flaring of dormant infection, osteoporosis of bones around the affected elbow joints, week musculature, and prolonged non-functional status of affected elbow. Among all these which factors are responsible for deterioration or functional recovery of following operation, could not be isolated

in postoperative follow up. TEA appears to be a viable proposition to be considered with caution, in cases with old healed sideswipe injuries of the elbow even in younger individual, provided they were agreed to avoid strenuous use of the replaced elbows.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/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.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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