Sloppy hinge prosthetic elbow replacement for post-traumatic ankylosis or instability

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From 1984 to 1995, 68 ankylosed elbows and 11 which were unstable after trauma were replaced in India by Baksi sloppy hinge prostheses. The mean age of the patients was 28.6 years (17 to 70) and the mean follow-up 9.6 years (2 to 13.5).

Of the 68 ankylosed elbows, 59 (87%) regained a mean arc of painless movement of 88.5° (27 to 115). The mean improvement of supination was 24° and of pronation 16.5°. There were 54 good results (80%), eight fair and three poor. There were two complete failures due to infection, and one due to a broken humeral stem.

Of the 11 unstable elbows, the nine with good results had a mean arc of 125° (15 to 140) of painless stable movement, with a mean improvement in supination of 26° and of pronation of 19.5°. There was one fair result and one failure due to loosening with subsequent late infection.

There were significant complications in 14 cases with infection in seven and aseptic loosening in four. Patients with loosening or late removal of the prosthesis often retained reasonably stable elbow movement because periprosthetic fibrosis had connected the approximated bone ends, and muscle balance had been restored.

Methods and Patients

Baksi sloppy hinge elbow prosthesis. The original prosthesis was a relatively rigid hinge, and its use has been reported mostly in post-traumatic ankylosed elbows.9 It was redesigned in 1983 to allow 7° to 10° of laxity at the hinge based on studies using a newly-designed elbow joint simulator.10,11 The new sloppy hinge design is simple, cost-effective and made locally of stainless steel (SMO 316 LV). It has been in use since January 1984 (Indian Registered Design 161541).

The current design (Fig. 1) has a humeral component with a stem of the same diameter as that of the ulnar component but shorter. The linking screw provides a smooth bearing surface which is thinner in diameter than the hole in the humeral component (Fig. 1). This provides a gap between the bearing surfaces and only partial articular contact during elbow movement; there is 7° to 10° of laxity which allows some varus-valgus movement, but still limits axial rotation. Forces across the prosthesis are therefore dissipated primarily to the surrounding soft tissues, thus protecting the cement-to-bone interfaces,10,11 as confirmed by an experimental cadaver study.12

The humeral stem is triangular and the ulnar stem quadrangular in cross-section; their lengths are 95 mm and 75 mm, respectively, and their curvatures conform to those of the medullary canals. They have cross-cut knurled surfaces. Five different combinations of shank sizes are available: 13 mm/7 mm, 14 mm/7 mm, 15 mm/8 mm, 16 mm/8 mm and 17 mm/8 mm for humeral and ulnar stems.
respectively. The only modifications since 1984 have been an increase in the length of the humeral stem and a change in the head of the small locking screw.

**Patients.** From January 1984 to July 1995 a total of 79 patients with 68 ankylosed and 11 unstable elbows was treated with the Baksi sloppy hinge prosthesis. There were 43 men and 36 women, with 48 right-sided and 31 left-sided replacements. Their mean age was 28.6 years (17 to 70). The relative youth of the patients made the functional disabilities of great concern (Fig. 2).

**Ankylosis.** Twenty-two elbows showed bony ankylosis at from 10° to 110° flexion (mean 65°). Forty-six elbows had a reduced range of movement, and were incongruous. Some had surrounding new bone formation. The mean elbow movement was 45° to 60° (mean range of 15°). There were 28 malunited intercondylar fractures and 18 fracture dislocations or subluxations. The mean duration of ankylosis was 17.5 months (6 to 121). Ten forearms were fixed in the midprone position, 49 had a limited range and nine had normal pronation-supination. The mean values were 18.5° of pronation and 32.5° of supination.

Six patients had sustained open fractures over 2.5 years previously and seven had failure of previous arthrolysis. Only patients with ankylosis in non-functional positions with non-strenuous occupations were accepted for operation.

**Instability.** The 11 unstable elbows were due to five ununited T- or Y-shaped intercondylar fractures, three old open injuries with bone loss and three failed excision arthroplasties. All had a nearly full range of unstable movement; four showed hyperextension. Six had limitation of forearm supination and pronation. Patients were considered for prosthetic replacement only after failure to regain functional stability after about two years of adequate physiotherapy.

**Operative technique.** With the patient supine and a tourniquet applied, a posteromedial incision is followed by subfascial dissection, first medially then laterally. The ulnar nerve is isolated and mobilised with flexor carpi ulnaris from the proximal ulna (Fig. 3).

The medial epicondyle, coronoid, olecranon process and lower humerus are exposed by elevating the soft tissues (Fig. 3). Further dissection reveals the posterior surface of the lower triceps, the lateral epicondyle and the supracondylar ridge. The head of the radius is excised at the level of the annular ligament, and the distal humerus is sectioned transversely just proximal to the olecranon fossa. A subarticular ‘L’-shaped bone resection at the upper end of the ulna preserves the insertions of triceps and brachialis (Fig. 3). The ankylosed bony mass is then removed, and the vertical height of the prosthetic hinge compared with the gap between the cut ends of the humerus and ulna in both full extension and full flexion. In patients with marked contractures of the flexors or extensors, it may be necessary to resect more bone from the lower humerus to accommodate the hinge.

The medullary canals of the ulna and humerus are reamed with the respective harpoon-shaped reamers and rasps to provide snugly fitting stems. The ulnar and humeral components are fixed with bone cement, using the special impactor just before the cement sets. The hinge components are assembled with the main screw, and then secured with a locking screw (Fig. 4).
In post-traumatic flail elbows, with loss of the olecranon and detachment of the triceps insertion, the latter is re-attached to the proximal ulna and adjacent posterior soft tissues by vicryl or stainless-steel wire sutures, placed through a transverse drill hole in the ulna after reaming its medullary canal and before cementing the ulnar stem.

The full range of elbow and forearm movements is tested during the operation. Haemostasis is secured after tourniquet release and the wound is closed in layers around a suction drain. A well-padded compression bandage around the elbow is covered by a plaster cast in full extension.

Seven days after operation the plaster is removed, the dressing changed, and the elbow held in an adjustable splint in 90° of flexion. Passive movements of the elbow and forearm are then allowed if there is no wound oedema, but may be delayed until the sutures are removed at two weeks. The elbow is then held alternatively in positions of maximum flexion and extension for periods of 12 hours, with intermittent passive movements of the elbow out of the splint. When some muscle power has recovered by three to five weeks, active movements of the elbow and forearm are encouraged, but heavy weight-lifting and strenuous activity are permanently banned.

### Results

The results were assessed on clinical and radiological criteria (Table I), with function of the replaced elbows recorded as the ability to feed, reach the perineum, dress, comb hair and perform light household activities. The mean follow-up was for 9.6 years (2 to 13.5). The pre- and postoperative pain levels are shown in Table II. Superficial wound infection or stem loosening caused occasional pain; constant pain was due to deep infection in two cases and significant loosening after delayed infection in one.

The pre- and postoperative ranges of movement are shown in Table III. In the ankylosed group, 59 out of 68 patients (86.8%) regained painless stable movement with a mean arc of 88.5° (Fig. 5). The mean improvement in supination was 24° and in pronation 16.5°. Of the unstable group, nine of the 11 patients (81.8%) gained painless stable movement with a mean arc of 125° (Fig. 6); five patients had a full range of flexion/extension. The mean improvement in supination was 26.4° and of pronation 19.5°.

### Table I. Criteria of analysis of results

<table>
<thead>
<tr>
<th>Grade</th>
<th>Pain</th>
<th>Elbow movement (degrees)</th>
<th>Forearm ROM (degrees)</th>
<th>Dynamic instability</th>
<th>Radioluency (mm)</th>
<th>Functional activity</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Fixed flexion</td>
<td>ROM*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>Nil</td>
<td>0 to 20</td>
<td>≥110</td>
<td>≥80</td>
<td>0 to 2</td>
<td>Perform all satisfactorily</td>
</tr>
<tr>
<td>Fair</td>
<td>Occasional</td>
<td>10 to 30</td>
<td>≥90</td>
<td>≥60</td>
<td>2 to 3</td>
<td>Perform all with difficulty</td>
</tr>
<tr>
<td>Poor</td>
<td>Painful</td>
<td>20 to 30</td>
<td>&lt;90</td>
<td>&lt;60</td>
<td>≥3</td>
<td>Grossly restricted</td>
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</table>

* range of movement

### Table II. Pre- and postoperative levels of pain in both groups of patients

<table>
<thead>
<tr>
<th>Grade</th>
<th>Ankylosed elbows</th>
<th>Unstable elbows</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Preop</td>
<td>Postop</td>
</tr>
<tr>
<td>None</td>
<td>39</td>
<td>63</td>
</tr>
<tr>
<td>Occasional pain</td>
<td>20</td>
<td>3</td>
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<tr>
<td>Constant pain</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>Total patients</td>
<td>68</td>
<td>68</td>
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### Table III. Pre- and postoperative ranges of movement in both groups of patients

<table>
<thead>
<tr>
<th></th>
<th>Mean elbow movement (degrees)</th>
<th>Mean forearm movement (degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Preop</td>
<td>Postop</td>
</tr>
<tr>
<td>Ankylosed elbows</td>
<td>45.5 to 60.5</td>
<td>26.7 to 115.2 (ROM† 88.5)</td>
</tr>
<tr>
<td>Unstable elbows</td>
<td>5 to 150 (passive)</td>
<td>15 to 140 (ROM 125)</td>
</tr>
</tbody>
</table>

* S, supination; P, pronation
† range of movement
Radiographs showing post-traumatic bony ankylosis at 20° flexion in a 23-year-old woman (a) and the appearance at 12.5 years after sloppy hinge replacement (b). There are 2 mm radiolucencies around the humeral stem. At this stage the range of movement was from 30° to 140°.

A 32-year-old man with a flail right elbow after an open injury (a). Neurovascular function was intact, but a radiograph (b) showed considerable loss of bone. At five years after sloppy hinge replacement, a radiograph (c) shows new bone formation around the prosthesis. The triceps tendon had been anchored to the proximal ulna and adjacent soft tissues by vicryl sutures. The patient had an asymptomatic stable elbow with a flexion arc of 120°.
Elbow flexion recovered earlier than extension, and some patients in the ankylosed group developed 10° to 30° of fixed flexion deformity due to new bone formation or poor recovery of the triceps, to only MRC grade 3.

The grading of results was difficult in some cases, particularly in those with a good range of flexion and extension but grossly limited forearm rotation, or with significant radiolucencies but good elbow function. Overall, the ankylosed elbows showed 54 (79.4%) good results, eight (11.8%) fair, three (4.4%) poor and three failures (4.4%). The poor results showed radiolucencies of 3 to 4 mm around both stems in two patients and painful restriction of movement with a healed sinus in the other. The three failures were in two patients with postoperative infection and discharging sinuses, and in one with a broken prosthetic stem.

Of the unstable elbows, nine had good results, one was fair, and one failed. The patient with a fair result had acceptable function in spite of radiolucencies of 3 mm and loosening. In the failed case, the prosthesis was removed after 10.5 years for loosening of both stems with the later development of a discharging sinus.

**Complications.** There were complications in 14 patients (17.7%) including wound infection in seven, a broken humeral stem in one, recurrence of elbow stiffness due to new bone formation in two, and aseptic loosening in four. The wound infections were primary in five and late in two. Three patients with discharging sinuses needed removal of the prosthesis, but the other four were controlled by conservative measures, although one had a poor result.

The olecranon was fractured in one patient at operation, but healed satisfactorily after wiring. There was temporary paresis of the ulnar nerve in four, all of whom had recovered by 3.5 months. One humeral prosthetic stem was broken by direct trauma leading to removal of the prosthesis. One fracture of the humeral shaft healed after immobilisation in a plaster cast. New bone formation in two elbows needed excision, but both patients recovered satisfactory movement.

Radiolucent lines of under 2 mm developed around the humeral stem in 11 of the ankylosed elbows at a mean follow-up of 7.2 years (6.5 to 8.0) and in three of the unstable elbows at a mean of 5.4 years (5 to 7), but all had satisfactory stable elbow movement. Radiolucencies of 3 to 4 mm of both stems were seen in two of the ankylosed series after primary infection and in one of the unstable series, with delayed infection. Four elbows showed aseptic loosening of 3 to 4 mm at the stem during follow-up for 9.6 years, three (4.4%) in the ankylosis series and one in the unstable series.

When the prosthesis had to be removed, the elbows were held at 110° of flexion in a cast for about seven weeks before gradual mobilisation in a sling. All these patients regained reasonably satisfactory elbow movement (Fig. 7).

**Discussion**

The Baksi sloppy hinge elbow prosthesis, although all metal, has provided satisfactory mid-term results for both ankylosed and unstable elbows in a developing country. The minimal contact area at the joint and the designed laxity are acceptable, because the elbow is non-weight-bearing except during extension against gravity and weight-lifting.

Most of the patients were young with a mean age of 28.6 years; the sloppy hinge replacement allowed effective elbow function during an active part of life (Fig. 2). In the event of later failure, removal of the prosthesis left reasonably satisfactory function, comparable with that after a successful fascial or other interposition arthroplasty.

The common late development of fixed flexion deformity of 10° to 30° in the ankylosed elbows may have protected against stress occurring during extension of the elbow, but by contrast the early postoperative recovery and almost full range of stable movement achieved in previously unstable elbows.

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**Fig. 7a**
Radiograph at 10.5 years after sloppy hinge replacement in a 21-year-old woman showing gross radioluency around both stems with new bone formation (a); there was a discharging sinus. Three years after the removal of the prosthesis (b) the patient had a painless stable elbow with flexion from 20° to 130° (c).
elbows may have overstressed the prosthesis. This probably accounts for the earlier radiological loosening in unstable as compared with ankylosed elbows. Patients with marked limitation of forearm rotation before operation had unpredictable recoveries of this, even after excision of the radial head.

The relatively high incidence of postoperative infection (8.8%) was probably secondary to previous operations, the presence of avascular bone and scar tissue, and the superficial position of the joint. Most loosening was seen around the humeral stem, probably because of rotational torque. The effect was a circumferential thinning of a segment of the cortex with thickening and sclerosis of the opposite cortex (Fig. 7). Despite loosening many elbows retained satisfactory movement with the arm by the side of the body or in abduction. Subsidence of the prosthetic stems in the presence of loosening allowed further approximation of bone ends (Fig. 7a) for periprosthetic fibrous tissue anchorage. When prosthetic removal was needed the stability of approximated bone ends from periprosthetic fibrous tissue, as seen during the removal of prostheses, was similar to our experience with rigid hinge prostheses. The bone ends remained stable for up to 11 years, with adequate function and little of the deterioration seen later after fascia lata or other interposition arthroplasties.13-15

The Baksi sloppy hinge elbow replacement appears to be a viable proposition for post-traumatic ankylosis and instability in a developing country. The results were satisfactory, even in younger patients, provided that they were willing to accept permanent restriction of strenuous activities.

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References