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A study on clinical outcome of total elbow arthroplasty

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Abstract
Introduction: Prosthetic total elbow arthroplasty (TEA) is a recognised treatment for the painful arthritic elbow is a challenging procedure for orthopedic surgeons. For elderly patients with deformity and ankylosis of the elbow due to posttraumatic arthritis or rheumatoid arthritis or comminuted fracture distal humerus, arthroplasty is one of the option. The clinical outcome and long-term survivorship differs from implant to implant, and the results obtained with a given linked or unlinked implant cannot be extrapolated to other members of the same implant family.
Materials and Methods: 13 cases of total elbow arthroplasty were included in this study, between June 2010 and October 2013. The indications for total elbow arthroplasty in this study were rheumatoid arthritis, comminuted fracture distal humerus with intraarticular extension, and posttraumatic bony ankylosis of elbow joint. Patients with compound fracture around the elbow joint, severely comminuted fracture proximal ulna, flaccid paralysis of the upper limb, non-restorable function of biceps or triceps and patients with high demanding jobs have been excluded from the study.
Results: The average operative time was 86.2 minutes (range 64 to 108 minutes). The follow up was from 4 months to 110 months (mean 71 months). The evaluation of the patients was based on clinical as well as on radiological parameters. Pre-operatively four patients had stable elbows as they had ankylosis in non-functional position between 80 to 90° due to rheumatoid arthritis or traumatic arthritis and also stable by virtue of bony fusion. Remaining nine patients had unstable elbows because of fracture distal humerus. Clinico- radiologically all the elbows were stable.
Conclusion: To conclude, a semi constrained total elbow arthroplasty is a predictable and effective method for decreasing pain and restoring function in elderly patients with chronic elbow dislocation or fracture dislocation. The rapid functional improvement provided by this procedure allows patients to return to activities of daily living early.

Keywords: Elbow arthroplasty, coupled implants, linked implants, unlinked implants, uncoupled implants, rheumatoid arthritis, humerus

Introduction
The elbow joint is the synovial hinge joint between the humerus in the upper arm and the radius and the ulna in the forearm which allows the forearm and hand to be moved towards and away from the body. The elbow is a non-weight bearing joint; however, static loading can create forces up to three times the body weight and dynamic loading up to six times [1, 2]. The function of the elbow joint is extension, flexion and reach for objects. Elbow joint movement is essential to coordinate shoulder movements and wrist joint movements which are helpful in performing the daily activities like eating, combing, writing, lifting weights, personal hygiene, etc. the range of movement in the elbow is from 0 degrees of elbow extension to 150 of elbow flexion [3]. In humans, the main task of the elbow is to properly place the hand in space by shortening and lengthening the upper limb. With the elbow extended, the long axis of the humerus and that of the ulna coincide. At the same time, the articular surfaces on both bones are located in front of those axes and deviate from them at an angle of 45°. Additionally, the forearm muscles that originate at the elbow are grouped at the sides of the joint in order not to interfere with its movement. The wide angle of flexion at the elbow made possible by this arrangement - almost 180° - allows the bones to be brought almost in parallel to each other. The elbow, like other joints, has ligaments on either side. These are triangular bands which blend with the joint capsule. They are positioned so that they always lie across the transverse joint axis and are, therefore, always relatively tense and impose strict limitations on abduction,

adduction, and axial rotation at the elbow. Elbow arthroplasty presents some unique peculiarities. Compared to the hip and knee joints, the elbow is relatively small and its stability depends greatly on ligamentous integrity. Indications of elbow arthroplasty are distortion of the elbow joint by comminuted fracture of distal humerus with intraarticular extension, rheumatoid arthritis or secondary inflammatory arthritis, post burn ankylosis or post-traumatic ankylosis, it may result in crippling deformity which hampers the activities of daily living. Universally, elbow arthroplasty is less frequently performed as compared to hip or knee arthroplasty [4] and possibly this is due to the higher incidence of complications like loosening of the implant or prosthesis due to cyclic loading in flexion and extension causing compressive and distractive load directed anteriorly, superiorly, and posterior [5]. However, during the last decade, there has been a marked improvement in implant survival and a considerable decrease in the rate of complications due to better implant designs.

Aim of the study

Aim of the study is to evaluate the outcome of the total elbow arthroplasty or total elbow replacement.

Materials and methods

13 cases of total elbow arthroplasty were included in this study, between June 2010 and October 2013. 4 male patients and 9 female patients and all the patients were between the ages 29 years and 71 years. Baksi's sloppy prosthesis or third generation sloppy hinged elbow prosthesis was used which is a semi constrained prosthesis and contains no polyethylene component.

The indications for total elbow arthroplasty in this study were rheumatoid arthritis, comminuted fracture distal humerus with intraarticular extension, and posttraumatic bony ankylosis of elbow joint. Patients with compound fracture around the elbow joint, severely comminuted fracture proximal ulna, flaccid paralysis of the upper limb, non-restorable function of biceps or triceps and patients with high demanding jobs have been excluded from the study.

Pre‑operative clinico-radiological assessment was done in these patients. Out of the 4 male patients, two had post-traumatic bony ankylosis of the elbow joint and the other two had severely comminuted intra-articular fracture of distal humerus. Out of 9 female patients, five had rheumatoid arthritis, one had ankylosis at 90 degree flexion, one had post traumatic arthritis with ankylosis in 80 degree of flexion and two cases were of fracture: One had nonunion of distal humerus with deformed ulno‑humeral joint with osteoporosis and the other had malunited fracture distal humerus with nonunion fracture proximal ulna with implant failure.

Surgical Procedure

All the surgeries were done in lateral decubitus position. Under regional or general anesthesia and tourniquet application, site of surgery was cleaned and draped with antiseptic solutions. Posterior midline incision was made with slightly curved over the tip of olecranon on the medial side extending from the distal arm downwards over the proximal part of ulna. The ulnar nerve was identified, mobilized, and transposed anteriorly, submuscularly to avoid stretching and irritation by the operative instruments. In few cases, we used a tongue‑shaped flap of the triceps attached to the tip of the olecranon and then reflected it downward, but later on we started mobilizing the triceps laterally as a continuous sleeve. Distal end of humerus was exposed along with its epicondyles extraperiosteally by detaching all the muscles around it. Elbow joint opened, synovectomy carried out followed by radial head excision. Humeral cut was made at the superior surface of olecranon fossa with the oscillating saw and a subarticular L-shaped cut was made at the proximal part of ulna preserving the insertions of triceps at olecranon process and brachialis at coronoid process. The bony mass was then removed and reaming of medullary canal of distal humerus was done with triangular humeral reamer and upper part of ulna with quadrangular rasp and harpoon shaped reamer and wound lavage done with a pulse lavage system. The vertical height of the prosthetic hinge was compared with the gap between the cut ends of the humerus and the ulna in both, extension and flexion. It may be necessary; to resect more bone from the distal humerus to accommodate the hinge, in patients with marked contractures of the flexors and extensors. Trial reduction was done and then the final ulnar and humeral components were fixed to the bone with manual technique of bone cementing. The humeral and ulnar hinged section were assembled with hinge screw and then secured with a lock screw. The range of movement of the elbow checked passively peroperatively, hemostasis achieved and secured after tourniquet release, triceps repair done, and wound closed in layers over a suction drain. A plaster of paris (POP) back slab was applied with elbow in 90 degree of flexion and forearm in supination, as it is the functional position and is comfortable to the patient. We routinely mobilized the elbow after 48 hours. Postoperatively the drain was removed after 48 hours of surgery. Intermittent active or passive movements of the elbow out of the slab encouraged. Sutures were removed 12 days after surgery and removable splint was discontinued at 6 weeks. Patients were advised to avoid lifting heavy objects and avoid strenuous activity.

Results

The average operative time was 86.2 minutes (range 64 to 108 minutes). The follow up was from 4 months to 110 months (mean 71 months). The evaluation of the patients was based on clinical as well as on radiological parameters. Pre-operatively four patients had stable elbows as they had ankylosis in non-functional position between 80 to 90° due to rheumatoid arthritis or traumatic arthritis and also stable by virtue of bony fusion. Remaining nine patients had unstable elbows because of fracture distal humerus. Clinico-radiologically all the elbows were stable. Postoperative radiographs were taken to see the placement of ulnar and humeral stem, bone cement interface (Figure 1, 2, 3, 4).

In the present study, average supination was 70° (range 60‑80) and average pronation was 70° (range 60‑80). Average flexion was 135° (range 130‑135). However, in 6 cases, there was loss of 15 to 35° (average 25°) of extension (45%) out of 13 cases. The average Mayo elbow performance score was 95.4 points (range 70 to 100).

In two cases, radiolucency was seen after 2 and 3 1/2 years respectively but the patients did not turn up for follow-up.

The arm length discrepancy was noted in four patients (31%) out of 13 cases. Clinico radiologically all the elbows were stable. In our series, we did not come across complications like nerve palsies or triceps weakness. However, heterotrophic ossification and radiolucency was notice in two cases. Loosening of ulnar stem was seen in three cases out of 13 cases.

Functional outcomes in the form of combing hair, holding a glass of water, buttoning the shirt, eating, writing and hand reaching the perineum, etc., were satisfactory in all the cases. All the patients were strictly advised not to lift any heavy objects postoperatively as it results in loosening of implant and decreases the life of the implant substantially.

Fig 1: Postoperative radiograph showing elbow prosthesis- posterior view

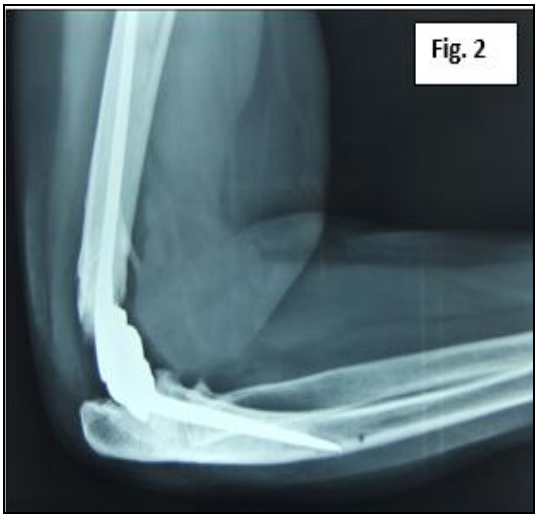

Fig 2: Postoperative radiograph showing elbow prosthesis- Lateral view

Fig 3: Immediate post operative clinical picture of the patient of elbow arthroplasty

Fig 4: Follow-up clinical image of the patient with elbow arthroplasty

Discussion

Prosthetic total elbow arthroplasty is a recognised treatment for the painful arthritic elbow. The field of elbow arthroplasty continues to experience substantial improvements. Currently, elbow replacement represents a successful treatment alternative for patients with inflammatory conditions as well as selected patients with post-traumatic osteoarthritis, elderly patients with low, comminuted distal humerus fractures, the salvage of distal humerus nonunion, ankylosis, haemophilic arthropathy, and elbow reconstruction after tumor resection. The success of elbow arthroplasty depends greatly on the surgeon's familiarity with the anatomy and surgical approaches to the elbow joint, the proper selection and implantation of prosthetic components, and compliance with postoperative recommendations.

There is some confusion regarding the types of implants available to replace the elbow joint. In general, there are two broad categories of implants, which differ in the presence or absence of a mechanism linking the humeral and ulnar components. A common misconception is to equate linking to constraint: some unlinked implants are more constrained than their linked counterparts.

Linked or Coupled implants- The distinguishing feature of this category of implant is the physical linking of the humeral and ulnar components at the time of surgery in order to avoid subluxation or dislocation episodes. Early linked implants were constrained hinges that only allowed flexion and extension. These implants were associated with a high failure rate secondary to the transmission of high stresses to the implant-cementbone interface and other design flaws. Currently, most linked implants are semiconstrained: their linking mechanism behaves as a sloppy hinge, allowing some rotational and varus-valgus play. Semiconstrained implants are believed to transmit less stress to the implant interfaces, which associated with other design improvements have resulted in more reliable long-term fixation. The linked semiconstrained implant most commonly used currently is the Coonrad-Morrey prosthesis.

Unlinked or Uncoupled Implants-In this kind of arthroplasty the components are not mechanically linked. Maintenance of prosthesis congruency depends on the adequate position of each component, ligamentous integrity, and the dynamic stabilizing effect of the musculature. Most of these implants provide a more or less anatomic resurfacing of the distal

humerus and proximal ulna; some incorporate a radial head component. The most popular unlinked implants are the Souter-Strathclyde and the Kudo prostheses.

Advantages and disadvantages of linked and unlinked implants are tabulated in table 1 [6].

Table 1: Advantages and disadvantages of linked and unlinked implants

	Linked	Unlinked
Advantages	• Ensure joint stability • May be used in the presence of ligamentous insufficiency • May be used in the presence of severe bone loss • Better range of motion (soft-tissue release and non-anatomic implantation)	• Less constrained implants may be associated with a lower risk of wear, loosening and osteolysis • Less bony-invasive, which may be beneficial if revision or resection are required • Some anatomic humeral components may be used as hemiarthroplasty
Disadvantages	• Increased constrained may result in increased tension to the interface and higher risk of mechanical failure secondary to wear and/or loosening • More extensive canal invasion, potentially complicating revision surgery • Cannot be used as hemiarthroplasty • Component linking may make implantation more difficult • Possible failure of the linking mechanism	• Most require more accurate component positioning in order to ensure proper articular tracking • It is possible to subluxate or dislocate the joint • Difficult to use when there is the need to compensate for bone loss or ligamentous insufficiency • Limited ability for soft-tissue release or non-anatomic implant positioning in patients with stiffness

Main indications of Total elbow arthroplasty are Chronic inflammatory arthropathies, Posttraumatic osteoarthritis, Acute distal humerus fractures, Distal humerus Non-unions Extreme intrinsic stiffness/ankylosis, Large posttraumatic bone defects, Primary osteoarthritis, Haemophilic arthropathy, Reconstruction after tumor resection.

Our study is in close correlation with the study done by Suresh kumar *et al* where they have included 11 cases in their study [7].

The average operative time in this study was 86.2 minutes (range 64 to 108 minutes) when compared to Suresh kumar *et al* which is 80 minutes [7]. The other parameters like follow-up duration, clinico-radiological evaluation and clinical outcome results were in close correlation with that study [7].

Gill and Morrey published the results obtained in 78 consecutive rheumatoid elbows using the Coonrad-Morrey design [8]. At most recent follow-up, 97 per cent of the patients had no or mild pain and the mean arc of motion were from 28 degrees of extension to 131 degrees of flexion. The main complications of this series included deep infection (2 cases), aseptic loosening (2 cases), triceps avulsion (3 cases), periprosthetic fractures (2 cases), and ulnar component fracture (1 case). Survivorship free of revision was 92.4% at ten years. Gschwend *et al* [9] published the results using the GSB III prosthesis in 65 elbows, 32 of which were rheumatoid, followed for a minimum of 10 years. Overall clinical results were satisfactory and the main complications included infection (6 per cent), loosening (4.6 per cent) and component disengagement (13.6 per cent). In our study we did not come across any minor or major complications when compared to the above study and this may be due to the small sample size of this study.

Van der Lugt *et al.* [10] published the results obtained in 204 rheumatoid elbows replaced using the Souter-Stractclyde prosthesis and followed for a mean of 76 months. At most recent follow-up, only 6 patients complained of pain at rest. Complications included infection (10 cases), humeral loosening (22 cases), and dislocation (4 cases). Kudo *et al*. [11] published the results obtained in 43 elbows replaced with the Kudo prosthesis and followed for a mean of three years; good or excellent results were obtained in approximately 86% of the patients, although some experienced loss of extension. Willems and De Smet published the results of 36 Kudo prosthesis in rheumatoid elbows; the main reported complications included infection (1 case), instability (2 cases), and loosening (6 cases) [12].

Generally most patients with rheumatoid arthritis experience satisfactory pain relief and functional improvement with both linked and unlinked implants. Most patients also maintain a good arc of motion and the rate of mechanical failure is small. Some authors believe that the outcome of elbow arthroplasty is similar to the outcome of hip and knee arthroplasty in rheumatoid patients [8, 9]. Linked arthroplasties allow the treatment of a wider spectrum of pathology, including patients with more extensive involvement, bone defects and instability.

To conclude, a semiconstrained total elbow arthroplasty is a predictable and effective method for decreasing pain and restoring function in elderly patients with chronic elbow dislocation or fracture dislocation. The rapid functional improvement provided by this procedure allows patients to return to activities of daily living early. The success of elbow arthroplasty depends greatly on the surgeon's familiarity with the anatomy and surgical approaches to the elbow joint, the proper selection and implantation of prosthetic components, and compliance with postoperative recommendations.

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