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Economics

SHORT TERM RESULTS OF REPLACEMENT ARTHROPLASTY IN IRREPERABLE MASON TYPE III RADIAL HEAD FRACTURES

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ABSTRACT

Background: The radial head is considered as the main stabilizer of the elbow especially when the medial and lateral ulnar collateral ligaments have been damaged. Radial head arthroplasty (RHA) is indicated for patients with unreconstructible radial head fractures or previously treated radial head fractures leading to non-union, irrespective of the mode of treatment given. The present study was carried out to analyze the early clinical results after treatment of irreparable radial head fractures with radial head replacement.

Methods:32 patients with Mason's type III radial head fractures were treated with cemented monoblock radial head replacement during 2014-2016. The patients were followed up for a period ranging from minimum of 12 months to a maximum of 23 months, with average being 1 year. During each visit their functional outcome with any associated complications were noted and were graded with Mayo's elbow performance score(MEPS).

Results: At the final follow up, 24 patients (75%) had excellent results, 6 (18.75%) good and two (6.25%) had fair results. 6 patients were associated with complications like pain, stiffness and valgus elbow instability. Variables like MEPS, pain and stiffness were found to have significant association with time interval between injury and surgery, with cases being operated earlier showing better results. Significant association was also seen between associated elbow injury and elbow instability. No case of radiocapitellar overstuffing was seen. However , one case was associated with lateral epicondylitis which is a relatively rare non-documented complication.

Conclusion: We conclude that radial head arthroplasty is a good treatment option for irreparable type III radial head fractures, with cases operated earlier showing better results. It restores elbow kinematics and stability with good functional outcome, provided care has been taken to avoid overstuffing of the joint. Early mobilisation of elbow is important to restore elbow motion and function.

KEYWORDS : Radial head arthroplasty, Mason type III fractures, mayo elbow performance score, lateral epicondylitis.

Introduction

Radial head is an elliptical structure and makes a neck – shaft angle of approximately 15^0 1 and articulates with capitellum of humerus making radio-humeral joint in the elbow. The radial head plays an important role in maintaining elbow stability. The ulnohumeral articulation with medial and lateral collateral ligaments(MCL/LCL) are the three primary static stabilisers of the elbow while radial head being the secondary stabiliser. Furthermore the radial head and capitellum represents the most important stabilising columns of the elbow and functions as an important stabiliser if the coronoid process is fractured, MCL or lateral ulnocollateral ligament are incompetent.[2,3,4]

The incidence of radial head fracture is estimated to be 1.7-5.4% of all fractures and 30% of fractures involving the elbow5 with mean age of 48 years and male:female ratio of [2,3.6] and most often results from a fall on the outstretched hand with the elbow partially flexed and pronated.[7,8,9]

Radial head fracture is classified according to Mason's classification and guides in treatment, with a satisfactory intra observer agreement and a moderate inter observer agreement .10

Identification of associated injuries are very important as principal goals of treatment remains maintaining longitudinal radioulnar relationship11 and to preserve elbow motion and stability.

The treatment of type I fracture is mainly conservative and good results are obtained in 85-95% of cases [12,13] and type II fractures are mainly treated operatively. The treatment of type III radial head fractures has been a debatable issue. Treatment is mainly surgical with options being- ORIF, excision and replacement arthroplasty. The preferred surgical treatment is still a matter of debate.

Radial head excision is now done for isolated comminuted fractures in which a reliable osteosynthesis cannot be achieved [14.] However, excision of the radial head should not be done in the presence of associated elbow or forearm instability, as restoration of the radiocapitellar contact is essential[15-19]. This method cannot be used in patients with terrible triad and is only indicated when radial pull test is normal4.Complications of radial head resection are-proximal migration of radius, wrist pain/stiffness, elbow instability, elbow pain/stiffness and decreased ROM, valgus deformity[20].

Replacement arthroplasty is another treatment option which has shown initial promising results. It is indicated for irreparable comminuted radial head fractures, type III fractures associated with elbow instability[21],post ORIF avascular necrosis and in post sequaele radial head resection20.Radial head arthroplasty restores axial and valgus stability reliably and returns elbow kinematics to nearly normal levels [22,23.]

The present study is aimed at evaluating the functional outcomes after radial head replacement in irreparable traumatic Mason type III radial head fractures.

Materials and Methods

Between 2104 – 2016, thirty two patients with Mason type III radial head fractures were managed with replacement radial head arthroplasty in CIO, VMMC & Safdarjung Hospital, New Delhi. Twenty one (65.6%) patients were between 30-50 years age group, with twenty female and ten male patients in the study. Twenty six patients sustained injury after fall on outstretched hand and six after road traffic accident.18 patients had right sided involvement, while

other 14 were injured in left side. Twenty four patients were operated in initial seven days after injury, three were treated between 1st – 2nd week and other five after 2 weeks.

Only four associated injuries were present in our study population- one Monteggia fracture, one volar barton fracture, one olecranon fracture and one fracture neck of femur.

Patients with Masons's type I and II radial head fractures, Open fractures, Local infection, Osteomyelitis, Open physis, deformity of proximal radio-ulnar joint were excluded from the study.

Initial assessment of the patients included local examination of the elbow, forearm and wrist to evaluate injury of other bone, ligament, interosseous membrane and DRUJ instability, if any.

Antero-posterior and lateral radiograph of the elbow along with whole forearm and wrist were routinely taken as part of pre-operative assessment. The radiocapitellar radiograph was taken with the elbow positioned as it was for the lateral radiograph but with the beam angled 45^0. MRI of elbow joint was performed to validate the clinical assessment.

The AP and lateral xrays of the contralateral elbow was also taken for comparision pre and post operatively. Decision for xrays of other parts was taken, based on our clinical examination. Once, routine xrays were done, fracture classified and decision for operative intervention was made CT Scan with 3D reconstruction was done to study fracture morphology for decision making of the type of operative intervention required. Cases with severely comminuted radial head fractures (Mason type III) were considered for radial head replacement.

We used stainless steel monoblock radial head prosthesis. Size of the prosthetic radial head diameter and thickness was determined pre-operatively by CT Scan measurement of the native radial head.

Approach

Under GA, patient was placed in lateral position. Postero-lateral approach to the elbow was used, which corresponds to the distal limb of the lateral- J approach of Kocher to the elbow. Kochers interval between the anconeous and extensor carpi ulnaris (ECU) identified by a thin strip of fat, which can be seen deep to the deep fascia. The interval is incised and the muscles are retracted to expose the lateral ligament complex. A longitudinal incision was given in the elbow joint capsule at the level of annular ligament to expose the underlying capitellum and the radial head. Care is taken not to violate the LCL complex and injure the PIN. As the extensor fibres are spread, the crossing fibres of the supinator will next be seen. The supinator can be safely divided for a distance of approximately 3cm, from the articular surface of the radial head with the forearm in pronation without injuring the PIN.

Once the decision for replacement arthroplasty was taken, all the free fragments were removed and the neck length was determined. The stability of medial/lateral collateral ligaments were assessed intra-operatively. MCL stability was assessed by placing a valgus force on the elbow and assessing the distance between the radial neck and capitellum. The forearm was placed in pronation with the elbow at 30^0 of flexion. A narrowing of the distance between the capitellum and the radial neck of >2mm indicates a disruption of the anterior band of MCL. Instability of the elbow in the extended position indicates that the anterior and posterior parts of the capsule are also torn. A kocher clamp is placed on the radial neck, and the radius is axially loaded to assess the interosseous ligament competence. A change in the distance between the radial neck and the capitellum of >2mm should be considered abnormal. However, in our study no gross ligamentous injury was evident.

The native neck-head rim is the ideal position, however depending upon prosthesis design(long head) slightly more resection of the neck may be required. The size of the radial head prosthesis was determined by assembling the excised radial head fragments and comparing the prosthesis trial head with the assembled head. Head diameter can also be assessed by placing the resected head into the sizer.

If between sizes, smaller size was selected . Care was taken to ensure that appropriate length of the neck was excised and resection was perpendicular to the axis of the neck. The medullary canal of the proximal part of the radius was prepared with the broaches. Sequential reaming was done where atleast 60% of the radial shaft was in contact with the reamer. Reaming of the canal was done keeping in mind the neck-shaft angle which on average is 15^0 and corresponds to the ulnar styloid (Fig. 1) . Than the trial head was inserted and proper articulation was checked with reference to capitellum and lesser sigmoid notch/coronoid. The coronoid needs to be in contact with trochlea to ensure proper positioning of the trial . Stability of the joint/prosthesis was checked by taking the elbow through a range of motion.

We followed few guidelines to avoid over stuffing. Routine AP xrays of both elbows were done and we compared medial as well as lateral ulno-humeral jont space pre and post operatively in both the injured and normal elbow. The most proximal osseous extent of the prosthetic radial head was kept on an average,0.9mm more proximal than the lateral osseous edge of the coronoid and lateral ulno-humeral joint space which is easily visualised intra-operatively was observed after excission of the native head and after implantation of the trial head, with over lengthening leading to loss of parallelism. Whenever there was doubt between two sizes, we opted for smaller size.

These guidelines are very important when the native radial head is extensively damaged and cannot be used to estimate prosthesis size, or in revision procedures in which the radial head has been previously excised.

Once the correct implant size was determined, the canal was plugged distally with bone chips taken from the fractured radial head. With the use of a syringe, cement was inserted in an antegrade manner and the corresponding monoblock radial head prosthesis was inserted keeping the direction towards the ulnar styloid. While implanting the radial head prosthesis, we kept the forearm at a rotation of 58.6^0 to full supination. After implantation position of the prosthesis was maintained securely without movement until the cement was hard and the prosthesis was firmly fixed in position (Fig. 2). Excess cement was removed before the cement hardened. Than the stability was re-assessed and range of movement was done to see any impingement.

Tourniquet was deflated followed by thorough wash and proper haemostasis was achieved. Incision was closed in layers after soft tissue repair and an above elbow POP slab was applied in 90^0 elbow flexion and neutral rotation.

All post-operative period was uneventful and above elbow POP slab was applied for 1week following surgery. The presence or absence of overstuffing was determined on post operative radiographs by comparing the medial ulno-humeral joint space of the operatively treated and untreated elbows. IV antibiotics were continued for first 24 hours and than changed to per oral for next 3 days. Elbow was first mobilised passively on day 3 with first dressing and patients were discharged on the same day if wound found to be healthy and were followed up in OPD basis.

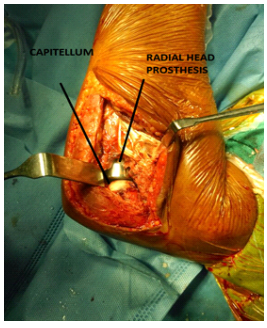


Fig. 2 : Implanted radial head prosthesis.

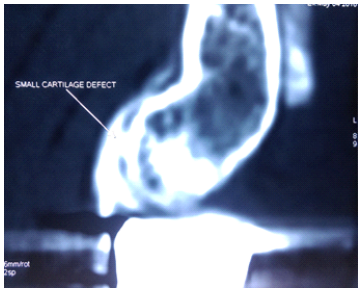
Active assisted ROM exercises were advised from 1st week after removal of slab. On each OPD visit ROM arc was assessed with the help of goniometer by the same junior resident every time and pain was assessed and graded accordingly. Clinical examination was done to assess any complication or instability of the elbow and difficulties(if any) in daily functional activities were noted. Tests for elbow instability was done by senior author. On follow visits radiographs were reviewed for joint congruity, evidence of capitellum osteopaenia /erosion, peri-prosthetic loosening, heterotopic ossification(HO) and osteoarthritis. The result thus obtained was assessed by Mayo's elbow performance score.

Fig. 4 : Congruent radio-capitellar articulation maintaining proper relation with coronoid ridge and neck-shaft angulation.

Results

In our study of thirty-two patients twenty four (75%) patients had excellent results, six (18.75%) good and two (6.25%) fair results with 0 poor results according to MEPS. The two fair results were seen in those who were operated after 2 weeks. The mean score at 6 month follow up was 90.78 with 70 minimum score and maximum 100. Elbow ROM score range was 15-20 with mean of 18.44. Elbow arc of flexion/extension mean was 110 and of rotation was 130. Elbow stability mean was 9.38 and of daily function was 19.84. Mayo's score showed a progressive curve with time and physiotherapy exercises.

Fig.1: Radial head prosthesis directed towards ulnar styloid process.
Mayo's score had significant correlation with time interval between injury and surgery, with better results in earlier operated cases. No significant association was found with other variables.



The average extension lag of the elbow was 12.18^0(range 0-30^0) with average flexion of 121^0(range 110-130^0). The average supination was 68.12^0(range 40-70^0) and that of pronation was 61.87^0(range 40-70^0) .

In our study out of 32 patients, 3 patients had pain and 3 patients had valgus instability. 3 patients had elbow stiffness, out of those 3 two were the same who had pain and one was the same who had valgus instability. 1 patient had lateral epicondylitis and 1 superficial infection, which were transitory and recovered on treatment. Therefore total 6 patients had complications out of 32,i.e 18.75 %. No case was associated with overstuffing, heterotopic ossification, distal neurovascular injury, deep infection.

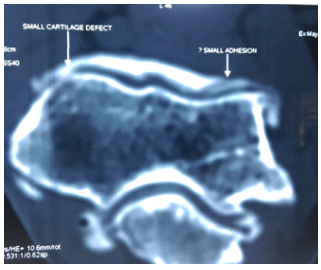
All cases with pain were mild in nature with Mayo's pain score of 30 and ROM score in those cases was 15. Regular anaelgesics were not required in any of these cases. Interestingly all these cases were operated after 2 weeks of injury, making it a significant association with time interval between injury and surgery (P value – 0.002). No correlation of pain was found with associated injury. In one case with pain we did CT arthrography (Fig. 3A and 3B) of the elbow to look for any capitellum wear-tear, although in xray no over stuffing was present. It revealed small chondral defect in the antero-lateral aspect of capitellum with small band like adhesion near the trochlea. That chondral defect might have been caused at the time of injury, as radial head does not come in contact with capitellum in that area during normal ROM activities.

Total 3 patients had elbow instability (Valgus instability) , out of those 3, 2 had associated injury of olecranon and monteggia fracture, making it a significant association (P value – 0.035). Duration of surgery was increased significantly in cases with associated injuries and significant association of elbow instability was found with those cases.

Elbow stiffness was seen in three cases. Arc of extension/flexion and elbow rotation was 90^0 and 90^0, 90^0 and 130^0, 100^0 and 90^0 respectively. All these 3 cases were operated after 2 weeks of injury making it a significant association (P value 0.026).

Radial head arthroplasty has been shown to restore axial and valgus stability reliably and to return elbow kinematics to nearly normal levels in biomechanical studies.

No patient had altered hand dominance due to injury. Patients with stiffness and valgus instability could not perform heavy manual work. Out of these group, 3 patients were daily wage manual labourer and had to change their profession to earn a living, at the time of final



follow up.
Fig 3A-3B : CT Arthrography was suggestive of a small chondral defect (2.2 ×1.8 mm) in the anterolateral aspect of the capitellum. The articular cartilage over rest of the capitellum, trochlea, coronoid and olecranon process of ulna appear intact. There was small band like adhesion in the volar aspect of the trochlea.
Radiographically congruent articulation of the radial head prosthesis with the capitellum and coronoid/lesser sigmoid notch could be seen in all the cases at the time of final follow up (Fig.4) and there was no evidence of overstuffing,erosion or sclerosis of proximal radio-ulnar joint, periprosthetic loosening, heterotopic ossification, implant dislocation. None of the patient needed reoperation for stiffness and instability.

Discussion

In our study 27 cases out of 32 were operated before 2 weeks and was associated with good outcome. Significant association was found between variables like Mayo's score, pain, stiffness with time interval between injury and surgery; with cases operated earlier showing better results. There was significant correlation between patients with associated elbow injury and prevalence of elbow instability. However no correlation existed with duration of surgery. Similar finding was seen in a study by N Ashwood 21 who had 3 fair results out of 16. These three fair result occurred in patients with delayed surgery.

We observed lateral epicondylitis in one patient which was transitory and got relieved after treatment. It might be due to injury to lateral extensor origin/ extensor carpii radialis brevis at the time of injury or during dissection/ forceful retraction on surgery This is relatively a rare complication and is not documented in any previous literature to the best of our knowledge.

We used stainless steel monoblock radial head prosthesis.

Historically different materials have been used in manufacturing radial head prosthesis , including siliastic, acrylic, vitallium, titanium and cobalt chromium. Silastic prosthesis were once popular but gradually discarded because of its associated complications of fragmentation and the resultant synovitis can lead to joint erosions. Recently biomechanical studies have demonstrated that metallic prostheses more closely reproduce the loads across the elbow joint21.

The insertion of a radial head prosthesis that closely replicates the dimension of the native radial head is of paramount importance .Insertion of an implant that is incorrectly sized has been associated with altered joint architecture and mechanics that may lead to complications. Use of a prosthetic radial head that is too thick leads to lengthening of the radius or overstuffing of the radio-capitellar joint, and has been reported to cause loss of elbow flexion, capitellar erosions, pain and early onset osteoarthritis.

In our study, size of the prosthetic radial head diameter and thickness was determined pre-operatively by CT Scan measurement of the native radial head. CT scan of normal elbow was also done and it reproduced the radial head dimensions more accurately. Radial head is an elliptical structure. The optimal diameter of a radial head implant is not known but the articular surface of the implant should likely approximate the articular surface of the native radial head.

Determination of correct implant size has been extensively studied by Frank SG et al 5. In radiological determination of medial ulno-humeral joint space, normally loss of parallelism can be seen in AP xray if over lengthening is >6mm in loaded state and >4mm in unloaded state(a condition which mimic intra-operative state) 5. The lateral ulno-humeral joint space in AP xray should be seen in both involved/normal elbow (because sometimes there is gaping in nomal elbow also, which if not considered will give erroneous result) and then compare it pre/post operatively5.

Doornberg et al concluded that the Most proximal osseous extent of the radial head was on the average,0.9mm more proximal than the lateral osseous edge of the coronoid 24. A weakness of this study was that the author did not consider for the thickness of the articular cartilage which may vary in thickness25.

If proper pre-operative planning is done and intra-operatively looking for lateral edge of the coronoid and lateral ulno-humeral joint space, prosthetic radial head can always replicate the native radial head size and thus avoiding over-lengthening which is the main reason for most of the complication. If there is any doubt between two sizes, the smaller size should always be selected as recommended by El sallakh.

Radial head arthroplasty has a steep learning curve and has shown initial promising results, with results being reproducible if properly consecuted.

LIMITATIONS OF THE STUDY :

- Limited numbers of patients with short follow up.
- Fewer cases with associated injuries was present in our study.
- In our prosthesis we had a number of design problems ,including lack of modularity, difficulties with sizing and a non anatomical design.

We recommend that taking a large sample size, with longer follow up and a modular implant will lead to better conclusions.

Conclusion

We conclude that replacement radial head arthroplasty is a good treatment option for irreparable type III radial head fractures, with cases operated earlier showing better results. It restores elbow kinematics and stability with good functional outcome, provided care has been taken to avoid overstuffing of the joint. Early mobilisation of elbow is important to restore elbow motion and function.

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