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ORIGINAL ARTICLE

Per Wretenberg · Anne Ericson · André Stark

Radial head prosthesis after fracture of radial head with associated elbow instability

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Abstract *Introduction*: Fractures of the radial head and associated elbow instability can be treated with operation with radial head prosthesis. In this study, we evaluate function 1–7 years after implantation and also function after removal of five prostheses. *Material and methods*: Eighteen patients with radial head fracture and associated elbow instability were evaluated 3.7 years (1–7) after implantation of a radial head prosthesis. Pain at rest and during activity was measured with a visual analogue scale (VAS). Test of stability and neurological examination was done manually as well as measurement of the range of motion, using a goniometer. Activity of daily living (ADL) was estimated using five questions where the answers were graded between 1 and 3. The patients were asked to grade their general satisfaction according to the following scale; very satisfied, satisfied, not satisfied, disappointed. Plain X-rays were taken and 14 patients agreed to have their elbow strength evaluated using the validated BTE work simulator. *Results*: Five prostheses had been extracted due to poor range of motion. All these patients improved after extraction. All elbows were stable. No patient with extracted prosthesis had VAS score >2. The mean extension defect for this group was 15° (5–25) compared to the mean extension defect for the 13 patients with the prosthesis still in place 15° (0–40). The highest VAS score for the patients with prosthesis was five but the mean as low as 0.8. In the whole group, 13 patients were pain free. ADL function was good in general. The X-rays of the prostheses, still in place, showed radiolucent lines in 7 of the 13 patients. In the whole group, there was a significant decrease in supination, flexion and extension strength ($P<0.01$, $P<0.01$, $P<0.05$). *Discussion*: Radial head prosthesis works as a spacer after fracture of the radial head and associated instability. If range of motion is much restricted post-operatively, the prosthesis can be removed with improved function as result.

Keywords Radial head · Fracture · Prosthesis · Instability · Extraction

P. Wretenberg (✉) · A. Ericson · A. Stark
Department of Orthopaedics, Karolinska University Hospital, SE-171 76 Stockholm, Sweden
E-mail: per.wretenberg@karolinska.se
Tel.: +46-8-51770000
Fax: +46-8-51776446

Introduction

Fractures of the radial head usually result from a fall on the outstretched hand. It may be isolated or associated with more complex injuries such as other fractures and ligament rupture causing instability. The so-called ''terrible triad'' includes radial head fracture, posterior dislocation and coronoid fracture [16, 18]. In our study, patients with coronoid fracture that needed operation was excluded. If soft tissue repair of the lateral complex was not enough to create stability, a radial head prosthesis was inserted for this purpose. The Mason [10] classification, as modified by Johnson [8], is widely used for the classification of the types of fractures. Type-I and undisplaced type-II fractures can usually be treated satisfactorily and conservatively while displaced type-II fractures can be operated with different techniques [2, 12, 14, 18, 20]. For Mason type-III and type-IV fractures, early excision of the radial head has been advocated both with good [2, 4, 7, 21] and bad [11, 22] results. The functional outcome after radial head prosthesis in the treatment of radial head fractures, associated with instability of the elbow, has shown to be relatively satisfactory [5, 15, 23]. Radial head prosthesis often has to be removed for different reasons. As far as we know, however, there are no data in the literature showing results after removal of radial head prosthesis inserted after a fracture of the radial head. In this study, we retrospectively analysed the functional outcome of 18 patients operated with radial head prosthesis due to fractures of the radial head in combination with instability of the elbow. One of the main purposes of this paper was to analyse a sub-group of five patients after

removal of the radial head prosthesis due to marked restriction in range of motion post-operatively.

Patients and methods

Between 1994 and 2001, 22 patients were operated consecutively with radial head prosthesis (Waldemar Link, GmbH & Co, Barkhausenweg 10, D 22339, Hamburg. Art. Nr 650–110) for fractures of the radial heads in combination with elbow instability (Figs. 1, 2). The radial head prosthesis can be put both with and without cement and all our prostheses were uncemented. A prosthesis was used when an osteosynthesis of the radial head was impossible and stability could not be reached just by repair of the lateral soft tissue structures. Hence, the main purpose of the prosthesis was stability and this was judged intra-operatively by the surgeon. In no case, the medial side of the elbow was opened. Post-operatively the patients were put in a cast for 2 weeks. There after full unloaded range of motion was allowed for another 4 weeks before loaded training started. All patients were offered physiotherapy for a total of 3 months.

The Link prosthesis come in three different sizes and the surgeons estimated the size from the fractured pieces of the radial head. The position of the implant was estimated during implantation and stability was tested. All operations were carried out only through a lateral approach. Of the 22 patients, one had died, one had several fractures of the same arm causing a lot of problems unrelated to the radial head fracture, one had severe problems with alcohol abuse and could not fully participate and one was lost to follow-up, leaving 18 patients, 7 women and 11 men available for follow-up. The mean age of the patients was 52 years (29–82) and the follow-up was done at a mean of 3.7 years (1–7) after the last surgery. Extraction of the five prostheses was done at a mean of 4.8 years (2–8).

Pain at rest and during activity was measured with a visual analogue scale (VAS). Test of stability and neurological examination was done manually as well as measurement of the range of motion, using a goniometer. Activity of daily living (ADL) was estimated using five questions where the answers were graded between 1 and 3 (Table 1). The patients were asked to grade their

Fig. 1 **a** Patient with Mason type-IV fracture and associated elbow instability. **b** Same patient after resection of the caput radii and implantation of caput radii prosthesis

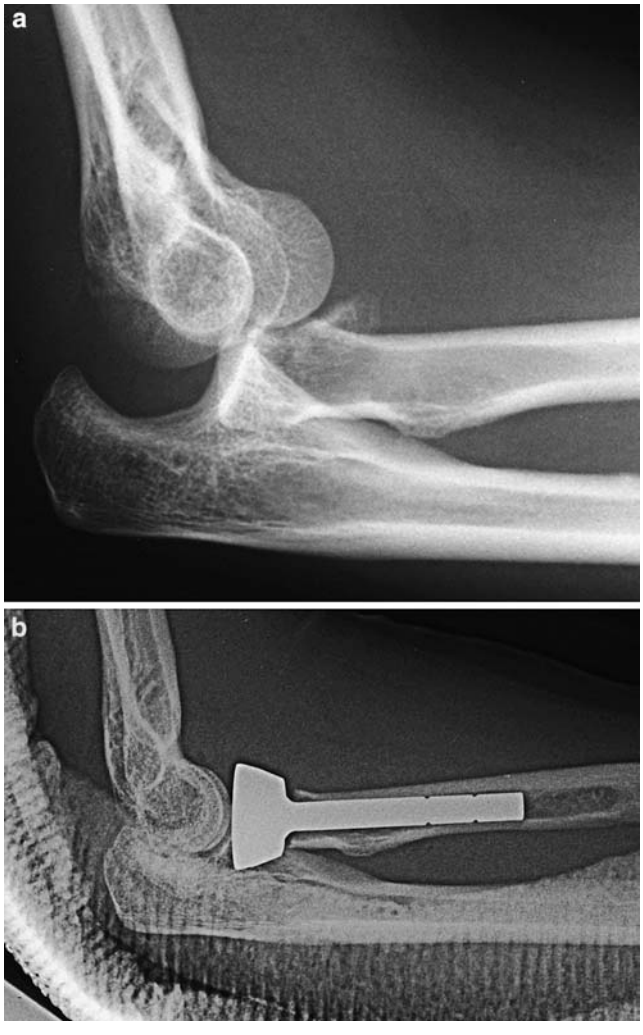

Fig. 2 **a** Patient with elbow luxation and Mason type-III fracture of the caput radii and associated elbow instability. **b** Same patient after resection of the caput radii and implantation of caput radii prosthesis

Table 1 Questions about ADL function

	1	2	3
Are you able to eat?			
Reach perineum?			
Camb your hair?			
Reach other shoulder?			
Dress your self?			

general satisfaction according to the following scale; very satisfied, satisfied, not satisfied, disappointed. Plain X-rays were taken and 14 patients (all the patients with extracted prostheses and 9 out of 13 with prostheses) agreed to have their elbow strength evaluated using the validated BTE work simulator [17] (Fig. 3).

Results

Five of the 18 patients had had their prostheses removed, all due to poor post-operative range of motion. The mean time from insertion of the prosthesis to extraction was 2.1 years (0.5–4) and the mean time from extraction to clinical evaluation was 4.6 years (1.5–7). The results for those five patients are shown separately as well as the data for the patients with the prostheses still in place (Table 2). Stability in varus and valgus was manually tested in both the full extension and 30 and 60° of flexion. All five patients with extracted prostheses were clinically stable. One of these patients had numbness in the fingers during activity with involvement of both the ulnar and median nerves, where the numbness came after the removal of the prothesis. No patient with extracted prostheses had VAS score >2 at rest and all five patients estimated less pain after the removal than before, however no VAS numbers before removal were available. All patients with extracted prostheses got better range of motion after the removal and the mean range of motion was better than for the patients with the prostheses still in place (Table 2). The mean extension defect before removal was 29° (20–35) and after removal was 15° (5–25). The mean flexion before removal was 124° (110–140) and the mean flexion after removal was 130° (120–140). The mean pronation was 90° (80–90) and the mean supination 70° (50–90). The ADL function was in general good. All the patients with extracted prostheses answered three (without difficulty) or all the ADL questions. Four out of five patients with extracted prostheses were very satisfied with the result and one was satisfied. Three out of five patients showed radiolucent lines on X-ray before extraction but during operation no radial head prosthesis was loose or had migrated significantly. During the extraction operation, partial cartilage destruction of the capitellum was noted in two out of five elbows. The distal radio ulnar joint (DRUJ) was unfortunately not examined which of course would have been an advantage since radial length is of importance for DRUJ function.

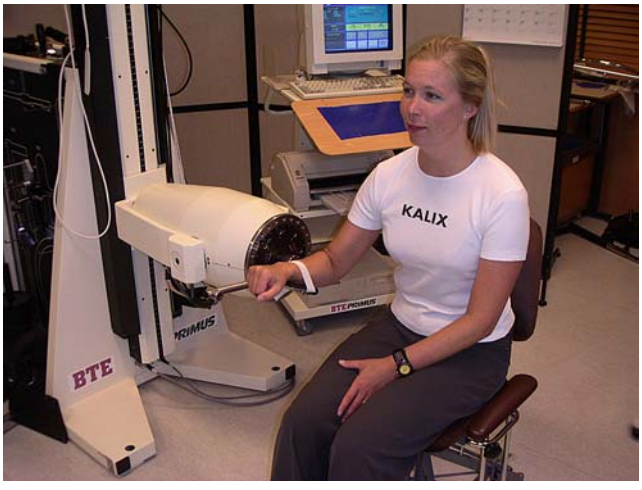

Fig. 3 BTE work simulator for measurement of elbow strength and range of motion

All the patients with the prosthesis still in place were stable and no one had neurological problems. One patient with prosthesis had a VAS score at rest of five but the mean VAS score at rest was as low as 0.8. The mean extension defect was 15° (0–40) and the mean flexion 125° (100–145). The mean pronation was somewhat lower and the mean supination was somewhat better than for the patients with extracted prosthesis (Table 2). Four of the patients with the prosthesis still in place answered two on at least one ADL question. One 82-year-old woman had very limited ADL function and was unable to dress herself. However this was also due to other medical reasons. Only four out of 13 patients with prostheses were *very satisfied*, seven were *satisfied*, one was *not satisfied* and one was disappointed.

The X-rays of the prosthesis still in place showed radiolucent lines in 7 of the 13 patients. No correlation between patients with radiolucent lines and worse clinical results could be found.

Since the groups were small no statistical calculations of strength differences were made for the sub-groups. For the whole group, there was a significant decrease in supination strength ($P < 0.01$), flexion strength ($P < 0.01$) and extension strength ($P < 0.05$). No significant decrease was found in pronation strength. Generally the same situation with the least effect on pronation strength was found for both the sub-groups.

Discussion

Radial head fractures and associated elbow instability can be treated in different ways. Transarticular fixation with Steinmann pins in combination with a long cast until healing of soft tissue and thereafter progressive physical therapy has been used with good results [3]. Treatment with external fixation which allows early movement has also been used with good results but also with some complications [11]. In this study, includes 18 patients of which 5 had their radial head prostheses

Table 2 Mean and range data for all patients and divided into subgroups

	All $n = 18$		Not extracted $n = 13$		Extracted $n = 5$	
	Mean	range	Mean	Range	Mean	range
Age	52.2	29–82	53.8	35–57	48.2	29–82
Year post op	3.7	1–7	3.3	1–7	4.6	2.0–7
VAS activity	2.9	0–7	2.4	0–7	3.0	2.0–6
VAS rest	0.8	0–5	0.6	0–5	1.0	0–2
Ext. Defect	15	0–40	15	0–40	15	5.0–25
Flexion	130	100–145	125	100–145	130	120–140
Pronation	80	30–90	75	30–90	90	80–90
Supination	75	45–90	75	45–90	70	50–90

removed due to poor range of motion. Only one patient had severe problems with the ADL function. She was an old lady, 82 years of age, who also had other problems unrelated to the operated elbow. All but this woman and one other patient stated that they were *very satisfied* or *satisfied* with the result. So the results in general were satisfactory both for the patients with the prosthesis still in place and for those where the prosthesis were removed. On the other hand, dissatisfaction was the reason for extraction of all the five prostheses. It can therefore be assumed that the results would not have been that good without extraction of some of the prostheses. The importance of radius length for adequate function of the proximal (PRUJ) and DRUJ have been discussed [11]. Restored length of the radius thereby is of importance both for elbow and wrist functions. This fact in it self favours the use of a radial head prosthesis. Unfortunately no specific data on the wrists were sampled. On the other hand, none of the patient with extracted prosthesis complained of increased wrist problems after removal. It might also be that the elbow problems were so much bigger than the wrist problems and therefore no comments about the wrist were discussed during evaluation.

As far as we know, there has been no previous report of the results after removal of radial head prosthesis implanted after fracture of the radial head (Figs. 4, 5). All the five patients estimated an improvement in elbow function after removal with following physiotherapy. This is interesting since the prostheses were removed at a mean of 4.8 years after the implantation and one would expect the stiffness in the elbows to be permanent. When it, during the follow-up, became clear that all patients with removed prostheses were clinically improved, we planed for a prospective series of these patients. So far, we have included two patients with complete both pre- and post-operative measurements, however, only with half a year follow-up. Both these patients have gained more than 25° of extension (26 and 28°) without loosing strength.

Obviously, it can be a good idea to extract a prosthesis that is believed to cause mechanical impingement. This finding suggests the possibility to use radial head prosthesis as a spacer in Mason type-III and IV fractures in combination with instability. If the range of motion is severely restricted, the prosthesis can be removed later and mobility be regained. The problem is of course to know when to do the extraction and on which criteria should be based to make the decision. The criteria we used were pain and highly restricted range of motion seen mainly as extension defects. Plain X-rays were taken but in no case there was any sign of loosening or obvious mal-position of the implant. What we would have liked to have, when we analysed the material, was the X-ray of the other elbow to be able to compare implant size with the size of the caput radii. Unfortunately no ethical proposal was made for X-ray of the contra lateral elbow. We have a feeling that the implants removed were larger than necessary and also that they should have been impacted a little longer which would have made the elbows less stiff. By comparing an X-ray of the unfractured side, it might be possible to plan for a revision arthroplasty with insertion of a smaller implant. That might be an advantage for the PRU and DRU joints in the long run.

To our knowledge, no previous data on arm strength has been published after implantation of a radial head prosthesis. The BTE work simulator is a validated and very exact way to measure movements and strength in

Fig. 4 Patient with implanted radial head prosthesis and 35° of extension defect before removal. After removal and following physiotherapy, the extension defect was 20°

Fig. 5 Patient with implanted radial head prosthesis and 30° of extension defect before removal. After removal and following physiotherapy, the extension defect was 15°

the upper extremities [16]. It was obvious that the patients lost strength in flexion, extension and supination. If the patients were sub-divided into those where the prosthesis was extracted and still in place, the same results were found. This might suggest more focus on strength training during the somewhat later post-operative period.

Some studies have shown difficulties in choosing the right size of radial head implants [1, 9]. Our experience is that the size of the prosthesis is often overestimated, causing restriction in motion due to impingement. Improvement in range of motion in all elbows where motion restriction was a great problem and the prosthesis removed support this theory.

In conclusion, operation with radial head prosthesis after fracture of the radial head in combination with elbow instability is an appropriate way of dealing with this problem. The prosthesis works well as a spacer and if the range of motion is much restricted, extraction of the prosthesis can be done with improved range of motion as result.

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