

**RESEARCH ARTICLE**

# Radiographic Predictors for Short-term Functional Outcome after Radial Head Arthroplasty in Patients with Persistent Symptoms after Treatment for Radial Head

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**Abstract**

**Background:** Evaluation of the accurate position after radial head arthroplasty remains a challenge for surgeons. Standard radiographs are used to evaluate the position of the implant, however, results regarding radiographic deficiencies on clinical outcome are not consistent. In this retrospective study our main aim was to determine if subtle radiographic deficiencies after radial head arthroplasty can predict functional outcomes measured with the Mayo Elbow Performance Score (MEPS).

**Methods:** A total of 24 patients, that had a press-fit bipolar radial head arthroplasty because of persistent symptoms after treatment of a radial head fracture, were included. The mean follow-up time was 27 months and the MEPS was assessed at the final follow-up. Three upper extremity orthopaedic surgeons evaluated 12 potential deficiencies on anteroposterior and lateral radiographs in consensus agreement.

**Results:** The median MEPS was 97.5 (Interquartile Range 82.5-100). No association was found between the presence of subtle radiographic deficiencies and MEPS.

**Conclusion:** Functional outcome of the elbow after uncemented press-fit bipolar radial head arthroplasty is not associated with subtle radiographic deficiencies. Therefore, surgeons might accept small imperfections on postoperative radiographs.

**Level of evidence:** IV

**Keywords:** Arthroplasty, Fracture, Outcome, Radial head, Radiographs

**Introduction**

Comminuted and irreparable radial head fractures in complex elbow trauma necessitate radial head arthroplasty. Patients with persistent symptoms

after conservative treatment or failed open reduction and internal fixation of a radial head fracture may also benefit from arthroplasty (1-7). Appropriate positioning

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and size of the implant remains an ongoing challenge for surgeons, since malpositioning may cause pain, restricted range of motion, instability and degeneration of the elbow joint (8, 9).

In daily orthopedic practice, standardized anteroposterior (AP) and lateral radiographs are carried out to evaluate positioning of the implant postoperatively and during follow-up. Numerous studies have reported radiographic abnormalities after radial head arthroplasty (1, 10-12). However, to the best of our knowledge, only a few studies have investigated the relationship between radiographic abnormalities and clinical outcome. Rottini et al found heterotopic ossification, radiolucency lines, and bone resorption in 1/3 of the patients after radial head arthroplasty (13). Despite this, functional outcome was excellent according to Mayo Elbow Performance Score (MEPS). Gauci et al. found frequent bone resorption around the radial neck after modular pyrocarbon radial head prosthesis. After one year of follow-up the bone resorption was stable and did not affect stem fixation. Moreover, elbow function and stability were excellent. Van Hoecke et al., Fehringer et al and Levy et al also found no association between radiological signs as for example loosening and functional outcome after radial head prosthesis (6, 14, 15). In contradiction, Ha et al reported a correlation between radiographic abnormalities (heterotopic ossification, periprosthetic lucency, and radiocapitellar degeneration) and the presence of symptoms (pain, limited ROM and instability) (16).

Aforementioned studies show promising clinical results after radial head arthroplasty, but they show conflicting results regarding the influence of radiographic deficiencies on clinical outcome. It would be useful to know if radiographic signs can predict functional outcome in patients with radial head implants. These signs could then guide appropriate treatment to improve long-term outcomes. Our hypothesis was that subtle radiographic deficiencies after radial head arthroplasty do not predict functional outcome of the elbow, as measured with MEPS.

## Materials and Methods

### Study design and participants

This study was waived by the Institutional Review Board of our hospital due to its retrospective design and the fact that data were collected as part of routine clinical care and patients were informed that their patient data could be used for scientific purposes.

Between 2007 and 2011, 24 patients underwent radial head arthroplasty (RHS<sup>®</sup>, Tornier, Montbonnot-Saint-Martin, France) because of persistent symptoms (pain, stiffness, restricted ROM, and instability) in previously treated radial head fractures. Nine radial head fractures were previously treated conservatively; 8 fractures were treated with open reduction and internal fixation; in 5 fractures radial head resection was performed; and 2 fractures were previously treated with a silicone radial head implant. Mean age of the included patients was 48 years (Standard

Deviation [SD]  $\pm$  11) and mean follow-up time was 27 months (SD  $\pm$  11). There were 8 male and 16 female patients, of which in 13 patients the left elbow was involved and in 11 patients the right side.

Standardized AP and lateral radiographs were available of all 24 patients. An independent research fellow removed all identifying information from the radiographs. Three fully trained actively practicing elbow surgeons of the Shoulder & Elbow platform were invited to evaluate the radiographs on a web-based study platform ([www.shoulderelbowplatform.org](http://www.shoulderelbowplatform.org)) using a built-in DICOM viewer. With the DICOM viewer raters were able to adjust brightness, contrast, and window leveling. The observers completed the study at their own pace, in their own time on various computers if necessary.

### Study Description

Our primary outcome variable was the MEPS at the last follow-up. A MEPS between 90 and 100 was considered as excellent; 75 to 89 as good; 60 to 74 as fair; and a score less than 60 as poor. MEPS was first described by Morrey et al and is nowadays a widely used scoring system with high accuracy and reliability for a variety of elbow disorders (17, 18). The MEPS includes assessment of pain, arc of motion, stability and a patient rating of functioning during daily activities.

The radiographic signs were selected based on previous studies in which the importance of these signs was described (9, 13, 16, 19-21). The following radiographic signs were evaluated by all three raters: 1) subcollar bone resorption, 2) non-bridging heterotopic ossification, 3) erosion of the capitellum, 4) osteopenia of the capitellum, 5) correct radial head size, 6) gapping of the ulnohumeral joint, 7) degeneration of the ulnohumeral joint, 8) congruent proximal radio-ulnar joint, 9) correct stem size, 10) correct stem positioning on AP view, 11) correct stem positioning on lateral view, 12) component dissociation or sign of polyethylene wear of the head with increased angulation of the head in relation to the shaft in AP direction [Figure 1]. Raters evaluated all 12 signs with either 'yes' or 'no'. The radiographic signs were interpreted by the raters since that corresponds to daily clinical practice. The presence or absence of radiographic signs for each of the 24 patients was based on the evaluation of the raters. If at least two raters responded 'yes', the radiographic sign was considered present. If at least two raters responded 'no', the radiographic sign was considered absent.

### Statistical Analysis

Categorical variables were presented as frequencies with percentages, nonparametric continuous variables were presented as a median with interquartile range (IQR), and parametric continuous variables were presented as a mean with standard deviation. In bivariate analysis, correlation between the response variable (MEPS) and explanatory variables (radiographic signs) was performed using a Wilcoxon rank-sum test. All



**Figure 1.** Radiographs of a 49-year-old female who underwent radial head arthroplasty and lateral collateral ligament repair after a nonunion of a comminuted radial head fracture. The radiographs demonstrate subcollar bone resorption along with erosion and osteopenia of the capitellum.

statistical analyses were performed using Stata 14 (StataCorp LP, College Station, TX, USA).

### Results

The prevalence of each radiographic sign is described in Table 1. Ten out of 12 radiographic signs were present in at least one of the 24 patients. Two signs (correct radial head size and component dissociation or sign of polyethylene wear of the head with increased angulation of the head in relation to the shaft in AP direction) were not present in any of the evaluated patients and were

therefore not included in the analysis. A consensus agreement about the presence of radiographic signs was reached for all signs.

Median MEPS was 97.5 (IQR 82.5 - 100) of which 15 patients had an excellent score (90 - 100), 5 patients had a good score (75 - 89) and 4 patients had a fair score (60 - 74).

Bivariate analysis revealed that there was no correlation between the evaluated radiographic signs and MEPS at mean follow-up time of 27 months (SD ± 11) [Table 2].

**Table 1. Prevalence of Radiographic Deficiencies (n = 24)**

Parameter	Prevalence	
Subcollar bone resorption	79%	(19 out of 24)
Non-bridging heterotopic ossification	8%	(2 out of 24)
Erosion of the capitellum	54%	(13 out of 24)
Osteopenia of the capitellum	54%	(13 out of 24)
Correct radial head size	100%	(24 out of 24)
Gapping of the ulnohumeral joint	8%	(2 out of 24)
Degeneration ulnohumeral joint	54%	(13 out of 24)
Congruent proximal radio-ulnar joint	83%	(20 out of 24)
Correct stem size	96%	(23 out of 24)
Correct stem positioning in anteroposterior direction	92%	(22 out of 24)
Correct stem positioning in lateral direction	92%	(22 out of 24)
Component dissociation with increased angulation of the head in relation to the shaft in anteroposterior direction	0%	(0 out of 24)

**Table 2. Association between Radiographic Deficiencies and Mayo Elbow Performance Score (n = 24)**

Parameter	Radiographic Deficiencies Present		Radiographic Deficiencies Not Present		P value†
	Median MEPS	IQR*	Median MEPS	IQR*	
Subcollar bone resorption	100	83 - 100	90	75 - 98	0.43
Non-bridging heterotopic ossification	95	95 - 100	100	80 - 100	0.78
Erosion of the capitellum	100	80 - 100	95	85 - 100	0.88
Osteopenia of the capitellum	100	85 - 100	95	80 - 100	0.62
Correct radial head size**	98	83 - 100	-	-	-
Gapping of the ulnohumeral joint	98	95 - 100	98	80 - 100	0.61
Degeneration ulnohumeral joint	95	75 - 100	100	85 - 100	0.29
Congruent proximal radio-ulnar joint	100	85 - 100	78	68 - 90	0.089
Correct stem size	100	85 - 100	60	60 - 60	0.089
Correct stem positioning (AP)	98	85 - 100	90	80 - 100	0.91
Correct stem positioning (lateral)	98	85 - 100	90	80 - 100	0.91
Component dissociation with increased angulation of the head in relation to the shaft in anteroposterior direction**	-	-	98	83 - 100	-

\*IQR, Interquartile Range; \*\*omitted, because in all casus assessed as good by the observers; †by Wilcoxon rank-sum test

## Discussion

Precise positioning of radial head arthroplasty is an ongoing contest for surgeons. Postoperative radiographs are used to evaluate the position of the implant, but there are conflicting results about radiographic deficiencies on clinical outcome and therefore these radiographic signs are less useful to guide treatment. In this retrospective study we investigated if subtle radiographic deficiencies after radial head arthroplasty predict functional outcome of the elbow measured with MEPS.

We found no association between functional outcome of the elbow after uncemented press-fit bipolar radial head arthroplasty and the tested deficiencies.

Findings of this study should be interpreted by taking into account some limitations. First, longer follow-up time would provide more information regarding osteolysis over time. Second, radiographs were made according to the hospital protocol and not otherwise standardized, although this represents our daily clinical practice. Third, although MEPS is frequently used in elbow disorders, this measure is not validated yet for radial head arthroplasty. Fourth, component dissociation probably is a radiographic predictor for short-term functional outcome after radial head arthroplasty. However, this was not present in any of the patients. So, it was not possible to test for this deficiency. Lastly, as often with radial head arthroplasty, a small cohort of patients was included.

The results of our study are in line with Van Hoecke et al., Fehring et al. and Levy et al. who did not find a relationship between postoperative radiographs and

functional outcome (6, 14, 15). No correlation was found between mean stem radiolucency and both MEPS and proximal radial forearm pain, at a minimum follow-up of 2 years. In order to quantify radiolucency, the maximum width on both sides of the stem was measured. As well as in our study a smooth-stemmed metal radial head implant was used.

Our results are in contrast with Ha et al who found a correlation between radiographic deficiencies and the presence of symptoms for both unipolar and bipolar implants (both  $P < 0.05$ ) (16). An explanation could be that predominantly unipolar implants were installed and to that 94% of the included patients had an acute radial head fracture, while in our study a bipolar prosthesis was implanted after persistent symptoms. Heterotopic ossification was associated with decreased flexion and extension ( $P = 0.0046$ ), and pronation and supination ( $P = 0.0027$ ). In our study, heterotopic ossification was only observed in 2 patients, which makes it difficult to validate correlations.

Different radial head implant designs are used in daily orthopaedic practice, ranging from unipolar to bipolar designs, from self-centering smooth stems to fixed stems, either press-fit or with the use of cement (2-4, 7, 13, 16, 22-24). Since we solely used an uncemented press-fit bi-polar prosthesis, the results may not apply to other designs due to other biomechanical forces on the implant. For instance, Berschback et al reported that smooth-stem bipolar implants tend to have more ectopic bone, while press-fit design unipolar implants tend to have more periprosthetic osteolysis (12).

In conclusion, clinical outcome of the elbow, as measured with MEPS, after pressfit bipolar radial head replacement, is not associated with subtle radiographic changes on plain radiographs after a follow-up of 27 months. Based on the results of this study surgeons can accept small imperfections on postoperative radiographs.

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