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REVIEW ARTICLE

Complications of radial head prostheses

Stéphanie Delclaux · Julie Lebon · Amélie Faraud · Julien Toulemonde · Nicolas Bonnevialle · Bertrand Coulet · Pierre Mansat

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Abstract Radial head prostheses are indicated for treatment of complex radial head fractures not amenable for fixation. After the initial experience with silastic implants, metallic or pyrocarbon arthroplasty have been used for 20 years. Little is known about complications related to these implants. Main complications are related to loosening whether they are cemented or not cemented. Hypotheses have been proposed like inadequate stem design, insufficient cement technique, stress shielding, and foreign body reactions secondary to polyethylene wear. Pain and stiffness are other common complications often related to oversized radial head component or overstuffing of the joint with excessive lengthening of the radius. Instability can be another complication in the context of more complex trauma with lateral collateral ligament complex lesion and coronoid fracture. Fixation of the coronoid fracture, reinsertion of the lateral collateral ligament complex, and the use of monobloc radial head prosthesis are recommended to stabilize the joint. Finally, osteoarthritis is common with follow-up.

Keywords Radial head · Prosthesis · Complications · Loosening · Dislocation · Osteoarthritis

S. Delclaux · J. Lebon · A. Faraud · J. Toulemonde · N. Bonnevialle · P. Mansat (✉)
Orthopaedic and Traumatology Department, University Hospital of Toulouse Riquet Hospital, CHU Purpan, Place du Dr Baylac, 31059 Toulouse, France
e-mail: mansat@cict.fr

B. Coulet
Department of Hand and Upper Limb surgery, Lapeyronie University Hospital, 371, avenue du Doyen Gaston Giraud, 34295 Montpellier cedex 5, France
e-mail: bertrand-coulet@wanadoo.fr

Introduction

Radial head prostheses are used to stabilize the joint after complex acute radial head fracture not amenable for fixation or radial head sequelae. After the initial experience with silastic implants, metallic prosthesis have been used for the last 20 years and pyrocarbon arthroplasty more recently. There are few reports in literature related to complications of radial head arthroplasty, but complication rates are not so uncommon. However, comparisons of different radial head implants are difficult because no comparative studies are available. Furthermore, indications of radial head prostheses varied from one study to another. The goal of this study was to make an overview of the literature focusing specifically on complications after radial head prostheses and to propose guidelines.

Materials and methods

Literature search

Medline was searched using the PubMed interface to identify all French and English language articles pertaining to radial head prostheses, radial head arthroplasty, radial head implant, radial head replacement, and prostheses of the head of the radius published between 1993 and 2015.

Study selection

Each identified study was reviewed and included in the analysis if it reported on outcomes and complications of radial head prostheses performed on an acute setting or secondary to chronic elbow sequelae. Studies lacking clear descriptions of clinical and radiographic results were excluded from the review.

Data abstraction

The type of radial head prosthesis, monobloc, bipolar or modular non-bipolar, was recorded. Silastic prostheses were excluded from the review. The number of cases, percentage of acute and chronic indications, percentage of satisfactory results, as well as average follow-up were recorded.

Results

Overall results

Even comparison between the different series of radial head prostheses is difficult; the results are summarized in Table 1. Thirty-four series have been reviewed with an overall of 795 prostheses. An acute indication for non-fixable radial head fracture was reported in 583 cases and a chronic indication to treat fracture sequelae in 136 cases. In 76 cases the indications were not specified. Satisfactory results were reported in 81 % of the cases in acute indications and 73 % in chronic sequelae with three to four years average follow-up, with an overall satisfactory result obtained in 80 % of the cases. No difference could be found between monobloc prostheses (50–94 % satisfactory results), modular prostheses with fixed radial head (61–97 % satisfactory results), and bipolar radial head arthroplasty (50–100 % satisfactory results).

Complications and revisions

A multicentre study initiated by the French Society of Shoulder and Elbow (SOFEC) evaluated 26 patients with revision of failed radial head prostheses [35]. Indications for a radial head prosthesis were: acute complex radial head fractures for 15 and chronic sequelae in 11. Radial head implants revised were: silastic implant – Wright (3), metallic monobloc – Wright (1), CRF2 bipolar Judet – Tornier (10), Mopyc monobloc – Tornier (5), unipolar or bipolar rHead RECON – SBI (2), bipolar GUEPAR – Depuy (5). Main causes of failure were: isolated pain (6), stiffness (7), instability (9), loosening (3) and infection (1). In 14, the arthroplasty had to be removed without being replaced, and in 12 a new implant had been used. At 83 months (14–274) average follow-up, pain evaluated with VAS was 3 (0–7), MEPS 77 points (55–100) and DASH score 18 points (6–36). There was no statistical difference between simple removal of the implant and new radial head prosthesis, concerning pain level (2.5±2 vs 2.7±2), MEPS (74±17 vs 80±14 points), DASH (21±10 vs 9±2 points), and strength in elbow flexion (8±4 vs 11±6 kg).

A study performed at the Mayo Clinic reported 47 revisions of failed radial head prostheses [36]. Initial indications were acute trauma of less than seven days for 13, and chronic sequelae of more than seven days (2.5 years on average) for 23. The main cause of failure was painful loosening of the implant in 30. Other causes were: stiffness (18), instability (9) and infection (2). All loose implants were uncemented initially except for three. There was radiographic instability of the implant in ten cases with subluxation of the radial head in four, dislocation in three and radial head disassembling in three. Overstuffing was evident in ten with excessive length of the prosthesis and sign of hyperpression on the capitellum. Signs of osteoarthritis were observed in all elbows. In 18 patients, the radial head replacement was removed and not replaced, whereas in 24 elbows the radial head prosthesis was removed and replaced. In three patients the radial head was removed and a total elbow replacement was implanted.

Recently, Schnetzke et al. [33] reviewing 35 monopolar modular prostheses in the context of complex elbow dislocations found at an average of 13.2±13.5 months that 90 % developed at least one radiographic abnormality. Frequent radiographic abnormalities included radiolucent lines in 63 %, heterotopic ossification in 53 %, oversizing in 50 %, capitellar erosions in 20 %, and subluxation with prosthesis incongruence in 20 % of patients.

Discussion

Implant loosening

Lucent lines are frequent around the radial component stem. However, they are not always correlated with clinical symptoms. They are sometimes observed very early after the initial procedure, and more frequently with uncemented stems compared to cemented stems or free stems [29, 30, 33]. Several hypotheses have been proposed. Stress-shielding mechanisms have been advanced for uncemented stems impacted in the radial medullary canal [30]. Inadequate matching between the uncemented stem and the medullary canal has been advanced by some authors, with often undersized implant [37]. Inadequate cement technique has been discussed for cemented prostheses. Because of a narrow radial medullary canal, use of a cement restrictor is recommended with low viscosity cement [32]. Foreign body reactions to polyethylene debris have been evoked with bipolar radial head component because of wear of the polyethylene inside the radial head around the metallic neck of the prosthesis [6, 18, 20, 23]. Other prostheses are left free inside the medullary canal with often asymptomatic periprosthetic osteolysis [38]. Very often, a localized osteolysis is observed under the neck of the prosthesis, regardless of the type of prosthesis, cemented or uncemented, bipolar or with a fixed radial head. However, it is not always symptomatic. A stress-shielding mechanism has been proposed by some authors [30, 32] (Fig. 1).

Table 1 Results from literature of the different series reporting the use of a radial head prostheses in acute trauma or chronic sequelae

Authors	Year	Type	Acute cases (% satisf)	Chronic cases (% satisf)	Total (% satisf)	Follow-up (year)
Knight et al. [1]	1993	Mono	31 (94)	–	31 (94)	4.5
Judet et al. [2]	1996	Bipol	7 (100)	7 (72)	14 (86)	4
Wick et al. [3]	1998	Mono	–	–	30 (73)	–
Smets et al. [4]	2000	Bipol	13 (77)	2 (0)	15 (67)	2
Popovic et al. [5]	2000	Bipol	11 (83)	–	11 (83)	2.5
Harrington et al. [6]	2001	Mono	–	–	20 (80)	12
Moro et al. [7]	2001	Mono	25 (68)	–	25 (68)	3.25
Holmenschlager et al. [8]	2002	Bipol	10 (100)	6 (67)	16 (81)	1.5
Alnot et al. [9]	2003	Bipol	18 (100)	4 (0)	22 (82)	1.5
Ashwood et al. [10]	2004	Mono	10 (100)	6 (50)	16 (75)	2.8
Brinkman et al. [11]	2005	Bipol	–	11 (81)	11 (81)	2
Gabrion et al. [12]	2005	Bipol	10 (50)	–	10 (50)	2,5
Chapman et al. [13]	2006	Mono	8 (100)	8 (87)	16 (93)	2.75
Dotzis et al. [14]	2006	Bipol	12 (83)	–	12 (83)	5
Grewal et al. [15]	2006	Modul/non bipol	26 (61)	–	26 (61)	2
Wretenberg et al. [16]	2006	Mono	18 (72)	–	18 (72)	3.7
Doornberg et al. [17]	2007	Modul non bipol	27 (82)	–	27 (82)	3.5
Popovic et al. [18]	2007	Bipol	51 (76)	–	51 (76)	8.4
Lim and Chan [19]	2008	Mono	6 (66)	–	6 (66)	2.4
Shore et al. [20]	2008	Mono (22) Modul non bipol (10)	–	32 (66)	32 (66)	8
Chien et al. [21]	2010	Modul non Bipol	10 (90)	3 (66)	13 (84)	3
Celli et al. [22]	2010	Bipol	16 (87,5)	–	16 (87,5)	3,5
Burkhart et al. [23]	2010	Bipol	9 (100)	7 (85)	16 (94)	8,8
Lamas et al. [24]	2011	Modul non bipol	47 (89)	–	47 (89)	4
Ricon et al. [25]	2012	Modul non bipol	27 (89)	–	27 (89)	3
Zunkiewicz et al. [26]	2012	Bipol	23	7	30 (92 pts)	3
Sarris et al. [27]	2012	Modul non bipol	30	2	32 (97)	2
Rotini et al. [28]	2012	Mono (12) Bipol (19)	31 (93)	–	31 (93)	2
Flinkkilä et al. [29]	2012	Modul non bipol	42 (62)	–	42 (62)	4
Chanlalit et al. [30]	2012	Modul non bipol	–	–	26	2.7
Katthagen et al. [31]	2013	Modul non bipol	16 (−)	15 (−)	31 (84)	2
Allavena et al. [32]	2014	Bipol	14 (71)	4 (100)	18 (78)	4
Schnetzke et al. [33]	2014	Modul non bipol	35	3	38	1
Yu et al. [34]	2015	Bipol	0	19 (100)	19 (100)	2
Total (% satisfactory)			583 (81 %)	136 (73 %)	795 (80 %)	4

Mono monobloc, *bipol* bipolar, *modul non bipol* modular non bipolar, *satisf* satisfactory

Only series where satisfactory results were expressed in percentage were reported

Hyperpression or overstuffing

Range of motion is often decreased after radial head arthroplasty, with loss of some degrees of extension, and sometimes of rotation. This can be related to long immobilization or to malpositioning of the prosthesis [39]. It is important that the elbow be mobilized soon after surgery. If a splint is needed during the first two weeks after the surgery, active mobilization must start at two weeks. In order to protect the lateral collateral ligament complex, flexion-extension must be performed with the forearm in pronation, and forearm rotation elbow flexed 90°. If there is an extension deficit of more than 30°, 45 days postoperatively, an extension splint must be prescribed.

Van Glabbeek et al. [40] have outlined recently the sensitivity of the condyle-radial joint to the accurate longitudinal positioning of the radial head prosthesis. Excessive lengthening of more than 2-mm induces measurable alterations of the

Fig. 1 Loosening of a cemented stem

elbow kinematics with loss of motion [33, 40]. A useful landmark to avoid this complication is the lesser sigmoid notch of the ulna; after radial head resection, the radial head prosthesis must be aligned to this landmark without exceeding it [41]. Similarly, lateral ulno-humeral joint line must be symmetrical to the medial ulno-humeral joint line on an anterior-posterior view. An asymmetrical aspect of the joint line correlated with an excess height of the prosthesis equal or greater than 4 mm [42–45] (Table 2). In case of radial head overstuffing, removal of the prosthesis is often the only solution to relieve the patient [33] (Fig. 2).

Capitellar erosion

Capitellar erosion with a radial head prosthesis is often related to malalignment of the prosthesis and/or hyperpression of the prosthetic head on the capitellum [46]. In case of painful erosion of the capitellum, removal of the prosthesis is mandatory. However, in certain circumstances a radio-condylar implant can be proposed [47]. Van Riet et al. have shown that osteoporosis of the capitellum could predispose to accelerate wear of the capitellum with a radial head prosthesis [46]. The radiographic appearance of the subchondral bone of the capitellum should be considered when a delayed implantation of radial head prosthesis is planned (Fig. 2).

Table 2 Parameters to avoid excessive lengthening of the radius and to make adequate sizing of the radial head

Radial head diameter
Diameter of the resected radial head
Per-operative clinical assessment
Per-operative X-ray control
Head height
Top of radial head aligned to top of lesser sigmoid notch
Avoid contact between radial head and capitellum elbow in flexion 90°
Congruency of lateral humero-ulnar joint line
Symmetrical aspect between lateral and medial humero-ulnar joint line on X-rays

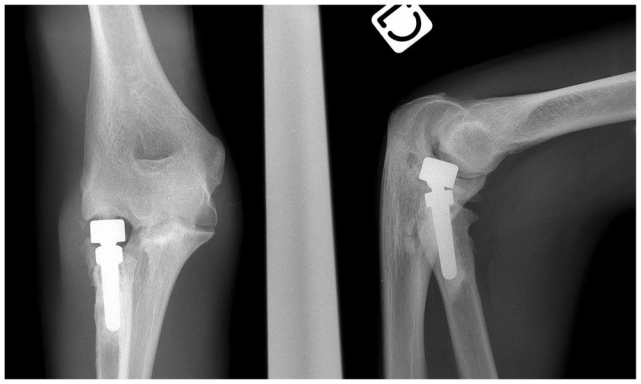

Fig. 2 Hyperpression of the radial head with capitellum erosion

Elbow instability

Elbow instability with radial head prosthesis is often seen acutely or in the early postoperative period. It is often related to associated lesions to the radial head fracture, like in a terrible triad, a Monteggia fracture or an Essex-Lopresti syndrome [12, 17, 29, 33, 48]. Absence of fixation of a coronoid fracture can compromise elbow stability. However, most of the time instability is related to incompetency of the lateral collateral ligament complex. Biomechanical studies have shown that radial head prosthesis alone could not stabilize the elbow to normal if the lateral collateral ligaments have been violated and non repaired [49]. Only lateral ligaments suture with a radial head prosthesis can restore elbow stability close to normal. The type of prosthesis can also influence elbow stability. Monopolar prostheses have been shown in vitro to restore better stability than bipolar prostheses [50, 51]. In the presence of lateral collateral ligaments incompetency, a bipolar radial head prosthesis may position the head under the capitellum facilitating postero-lateral instability by the same effect [52] (Fig. 3).

Elbow instability with radial head prostheses requires open reduction, evaluation of the lateral collateral ligament

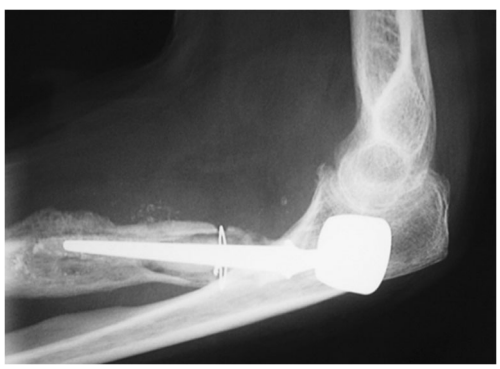

Fig. 3 Posterolateral instability of a bipolar radial head prosthesis

complex, the status of the capitellum, and the integrity of the coronoid process. A coronoid fracture of 50 % or greater must be fixed. The radial head prosthesis can be left in place, sometimes with a decrease of radial head size to avoid capitellum hyperpression. The lateral collateral ligament complex must be reinserted on the lateral condyle with trans-osseous sutures or using anchors. An articulated external fixator can be useful to neutralize joint forces, and to protect ligament healing, while allowing early mobilization [33, 48, 53]. In case of Essex-Lopresti lesions, pinning above the distal radio-ulnar joint can protect healing of the interosseous membrane [32, 48] (Fig. 3).

Neurologic lesions

Neurologic complications can be related to acute elbow trauma, can be secondary to surgical approach or can appear later. It may concern the radial nerve, the posterior inter-osseous nerve, or the ulnar nerve [10, 15, 17–20, 24, 29, 31]. Resolution is often spontaneous and definitive deficit is uncommon. During surgery, dissection distal to the radial tuberosity must be avoided in order to preserve the radial nerve and the posterior inter-osseous nerve. Similarly, retractors around the radial neck must be avoided. Maintaining forearm in pronation during radial head exposition, which increases distance from the posterior inter-osseous nerve, decreases this complication rate [54–58].

Radial head disassembling

Radial head disassembling of bipolar prosthesis has been reported by several authors [9, 32, 36, 59, 60] (Fig. 4). This complication is often related to persistent postero-lateral instability, the bipolar head engaging below the capitellum and supporting radial head disassembling. Management consists of open reduction, radial head repositioning, and most importantly, reinsertion of the lateral collateral ligament complex. Postoperative immobilization in a splint at 90° flexion forearm in pronation is required for two weeks, followed with early mobilization in the hinged splint limiting the last 30° of extension, and forearm in pronation for one month. However, radial head disassembling has also been reported with fixed radial head, mainly because of inadequate impaction of the radial head on the radial neck [23].

Osteoarthritis

Osteoarthritis of the capitellum is often related to the initial trauma with cartilage lesion, and to the increase of joint pressure secondary to radial head prosthesis or persistent postero-lateral instability. Recurrence of pain and loss of motion are often the first symptoms of osteoarthritis. Initially localized to the lateral compartment, it then progresses to the humero-ulnar joint. In the study of Van Riet et al. [36] signs of osteoarthritis were observed in all 47 elbows revised for failed radial head prosthesis. Depending of the severity of the stiffness, surgical release of the elbow either open or arthroscopic may decrease intensity of symptoms [61, 62]. Removal of the radial head arthroplasty can be useful if there are osteoarthritic changes of the capitellum and if the humero-ulnar joint is intact without elbow instability. However, after radial head arthroplasty removal, osteoarthritis can progress and a pain free elbow is rarely obtained. In case of global osteoarthritis, a total elbow arthroplasty is discussed [36] (Fig. 5).

Fig. 4 Radial head disassembling

Weaknesses of this study are related to the quality of the review process that was not exhaustive and the quality of the studies reviewed. Most of the papers analysed were of level-IV evidence with low scientific level. Furthermore, different outcome measures were used in the different studies making comparison difficult and making the pooling of results unreliable. To date, there were no comparative studies available. However, this study has allowed getting an overview of the

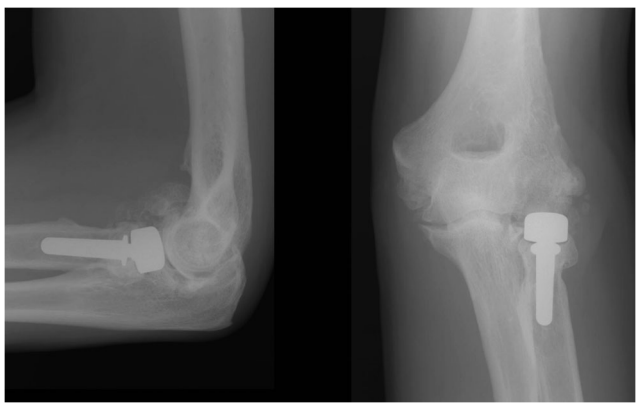

Fig. 5 Elbow osteoarthritis ten years after the radial head prosthesis procedure

last 20 years experience with radial head prosthesis with specific attention to complications and revisions.

Conclusion

Radial head prostheses have been used in acute trauma cases or to treat fracture sequelae. No difference could be found in literature between different types of prosthesis, regardless of the indications. Complications are not uncommon. The main complications are related to loosening whether they are cemented or not cemented. Pain and stiffness are other common complications often related to oversized radial head component or overstuffing of the joint with excessive lengthening of the radius. Instability can be another complication in the context of more complex trauma with lateral collateral ligament complex lesion and coronoid fracture. Finally, osteoarthritis is common with follow-up.

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