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Options and limits of angle stable plates in the treatment of comminuted radial head fractures

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ABSTRACT

Objective: New angle-stable plates provide more stability and better anatomical fit than previous plates.
Methods: 22 patients treated with an angle-stable plate were included. Postoperative the outcomes were evaluated according to the scoring systems of Morrey, Radin and Riseborough.
Results: 3 patients received a score of excellent, 14 good, and 5 satisfactory. We detected 3 cases of implant failure and 2 cases of postoperative neurological damage. 3 patientes received a radial head necrosis.
Conclusions: Our results show that the angle-stable radial head locking plate can only be used in limited cases in the treatment of multi-fragment radial head fractures.

1. Introduction

The radial head is involved in about one-third of all elbow-fractures and up to 3% of all fractures. The mean female patient is 50–60 years old. The average male patient is younger with an average age of 30–40. The sex ratio is about 1:1 (f:m).[1–4]

The aim of surgical treatment in cases of radial head fractures is the reconstruction of the physiological joint configuration, especially to restore the radial axis of the elbow. Furthermore, a mobilisation-stable osteosynthesis is pursued to enable an early functional mobilisation. The procedure of Open Reduction and Internal Fixation (ORIF) is mostly used for fractures of Mason type II and produces good results.[4,5] ORIF is also a possibility for Mason type III and IV fractures if a stable status for early functional mobilisation can be achieved. But the succes rate seems to be lower in comparison to Mason type II fractures.[4–7] The possibility of a sufficient osteosynthetic reconstruction is often reduced for Mason type III and IV fractures because of the complexity of the injuries. In particular, high-graded injuries are more likely to show complications such as implant failure, radial head necrosis, pseudarthrosis or restriction of motion.[8,9]

According to some authors, fractures with more than 3 fragments should not be reconstructed because they have a common chance of a weak outcome and a high complication-rate.[6,8]

The alternative treatment for these fractures is an endoprosthesis or in rare cases a total resection of the radial head. A partial resection showed unsatisfactory results and is not recommended anymore.[6,10]

While the total resection is only an option for isolated radial head fractures with an intact ligaments situation and a very restricted indication, radial head prostheses are a relative new option; there are no authoritative long-term results yet and the durability is not yet apparent.[6,10,11] Therefore, particularly for younger patients, the reconstruction of the radial head is aspired.

The new angle-stable plates offer another option for osteosynthesis. These plates present a better primary stability and a lower profile in comparison to the non-angle-stable plates. These characteristics may allow a wider range of indications as well as a possible mobilisation-stable osteosynthesis for multi-fragmented fractures.[12–14]

Former studies have demonstrated that ORIF leads to good result in isolated radial head fractures and it has become the established technique for these kind of fractures.[15] The question is if the new angle-stable plates can widen the range of indications and if multi-fragmented fractures can be included.

The aim of this retrospective study is to evaluate the indication, clinical and functional outcome of multi-fragmented radial head fractures treated with angle-stable plate osteosynthesis.

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2. Indications for angle-stable radial head locking plates

- Mason type II fractures involving more than one-third of the articular surface and a displacement of more than 2 mm
- radial head fractures of up to 3 fragments (Mason type III and IV)
- instable fractures of the radial head or neck

3. On basis of this research the following questions should be evaluated

- In which cases were the angle-stable plates used?
- Which outcome can be expected?
- Which indication seems to be a possible option for this kind of plate?
- For which kind of injuries is the angle-stable plate not recommendable?

4. Patients and methods

Between 08/2009–06/2014, 22 radial head fractures in 22 patients were treated with an angle-stable radial head plate, included in this study and re-examined after an average of 28.4 (27.5; 16–56) months.

All patients were examined according to a standardised follow-up protocol, which included the topics of pain, strength, function and everyday complaints.[6] Furthermore, the subjective satisfaction of the result was evaluated. To assess the outcome of the treatment, the score of Morrey[16,17] and the score of Radin and Riseborough[18] were used.

To provide internationally valid results, the classification of Mason,[19] modified by Broberg and Morrey,[20] was used on the basis of a.p. and lateral x-rays along with a radial head-capitulum view as described by Greenspan.[21]

5. Indication of treatment

In our center, radial head fractures that presented an injury of the articular surface of more than one-third or a dislocation larger than 2 mm were treated surgically.

Mason type II fractures were usually treated with screws, Mason type III and IV fractures mostly with an angle-stable plate. If a reconstruction was not possible, a radial head prosthesis was implanted.

In addition to a.p., lateral and greenspan imaging of the radial head, x-rays of the wrist joint were taken if the injury was a comminuted fracture. If there was a special issue or a better assessment of the fracture was necessary (e.g. in case of an additional fracture of the capitulum humeri), a computer tomography (CT) scan was performed. Depending on the intraoperative appearance, an ORIF was conducted if an anatomically correct and functionally stable reduction was accessible.[11]

6. Postoperative-treatment

Early functional mobilization was enforced as early as possible. The patients, who had a refixation of the collateral ligament, were instructed to avoid varus and valgus stress for 6 weeks. A dorsal splint was applied to limit the extension of the elbow, if a refixation of the processus coronoideus was indicated. To prevent periarticular ossifications, which is very common in radial head fractures, all patients were medicated with Diclofenac-Colestyramin 145,6 mg for 4 weeks postoperatively.

7. Radiographic examination

In the course of this retrospective study, the x-ray images were interpreted by 2 orthopaedic surgeons. The radiographic evaluation and assessment was held on the basis of the x-ray images of the accident and the follow-up images. Evaluated were the position of the implant, the humeroulnar arthrosis and loss of reduction as well as implant loosening and implant failure. The grade of periarticular ossification was scaled on the basis of Brooker.[22]

8. Ethics committee vote and analysis of the data

This study was approved by the ethics committee of the Medical Faculty of the University of Heidelberg (No. S-531/2011). The study design and patient inclusion follows the declaration of Helsinki in its present form. The analysis of the data was performed using Microsoft Office Excel® 2016 and IBM SPSS® Statistics 24. Data is shown as mean value, median and range.

9. Results

In total, in our collective consisted of 1 (4.5%) Mason type II fracture, 7 (31.8%) Mason type III fractures and 14 (63.6%) Mason type IV fractures. The mean age at the time of the accident was 51.2 (53.0; 21–83) years. The collective showed a sex ratio of 14 (63.6%) women and 8 (36.4%) men. The right extremity was affected in 10/22 (45.5%) cases, the left extremity in 12/22 (54.5%). In half of the cases (11/22 (50.0%)) the dominant side, in the other half (11/22 (50.0%)) the non-domiant side was injured.

In 11/22 (50.0%) cases a direct trauma of the elbow occurred, in 7/22 (31.8%) a forward spill on the outstretched arm and in 4/22 (18.2%) cases a backward spill on the outstretched arm. Mostly the accident happened during sporting activity or leisure (10/22 (45.5%) patients), followed by work accidents (7/22 (31.8%) patients), in a home environment (4/22 (18.2%) patients) and in traffic (1/22 (4.5%) patients). The operation was performed 2.5 (1.0; 0–10) days after the injury on average. 1 (4.5%) patient was first treated externally with a splint and then transferred to our hospital for operation. The mean time between the operation and the pain-adapted, early functional mobilisation was 3.1 (1.0; 1–14) days.

The average follow-up period was 28.4 (27.5; 16–56) months.

A deficit in extension of 13.6° and of 11.6° in flexion compared to the opposite side was evaluated. The flexion and also the deficit of extension were found to be significantly different from the non-injured side (p (flexion): < 0.001; p(deficit of extension): < 0.001) (Table 1). The mean extension/flexion (neutral-zero-method) was 0°/14.5°/122.3° of the affected side compared to the non-affected side with 0°/0.9°/133.9°.

The deficit in pronation was 10.9° (p: 0.003) and 24.5° (p: 0.001) in supination in comparison to the opposite side. The mean pronation/supination was 74.8°/0°/61.4° of the affected side and 85.7°/0°/85.9° of the non-affected side (Table 1).

In 9 (40.9%) cases a posttraumatic high restriction in movement were measured. We defined a deficit in extension of more than 30°, a maximal flexion under 100° and a pronation respectively supination under 50° as high. A high deficit in flexion was found in 3/22 (13.6%) patients with a mean flexion of 93.3° (95.0; 90–95°) (opposite side: 111.7° (120.0; 95–120°); $p > 0.05$/). Likewise, 3/22 (13.6%) showed a

Table 1
Results of the clinical examination mean (median; minimum-maximum).

	affected extremity	non-affected extremity	p
flexion	122.3° (127.5; 90–145°)	133.9° (140.0; 95–150°)	< 0.001
deficit of extension	14.5° (15.0; 0–40°)	0.9° (0.0; -5-10°)	< 0.001
Supination	61.4° (70.0; 5–90°)	85.9° (90.0; 70–90°)	0.001
Pronation	74.8° (80.0; 10–90°)	85.7° (90.0; 70–95°)	0.003
cubitus valgus	9.8° (10.0; 0–25°)	7.7° (10.0; 0–15°)	0.160
strenght (kg)	22.7 kg (22.0; 1–47 kg)	26.1 kg (25.5; 10–51 kg)	0.010
wrist flexion	56.1° (60.0; 20–80°)	59.8° (60.0; 40–80°)	0.112
wrist extension	59.8° (60.0; 30–80°)	61.4° (60.0; 30–80°)	0.216
radial abduction	25.0° (25.0; 10–35°)	27.0° (30.0; 20–35°)	0.066
ulnar abduction	35.2° (40.0; 10–40°)	37.5° (40.0; 30–40°)	0.102