13 Failed Fixation of Radial Head Fractures

Charalampos G. Zalavras and John M. Itamura

Introduction

Open reduction internal fixation (ORIF) of displaced radial head fractures typically results in fracture healing and a good clinical outcome when anatomic reduction and stable fixation are achieved and early postoperative motion is initiated [1]. However, fixation failure after radial head ORIF has not been well described in the literature.

This chapter will summarize what we currently know about the rate and risk factors for failed fixation of radial head fractures and then present an algorithm for the assessment and management of this challenging complication.

Fixation Failure Incidence and Risk Factors

Comminuted fractures of the radial head are subject to early fixation failure, especially in the setting of elbow or forearm instability [2–4].

Ring et al. reported that none of 15 patients with an isolated, non-comminuted type-2 radial head fracture had an unsatisfactory result compared to 4 of 15 patients with a comminuted Mason type-2 fracture (these four patients had fractures associated with a fracture-dislocation of the forearm or elbow) and 13 of 14 patients with a Mason Type-3 comminuted fracture with more than three articular fragments [3].

Reinhardt et al. identified 7520 patients in a database review and found that ORIF of radial head/neck fractures had fewer complications and reoperations in simple fractures without an associated elbow dislocation. Interestingly, the rate of reoperation in fractures with an associated elbow dislocation was 45%, which underscores the complex task of achieving stable fixation that can withstand the increased mechanical requirements when other elbow stabilizing structures are injured [5].

Furthermore, osteoporosis compromises the stability of the fixation construct and patient nutritional deficiencies and comorbidities may delay or arrest the healing process and eventually lead to fixation failure.

Assessment

Detailed clinical, imaging, and laboratory assessment of the patient is necessary to determine the reasons for fixation failure and help devise a

C. G. Zalavras (✉) · J. M. Itamura
Department of Orthopaedics, Keck School of Medicine, University of Southern California, LAC+USC Medical Center, Los Angeles, CA, USA

The Kerlan Jobe Institute at White Memorial Medical Center, Cedars Sinai Medical Center, Los Angeles, CA, USA
e-mail: zalavras@usc.edu

P. V. Giannoudis, P. Tornetta III (eds.), *Failed Fracture Fixation*,
https://doi.org/10.1007/978-3-031-39692-2_13

management plan, based on factors pertaining to the radial head, the elbow and forearm, the upper extremity in general, and the patient.

This chapter focuses on aseptic causes of fixation failure, so we will not present details on the diagnosis of infectious complications, but infection should always be considered in the presence of failed fixation, even in the absence of any clinical suspicion [6].

Clinical Assessment

Elbow pain and limited motion of the elbow and forearm are usual symptoms reported by patients with failed fixation of the radial head. The patient should be asked whether an elbow dislocation took place at the time of the initial injury.

Inspection of the elbow will reveal the location of previous incision(s) that has to be taken into account when planning revision surgery. Any erythema and/or drainage should be noted.

Palpation may elicit tenderness over the radial head. Tenderness over the wrist and/or interosseous membrane of the forearm suggests an Essex-Lopresti injury that is often missed in patients with radial head fractures.

Elbow flexion and extension, as well as forearm pronation and supination, are documented paying attention to the presence of crepitus, clicking, or a hard stop suggesting intra-articular protrusion of implants. Complete lack of forearm rotation may indicate transfixion of the radial head/neck to the proximal ulna by screws that are too long.

Posterolateral rotatory instability indicates posterior subluxation of the radial head and alerts the examiner to the presence of elbow instability due to associated injuries of other stabilizing structures.

The neurovascular status of the upper extremity should be carefully assessed and documented. It is important to determine the current impact of the injury/surgery on the patient's function. The degree of pain and loss of motion after failed fixation of the radial head may vary from patient to patient but also the functional status and demands of each patient vary considerably. For example, a similar condition on the dominant extremity of a young manual laborer may have a vastly different impact compared to an elderly, retired, low-demand individual.

Imaging

Careful evaluation of good-quality plain radiographs of the elbow will clarify several important factors about the injury and previous surgery.

- Radial head: Is there a nonunion or malunion of the radial head? Is there comminution?
- Implants: Are the existing implants broken or loose? Or are they intact with loss of fixation and displacement of the radial head fragment(s)? Are there screws penetrating into the proximal radio-ulnar joint (PRUJ), the radiocapitellar joint, or the proximal ulna? Is a plate positioned outside of the safe zone or too proximally? What exactly are the implants used, so as to have the appropriate extraction tools available?
- Elbow: Are the radiocapitellar and ulnohumeral joints reduced? Is there evidence of a coronoid fracture?
- Bone quality: Does the bone quality appear compromised?

Wrist radiographs of the injured side should be obtained when an Essex-Lopresti injury is suspected to assess shortening/proximal migration of the radius. Radiographs of the contralateral wrist may be useful for comparison purposes.

Computed tomography scan of the injured elbow may provide further detail on the factors listed above and especially on intra-articular penetration of screws.

Laboratory Studies

Inflammatory markers may be helpful when infection is suspected.

Screening for metabolic abnormalities, e.g., vitamin D deficiency, calcium imbalances, and endocrine abnormalities, e.g., thyroid disorders, should be done in nonunions or when revision of fixation is planned [7].

Metal allergy screening, for example by lymphocyte transformation testing, may be helpful in select patients with pain and implant loosening after other causes (infection, elbow or forearm instability) have been ruled out.

Elbow Arthroscopy

In cases where the fixation implants are still intact but a block to motion exists and imaging studies are indeterminate regarding intra-articular screw penetration or the exact cause for the block to motion, elbow arthroscopy can be helpful.

Preoperative Planning

A preoperative plan tailored to the specific characteristics of the injury and the patient is developed based on the aforementioned detailed assessment. This chapter focuses on aseptic failure of fixation, so we will not discuss our approach when infection is present or suspected.

No Instability & No Block to Motion

This clinical scenario may result from a malunion due to loss of fixation into the radial head fragment. Slight displacement of the radial head into a new position with bone contact with the neck may provide stability, prevent further displacement, and lead to union in this position. In the absence of elbow/forearm instability or block to motion, intervention is not required.

Block to Motion Without Instability

Block to motion may result from displacement of the radial head/neck fracture, implant malpositioning, or both.

Surgery is usually required unless the degree of motion loss is small without a functional impact on the patient.

The surgical plan starts with addressing the current implant (screw revision or implant removal) followed by intraoperative reassessment of elbow and forearm motion. Then we may stop there or proceed with revised fixation or resection of the radial head.

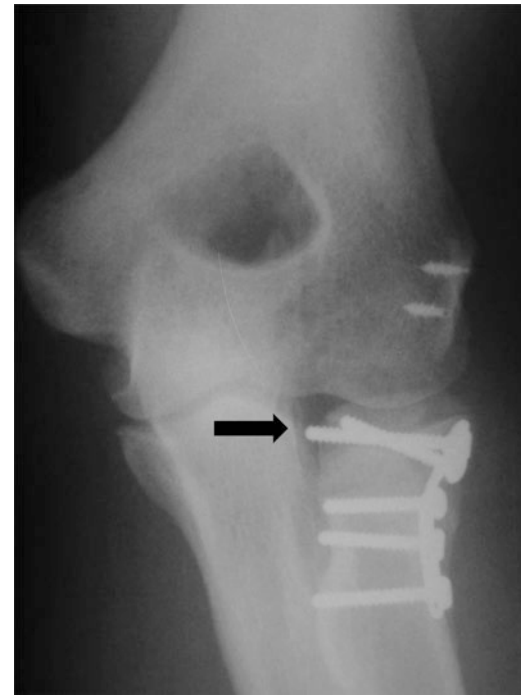

Fig. 13.1 Intra-articular screw penetration (black arrow) into the proximal radio-ulnar joint

- Screw revision: This is indicated if the block to motion is due to intra-articular penetration of screws (Fig. 13.1), or even transfixion of the radial head/neck to the proximal ulna, due to screws that are too long. The offending screws are revised and if motion is restored we can stop there. If motion is still blocked by a malpositioned implant or a displaced/malunited radial head, we proceed with one of the following options.
- Implant removal only: This is indicated if the block to motion is due to plate malpositioning and the fracture has healed in an acceptable position.
- Revised fixation: This is an option when the fixation has failed, and the radial head/neck fracture has displaced. Revised fixation is also an option in nonunions or malunions in an unacceptable position (in malunions revised fixation will be done after an intra-articular

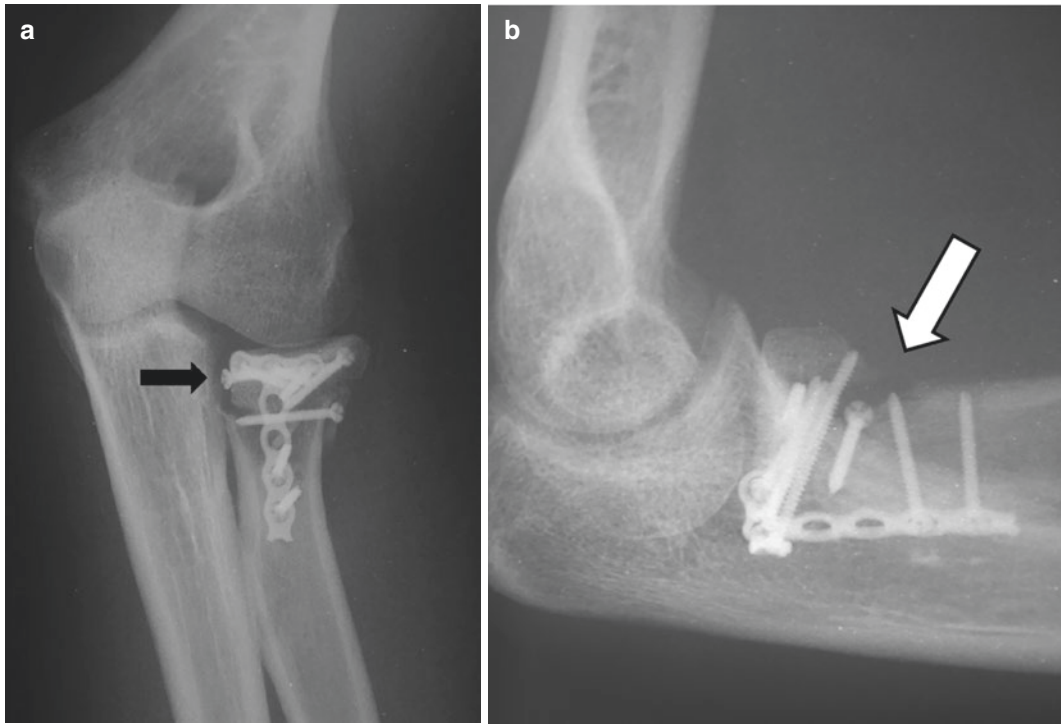

Fig. 13.2 Nonunion of a radial head and neck fracture following ORIF. The fixation has failed to take the fracture to healing and breakage of the plate will follow without further intervention. Note the presence of implant impingement at the lesser sigmoid notch (**a**, black arrow) and the presence of a bone defect at the level of the neck (**b**, white arrow). When fixing these fractures, it is important to place implants in the safe zone and to fill any defects with bone graft. In this case, the implants were removed, and the radial head excised because both the elbow and the forearm were stable

osteotomy). Revised fixation is challenging due to the limited remaining bone stock of the radial head once the existing implants are removed. This option is best reserved for younger patients with a simple fracture and a radial head fragment of adequate size and bone stock to allow for stable fixation. Bone grafting is required to fill any defects created after fragment disimpaction.

- Radial head resection: If the above conditions are not met and stable revised fixation is unlikely in the setting of failed fixation and nonunion (Fig. 13.2a, b) or malunion, radial head resection is indicated. It should be emphasized that radial head resection should not be done in the setting of an unstable elbow or forearm.

Elbow or Forearm Instability

Failed fixation of the radial head in the setting of elbow or forearm instability requires prosthetic replacement.

When elbow instability is present, as in fracture-dislocations of the elbow, other stabilizing structures, such as the lateral collateral ligament and the coronoid process, are injured. In this setting, the reconstructed radial head (either stably fixed or replaced) becomes critically important.

Fracture-dislocations of the elbow are usually associated with comminuted radial head fractures, which would preclude stable fixation. However, after failed fixation, it would be extremely challenging or impossible to achieve

stable fixation with revision osteosynthesis even in simple fracture patterns [4]. Much of the previously available bone stock has been already lost due to the insertion of the previous implants and the displacement of the fracture after the previously unstable fixation.

Moreover, the surgeon should prepare a plan to address any associated injuries, for example by repair or reconstruction of the lateral collateral ligament or fixation of a large coronoid fragment. Also, the surgeon should be ready to address any residual instability, for example by a hinge external fixator.

The aforementioned preoperative planning is essential, but the surgeon needs to be aware that in some cases the best course of action may only become apparent during surgery. For example, subtle elbow or forearm instability may not be evident before and may be demonstrated during surgery with the assistance of fluoroscopy. Furthermore, a fracture that appeared to be simple may prove to be more complex, or an initial attempt to revise the fixation may not result in adequate stability. Therefore, the surgeon should always be prepared to proceed with the replacement of the radial head in these cases.

The plan and the potential for intra-operative plan modifications should be discussed with the patient and informed consent should include all potential procedures. Furthermore, all surgical trays and implants that may potentially be used should be available. These include implant extraction tools, fixation implants (headless compression screws, anatomic radial head plates, other mini plates, and screws), and radial head replacement implants.

Revision Surgery

The surgical approach is usually performed through the existing skin incision and the deeper interval depends on the specifics of each case. If the elbow is stable, an extensor split anterior to the fibers of the lateral collateral ligament is utilized. If elbow instability is present, a Kocher or Wrightington approach that allows improved access to the radial head and the lateral collateral ligament is required.

Based on the algorithm outlined in the preoperative planning section, the existing implants are removed, the elbow and forearm are carefully assessed under direct visualization and fluoroscopy, and the next step is determined.

Technical Tips for Revision ORIF

The radial head fragment is reduced with a dental pick and the fracture site is carefully inspected for any voids secondary to bone loss at the previous surgery or cancellous bone impaction at the level of the neck (Fig. 13.2b). Small voids can be filled with cancellous autograft from the adjacent proximal ulna or cancellous allograft chips but the presence of bone loss may dictate a change of the plan to prosthetic replacement instead of revised fixation.

The radial head fragment is provisionally held in place with a clamp and Kirschner wires. If headless cannulated screws will be used, the guide wires for the screws can be used for provisional fixation.

Plate fixation requires careful placement of the plate in the safe zone to avoid impingement and precise screw length [4] (Figs. 13.1 and 13.2a). The forearm should be maximally pronated and supinated to ensure that the plate is appropriately placed. Following fixation, the elbow and forearm should be ranged to ensure that no screw penetration into a joint space has occurred, especially into the PRUJ.

Technical Tips for Prosthetic Replacement

Avoidance of excessive diameter and height of the radial head prosthesis is essential. It is helpful to reconstruct the radial head at the back table and use it as a template. The diameter of the prosthesis should correspond to the inner and not the outer diameter of the native radial head. The radial head trial should articulate well with the

lesser sigmoid notch without the superior aspect of the implant protruding more proximally.

Fluoroscopic evaluation of the radial head prosthesis is also useful to assess both the diameter of the implant, especially when the native radial head is comminuted or fragments are missing, and its height. The superior aspect of the implant should be in line with the lesser sigmoid notch and 2 mm distal to the coronoid.

In cases of Essex-Lopresti injuries, the surgeon should verify that the ulnar variance at the wrist has been restored to that of the contralateral side and modify the height of the implant appropriately.

Soft Tissue Considerations

Radial head fractures are very rarely associated with soft tissue compromise or loss and the wound is primarily closed uneventfully. Consultation with a plastic or hand surgeon is needed in the event of local soft tissue injury.

Postoperative Protocol

- Excision: Motion is initiated immediately to avoid any stiffness.
- Revised fixation: Motion is initiated in a week, but weight bearing is avoided for 6 weeks. After that progressive use of the extremity for activities of daily living is started with resumption of full weight bearing in 12 weeks.
- Replacement: Motion is initiated in 1–2 weeks with the use of a hinge elbow brace while avoiding any varus stress on the elbow. Overhead range of motion of the elbow with the patient supine is helpful as gravity helps maintain the elbow reduced. Weight bearing is avoided for 6 weeks with progressive use of the extremity for activities of daily living after that. Resumption of full weight bearing in 12 weeks.

References

1. King GJ, Evans DC, Kellam JF. Open reduction and internal fixation of radial head fractures. J Orthop Trauma. 1991;5(1):21–8.
2. Ring D. Radial head fracture: open reduction-internal fixation or prosthetic replacement. J Shoulder Elb Surg. 2011;20(2 Suppl):S107–12.
3. Ring D, Jaime Quintero J, Jupiter JB. Open reduction and internal fixation of fractures of the radial head. J Bone Joint Surg Am. 2002;84(10):1811–5.
4. King GJW. Fractures of the radial head. In: Wolfe SW, Pederson WC, Kozin SH, editors. Green's operative hand surgery. Elsevier; 2022.
5. Reinhardt D, Toby EB, Brubacher J. Reoperation rates and costs of radial head arthroplasty versus open reduction and internal fixation of radial head and neck fractures: a retrospective database study. Hand (N Y). 2021;16(1):115–22.
6. Olszewski D, Streubel PN, Stucken C, Ricci WM, Hoffmann MF, Jones CB, Sietsema DL, Tornetta P 3rd. Fate of patients with a "surprise" positive culture after nonunion surgery. J Orthop Trauma. 2016;30(1):e19–23.
7. Brinker MR, O'Connor DP, Monla YT, Earthman TP. Metabolic and endocrine abnormalities in patients with nonunions. J Orthop Trauma. 2007;21(8):557–70.