51

Postoperative Management After Open Reduction and Internal Fixation of Distal Humeral Fractures

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Abstract

Postoperative care is a critically important component in treating patients with complex distal humeral fractures. The immediate, intermediate, and late phases of the postoperative period present different issues that require specific management to maximize the eventual functional outcome for patients with these injuries.

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Several factors, including the severity of injury, the stability and accuracy of internal fixation, and postoperative management contribute to the functional outcome after open reduction and internal fixation (ORIF) of distal humeral fractures. Although there is extensive literature that discusses injury classification, surgical technique, and functional outcomes, there are relatively few evidence-based studies in the literature concerning postoperative management. Most of the published reports include recommendations that are based on the clinical experience of the individual researchers. Optimal restoration of elbow function cannot be achieved without careful attention to the details of postoperative management and rehabilitation.

Postoperative Time Periods

The postoperative management of ORIF of distal humeral fractures can be considered relative to three time periods: the immediate postoperative period, an intermediate period from approximately 1 week to 4 months, and a late period beyond 4 months. The severity of the injury, including associated soft-tissue and neurovascular injury, and the surgical technique and internal fixation stability are important factors in determining management in the immediate and intermediate periods. The late period involves management of the sequelae of the injury and treatment.

Immediate Postoperative Management

Treatment during the immediate postoperative period is directed toward initial wound and soft-tissue protection, initiation of range-of-motion exercises, and prophylaxis for heterotopic ossification. The skin condition and the severity of deeper soft-tissue injury may necessitate early protection with splinting and elevation of the upper extremity. Postoperative splinting of the elbow in extension with the forearm supinated protects the posterior soft tissues and inhibits the early development of a flexion contracture of the elbow and pronation contracture of the forearm.[1,2] Extension splinting is preferred to splinting with the elbow flexed. Flexion splinting encourages scarring and shortening of the anterior capsule and musculature, which leads to flexion contracture. In addition, extension splinting may prevent the buildup of scarring in the olecranon fossa, which can create a block to extension. Extension splinting also is used to protect the posterior soft tissues and to allow early healing of the posterior incision. Subsequently, an extension resting splint can be used at night to further prevent flexion contracture. Elevation of the extremity is important to reduce swelling. The use of compressive dressings can also help to reduce swelling.

Range-of-motion exercises are initiated within the first week after surgery. Active-assisted motion and gentle passive motion exercises can be initiated for elbow flexion and extension, as well as forearm pronation and supination. Active extension is delayed until approximately 6 weeks to allow initial healing of the triceps, if a triceps-splitting or Bryan-Morrey approach was used, or to allow initial healing of an olecranon osteotomy. If the internal fixation of the distal humerus is tenuous, elbow motion should be delayed until there is early bone healing. Although delaying the onset of range-of-motion exercises is

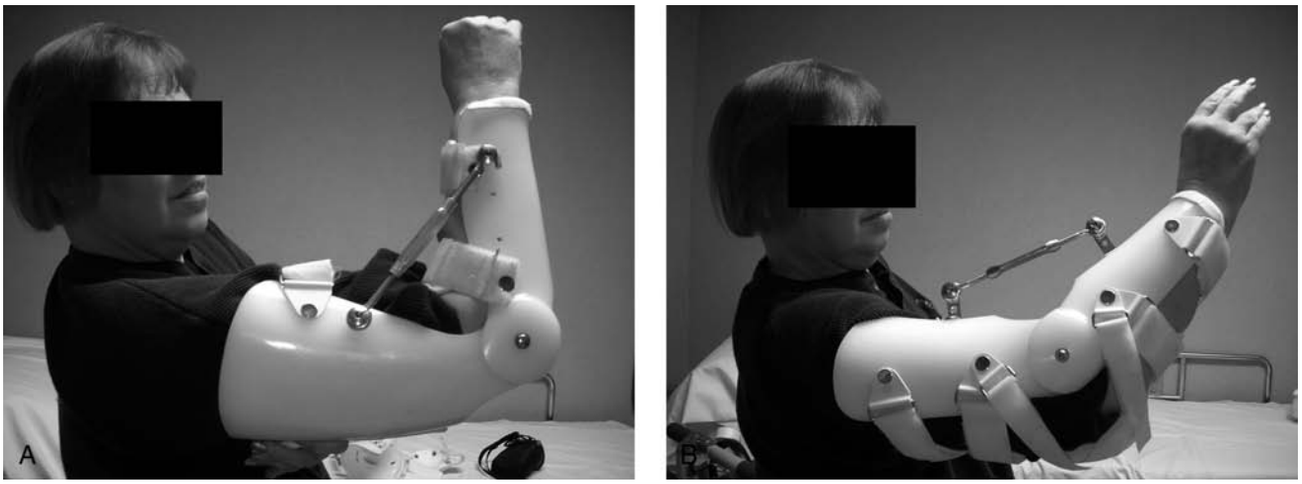

Figure 1 Custom fabricated turnbuckle flexion and extension braces are shown. **A,** The cuffs of the flexion brace are located on the posterior aspect of the arm and forearm. The bolts can be exchanged to different lengths as motion improves. **B,** The cuffs of the extension brace are located on the anterior aspect of the arm and forearm.

likely to lead to elbow contracture, it is better to protect the reduction and internal fixation as necessary and treat a contracture after satisfactory fracture healing.

Prophylaxis for heterotopic ossification also is a consideration. Although there is support for the use of indomethacin and single-dose irradiation to prevent heterotopic ossification after hip replacement and acetabular fracture surgery, there is no similar support for prophylaxis in the elbow.[3,4] However, these modalities should be considered for higher energy injuries, when swelling is severe, and in the presence of a head injury. Helfet and Schmeling[5] recommended using indomethacin. Pharmacologic prevention of flexion contracture with botulinum toxin is being investigated.

Pain management is an important component of early rehabilitation. Oral narcotics are the mainstay of treatment. Nonsteroidal anti-inflammatory medications also can be used, although there is concern about the effects on bone healing.[6] Ulnar nerve entrapment can be a cause of postoperative pain and should be considered if pain persists.[7]

Intermediate Postoperative Management

Early range-of-motion exercises can be initiated if the internal fixation construct is stable.[2] Delaying range-of-motion exercises can lead to stiffness.[8] Passive range of motion is more effective than active range of motion because it encourages relaxation of the muscles. Passive stretching should be steady and not overly aggressive to avoid injury. By 6 weeks after surgery, there usually is enough bone healing to permit more aggressive range-of-motion exercises. Static night splinting in either flexion or extension, depending on which is more limited, can be used to maintain gains that are made during the daytime.

Once there is sufficient early skeletal healing, bracing can be used to overcome stiffness. Static and dynamic bracing are available. Static progressive stretching can be done with turnbuckle braces that are controlled by the patient and used to gradually and incrementally stretch the soft tissues[1,9-12] (Figure 1). Flexion and extension bracing can be used. Prefabricated braces, as well as custom-made braces, can be used. Doornberg and associates[10] found that most patients with stiffness after a traumatic elbow injury were successfully managed with static progressive splinting that obviated surgical treatment of their contractures. Turnbuckle bracing is less effective for achieving flexion beyond 120°. A collar-and-cuff hyperflexion splint is more effective for stretching at the end range of elbow flexion[13] (Figure 2). Dynamic splitting is an alternative to static progressive stretching. In contrast to static progressive stretching, dynamic splinting applies a continuous force to the elbow.[1] Most patients are better able to tolerate static progressive stretching than dynamic stretching.

Late Postoperative Management

Elbow stiffness with loss of motion is the most common long-term sequela of ORIF of distal humeral

fractures. Several factors other than the bony reduction and internal fixation are believed to contribute to the development of a postoperative contracture, including the extent of associated soft-tissue injury, timing of the ORIF, the presence of heterotopic ossification, and patient participation and compliance with the postoperative rehabilitation program. Historically, avoiding delayed surgical treatment has been recommended, because it is believed to lead to an increased risk of stiffness.[8] Although immediate ORIF of a closed distal humeral fracture is not necessary, definitive treatment should be performed within a few days of the injury. Late surgery also is associated with increased risk of heterotopic ossification.

Stiffness has a variable impact on upper extremity function. A flexion arc of 30° to 130° is considered functional.[14] It is common for patients to have a residual flexion contracture. Some patients can tolerate more limitation than others. Limitation beyond a 30° to 130° flexion arc is generally considered to be an indication for surgical contracture release. Stiffness usually is classified as either intrinsic, extrinsic, or combined.[15] Intrinsic stiffness can be caused by articular incongruity or arthrofibrosis. Extrinsic contracture is caused by thickening and contracture of the elbow joint capsule and scarring of the brachialis muscle anteriorly and the triceps muscle posteriorly. Heterotopic ossification also can block motion.

Contracture release is considered when limited motion persists more than 6 months after surgery. The potential for persistent stiffness becomes apparent by approximately 3 or 4 months after surgery. This is the time when a concerted effort can overcome stiffness and avoid a substantial contracture. If pain is still substantial, possible causes such as occult infection, peripheral neuropathy, articular incongruity, posttraumatic arthritis, and delayed union should be considered. Ulnar neuropathy is a relatively common complication. If the ulnar nerve was not released or transposed at the time of fracture fixation, it may become scarred and tethered such that attempts to flex the elbow will stretch the nerve and cause pain.[7] If there is delayed healing, aggressive attempts to mobilize the joint should be avoided because they will jeopardize the fixation. Articular incongruity further complicates the treatment of a contracture. Some studies have reported significant improvements in elbow motion and function after contracture release.[16-19] Contracture release should be delayed until 6 months after the original surgery.

Figure 2 A collar-and-cuff apparatus for elbow flexion stretching. (Reproduced with permission from Mansat P, Morrey BF, Hotchkiss RN: Extrinsic contracture, in Morrey BF (ed): *The Elbow and Its Disorders*, ed 3. Philadelphia, PA, WB Saunders, 2000, pp 447-456.)

Functional limitations that result from heterotopic ossification can be treated with excision of the heterotopic bone in conjunction with soft-tissue contracture release.[20] Excision of heterotopic bone should be delayed until there is a mature radiographic appearance (Figure 3). This usually occurs approximately 6 months after the original injury and surgery. Although postoperative single-dose irradiation and oral indomethacin are believed to prevent recurrence, there is no scientific basis to support or refute the use of either in the treatment of posttraumatic elbow contracture.[21] Lindenhovius and associates[21] found that the improvement in the elbow flexion arc after release of a posttraumatic elbow contracture was actually better if there was associated heterotopic ossification that was excised.

Although the ulnar nerve often appears contused or stretched after a distal humeral fracture, acute ulnar neu-

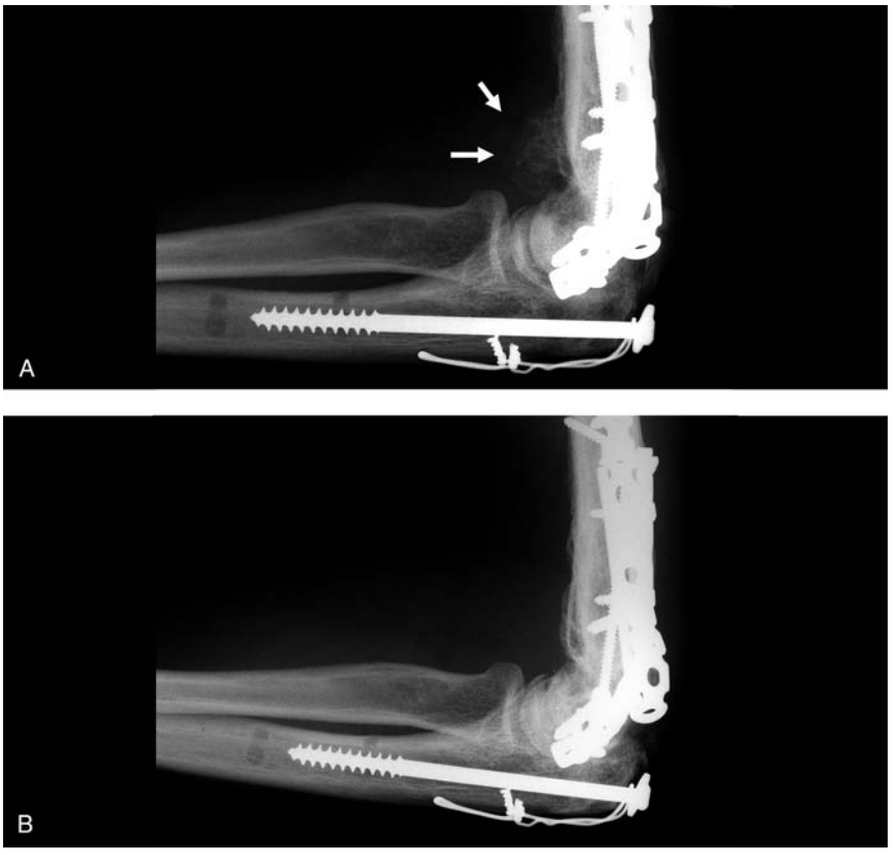

Figure 3 **A,** Radiograph of mature-appearing heterotopic ossification after surgical treatment of an open distal humeral fracture. The arrows indicate heterotopic bone that formed anterior to the distal humerus and was blocking elbow flexion. **B,** The heterotopic bone was successfully excised 8 months after the original treatment.

ropathy is uncommon. Subsequent insult at the time of surgery, as well as hardware impingement and postoperative scarring, also can contribute to the neuropathy.[7] Treatment of posttraumatic ulnar neuropathy generally results in improvement, but often a neurologic deficit persists.[22] Careful initial examination may demonstrate an injury related to the original trauma. Meticulous protection of the nerve during surgical treatment of the fracture is essential. Many authors recommend routine anterior transposition at the conclusion of ORIF. When transposition is done, it is critically important that the nerve be adequately released distally into the flexor carpi ulnaris muscle. Persistent ulnar neuropathy can be treated with ulnar neurolysis.

Summary

The postoperative management after ORIF of complex distal humeral fractures has an important role in the eventual functional outcome for patients. Assuming that an adequate fracture fixation construct is achieved, early range of motion can be pursued with little risk of fixation failure. The combination of adequate surgical exposure, stable internal fixation, and appropriate postoperative management increases the likelihood of achieving satisfactory outcomes even in severe bicolumn distal humeral fractures.

References

1. Davila SA, Johnston-Jones K: Managing the stiff elbow: Operative, nonoperative, and postoperative techniques. *J Hand Ther* 2006;19: 268-281.
2. Jupiter JB: Complex fractures of the distal part of the humerus and associated complications. *J Bone Joint Surg Am* 1995;44:187-198.
3. Iorio R, Healy W: Heterotopic ossification after hip and knee arthroplasty: Risk factors, prevention, and treatment. *J Am Acad Orthop Surg* 2002;10:409-416.
4. Board TN, Karva A, Board RE, Gambhir AK, Porter ML: The prophylaxis and treatment of heterotopic ossification following lower limb arthroplasty. *J Bone Joint Surg Br* 2007;89:434-440.
5. Helfet DL, Schmeling GJ: Bicondylar intraarticular fractures of the distal humerus in adults. *Clin Orthop Relat Res* 1993;292:26-36.
6. Dahners LE, Mullis BH: Effects of nonsteroidal anti-inflammatory drugs on bone formation and soft-tissue healing. *J Am Acad Orthop Surg* 2004;12:139-143.
7. Shin R, Ring D: The ulnar nerve in elbow trauma. *J Bone Joint Surg Am* 2007;89:1108-1116.
8. Waddell JP, Hatch J, Richards R: Supracondylar fractures of the humerus: Results of operative treatment. *J Trauma* 1988;28:1615-1621.
9. Bonutti PM, Windau JE, Ables BA, Miller BG: Static progressive stretch to reestablish elbow range of motion. *Clin Orthop Relat Res* 1994;303: 128-134.
10. Doornberg JN, Ring D, Jupiter JB: Static progressive splinting for posttraumatic elbow stiffness. *J Orthop Trauma* 2006;20:400-404.
11. Gelinas JJ, Faber KJ, Patterson SD, King GJ: The effectiveness of turnbuckle splinting for elbow contractures. *J Bone Joint Surg Br* 2000;82: 74-78.

12. Green DP, McCoy H: Turnbuckle orthotic correction of elbow-flexion contractures after acute injuries. *J Bone Joint Surg Am* 1979;61:1092-1095.

13. Mansat P, Morrey BF, Hotchkiss RN: Extrinsic contracture: The "column procedure," lateral and medial capsular releases, in Morrey BF (ed): *The Elbow and Its Disorders.* Philadelphia, PA, WB Saunders, 2000, pp 447-456.

14. Morrey BF, Askew LJ, Chao EY: A biomechanical study of normal functional elbow motion. *J Bone Joint Surg Am* 1981;63:872-877.

15. Bruno RJ, Lee ML, Strauch RJ, Rosenwasser MP: Posttraumatic elbow stiffness: Evaluation and management. *J Am Acad Orthop Surg* 2002; 10:106-116.

16. Cikes A, Jolles BM, Farron A: Open elbow arthrolysis for posttraumatic elbow stiffness. *J Orthop Trauma* 2006; 20:405-409.

17. Morrey BF: The posttraumatic stiff elbow. *Clin Orthop Relat Res* 2005;431: 26-35.

18. Ring D, Adey L, Zurakowski D, Jupiter JB: Elbow capsulectomy for posttraumatic elbow stiffness. *J Hand Surg Am* 2006;31:1264-1271.

19. Tan V, Daluiski A, Simic P, Hotchkiss RN: Outcome of open release for post-traumatic elbow stiffness. *J Trauma* 2006;61:673-678.

20. McAuliffe JA, Wolfson AH: Early excision of heterotopic ossification about the elbow followed by radiation therapy. *J Bone Joint Surg Am* 1997;79: 749-755.

21. Lindenhovius AL, Linzel DS, Doornberg JN, Ring DC, Jupiter JB: Comparison of elbow contracture release in elbows with and without heterotopic ossification restricting motion. *J Shoulder Elbow Surg* 2007;16: 621-625.

22. McKee MD, Jupiter JB, Bosse G, Goodman L: Outcome of ulnar neurolysis during post-traumatic reconstruction of the elbow. *J Bone Joint Surg Br* 1998;80:100-105.