Conservative Management of Elbow Dislocations With an Overhead Motion Protocol

Joseph J. Schreiber, MD, Sophia Paul, BA, Robert N. Hotchkiss, MD, Aaron Daluiski, MD

Purpose To report the results of using an overhead motion protocol in 27 patients and to assess final range of motion and incidence of persistent instability in this cohort.

Methods A total of 27 patients were included who sustained a simple elbow dislocation and were treated nonsurgically with an overhead motion protocol designed to convert gravity from a distracting to a stabilizing force. Motion was initiated within 1 week of injury and average follow-up was 29 months. Final arc of motion and prevalence of instability were the primary outcomes measures.

Results Final mean arc of extension to flexion was from 6° to 137°, and of pronation to supination was from 87° to 86°. No recurrent instability was observed in this cohort and all patients were fully functional and without limitations at latest follow-up.

Conclusions The overhead motion protocol was a reliable rehabilitation program after elbow dislocation that allowed for controlled early motion by placing the elbow in an inherently stable position. Prompt initiation of motion in a protected position can optimize final motion and satisfaction outcomes, and when done in a mechanically advantageous position it can potentially limit the risk of recurrent instability. *(J Hand Surg Am. 2015;40(3):515–519.*

Type of study/level of evidence Therapeutic IV.

Key words Elbow dislocation, rehabilitation, overhead motion.

THE ELBOW IS A RELATIVELY STABLE joint owing to a congruous osseous articulation, stabilizing ligaments, and the coaptation forces of muscles traversing the joint. However, elbow dislocations are estimated to occur at an annual incidence of 5.2/100,000, which makes it the second most commonly dislocated human joint.[1]

Preferred management of simple elbow dislocations is a nonsurgical rehabilitation program but the period and position of initial immobilization have historically varied.[2–5] Although early mobilization of the joint is generally preferred, protected motion has been initiated at various early time points[4–7] and in various positions, including upright,[6] underwater,[7] and supine.[8]

In 2006, Wolff and Hotchkiss[8] reported a rehabilitation protocol based on limiting varus or valgus stress and using gravity to assist in maintaining the reduction, particularly in the first days after injury when muscle control is limited. The concept of the gravity-assisted overhead motion protocol was later substantiated in a biomechanical analysis demonstrating its superiority in maintaining reduction compared with a traditional upright motion protocol.[9] The purposes of this study were to ascertain the results of using this protocol in 27 patients and to assess final range of motion and incidence of persistent instability in this cohort.

MATERIALS AND METHODS

We performed an institution review board–approved retrospective review to identify patients who had been managed nonsurgically after a simple posterior

From the Department of Orthopaedic Surgery, Hospital for Special Surgery, New York, NY.

Received for publication July 8, 2014; accepted in revised form November 10, 2014.

No benefits in any form have been received or will be received related directly or indirectly to the subject of this article.

Corresponding author: Aaron Daluiski, MD, Department of Orthopaedic Surgery, Hospital for Special Surgery, 523 E 72nd Street, New York, NY 10021; e-mail: daluiskia@hss.edu.

0363-5023/15/4003-0016$36.00/0
http://dx.doi.org/10.1016/j.jhsa.2014.11.016

elbow dislocation between 2006 and 2012. All patients were managed in an emergency department and initially reduced by either orthopedic surgery residents or emergency room physicians. All patients were subsequently treated nonsurgically based on the imaging, injury pattern, and stability at the time of initial consultation by the treating surgeon. Patients with previous dislocations or fracture-dislocations requiring surgical intervention, those who underwent operative management for chronic instability, and those with rheumatoid arthritis were excluded.

Clinical management

After initial consultation by the treating surgeon, patients were referred to an on-site therapist and were prescribed twice-weekly therapy sessions for instruction and supervision of appropriate motion exercises. Patients were next evaluated 2 weeks later, at which point a lateral radiograph was obtained in extension and supination with the forearm in a gravity-dependent position to assess ulnohumeral joint congruency, which was used to complement the clinical evaluation of instability. The patients were next seen at 4 to 6 weeks after dislocation and lateral extension radiographs were routinely obtained in addition to clinical evaluation.

Rehabilitation protocol

Nonsurgical management consisted of an overhead motion protocol as previously described.[8,9] In the early post-injury period, range of motion (ROM) exercises were initiated in a safe overhead position that maintains stability while allowing motion to minimize joint stiffness. A custom thermoplastic orthosis was fabricated to immobilize the extremity in elbow flexion with a goal of 90°, and with occasionally greater flexion required to approximate the radial head to the capitellum; forearm neutral or pronated to minimize lateral ligamentous stress; and wrist inclusion in a neutral position to relax muscular attachments and optimize patient comfort. Each patient was instructed to wear the orthosis at all times except when performing overhead exercises for the first 3 weeks.

Exercises are performed in a supine position with the shoulder flexed to 90°, adducted, and in a neutral to external rotation position (Fig. 1). This position minimizes the effect of gravity, decreases posteriorly directed forces, and allows the triceps to function as an elbow stabilizer. By avoiding abduction and internal rotation, the gravitational varus and extension-distraction force is eliminated, thereby allowing the lateral collateral ligament to heal in an isometric fashion. This position has been shown in a biomechanics model to minimize ulnohumeral distraction.[9] With the limb in this position, 2 exercises are performed: active-assisted forearm pronation and supination and active and active-assisted elbow flexion without limits and elbow extension tailored to the instability of the injury. The limits of motion are ultimately determined by patient tolerance. No motion restrictions are imposed while in this protected position.

By the third or fourth week, joint stability is typically achieved and the second phase is initiated. Commencing motion in an upright position depends on joint congruency seen on the lateral extension radiograph. Active and active assisted elbow and forearm rotation ROM exercises are allowed in the sitting or standing position with the elbow dependent. The arc of motion is based on the individual's degree of stability, apprehension, and comfort. Shoulder internal rotation and abduction are avoided to minimize gravitational varus strain.

The third phase begins 6 weeks after injury and includes ROM exercises without limits, strength and endurance exercises, and resumption of normal activities. Soft tissue stretching through passive and active assisted motion and static progressive orthoses are used if needed.

Outcome measures

At most recent follow-up, all patients had clinical examination and ROM assessment by the treating surgeon with the use of a long-arm goniometer. The primary outcome measure was range of elbow flexion-extension and forearm pronosupination after completing a minimum of 6 weeks of supervised rehabilitation. The treating surgeon evaluated ligamentous stability on physical examination by assessing varus and valgus laxity, posterolateral rotatory pivot shift, and drawer tests. Patients were also queried regarding the occurrence of any subsequent subluxation or dislocation events or any limitations in activities of daily living. In the event of subsequent surgery for contracture release, preoperative motion was used in the analysis.

RESULTS

A total of 27 patients, mean age 46.2 years (range, 22–78 y), were identified, all of whom met inclusion criteria. There were 6 females and 21 males, with 10 dislocations involving the dominant arm and 17 the nondominant arm. These patients had a mean clinical follow-up of 29 months (range, 6–90 mo; median, 20 mo). No patient with a first-time simple elbow dislocation required operative intervention. Patients were first evaluated by the treating surgeon at an average of 2.9 days after injury (range, 1–6 d). The overhead motion protocol was initiated at an average of 1.3 days after presentation

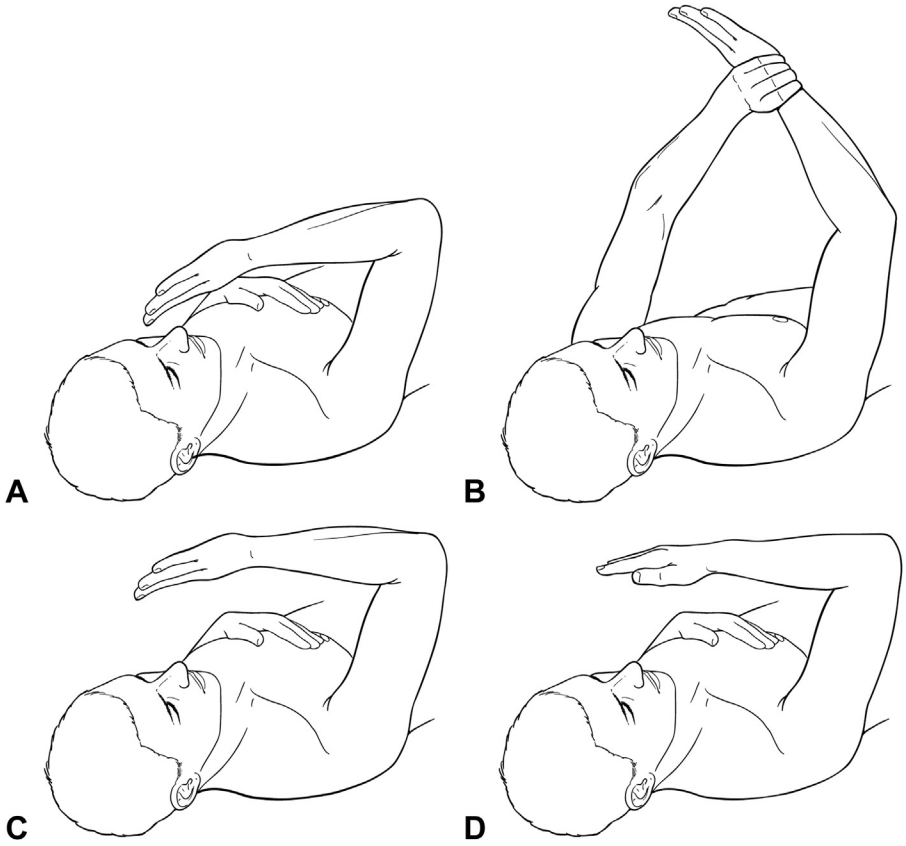

FIGURE 1: Overhead motion exercises. The patient is positioned supine with the shoulder flexed, adducted, and in a neutral to external rotation position, thereby eliminating gravitational varus and distraction forces. In this position, **A** elbow flexion, **B** extension, **C** pronation, and **D** supination motion exercises are performed.

(range, 0–5 d). All patients started exercises within 1 week of injury. Initial orthosis position was at an average of 101° flexion (range, 90° to 120°). At most recent follow-up examination, mean arc of motion was from 6° to 137° in the flexion–extension axis, with an extension range of 0° to 30° and a flexion range of 90° to 150°. Mean forearm pronation was 87° (range, 70° to 90°) and mean supination was 86° (range, 70° to 90°).

No patient had subsequent subluxation or dislocation and no clinical instability was noted on most recent physical examination. One patient required a contracture release 12 weeks after dislocation for a flexion-extension arc from 10° to 90°, which improved to 5° to 140°. Motion before the contracture release was used for analysis in this patient. All patients were fully functional at most recent follow-up.

DISCUSSION

We demonstrated that with an appropriate, supervised rehabilitation protocol, early motion can be initiated after elbow dislocation and good functional outcomes can reliably be obtained. The gravity-assisted overhead motion protocol minimizes stress on the collateral ligamentous complexes, thereby facilitating isometric ligamentous healing and potentially decreasing the risk of recurrent instability.[9] The effects of gravity are detrimental across the ulnohumeral joint in an upright position, whereas they provide a reducing effect when motion is performed in a supine position with the shoulder flexed and internally rotated.[9] In addition, the overhead motion protocol is conceptually simple and can be performed with minimal assistance after the patient has been appropriately instructed.[8] The protocol's concept and efficacy are intuitive and backed by biomechanical data.[9]

Although the order of ligamentous disruption about the elbow that facilitates a dislocation is debated,[10–12] a significant soft tissue compromise, often involving both medial and lateral collateral ligaments,[12] is required for a dislocation event. Protecting the injured collateral ligaments is essential when managing these injuries conservatively, and early initiation of motion must be done judiciously. Failure of the lateral collateral ligaments to heal in an isometric fashion can result in posterolateral rotatory

instability.[11,13,14] Conversely, failure of appropriate healing of the medial collateral ligament can result in valgus instability.[10,13,15]

The biological benefits of early motion on soft tissues include enhanced healing, prevention of contractures, and nourishment of articular cartilage.[16] In the elbow, pain and contracture after immobilization result from a combination of fibrosis of the capsule, adaptive shortening of anterior fibers of the collateral ligaments, brachialis muscle adherence and scarring, and development of intra-articular adhesions.[4,17,18] Multiple studies have reported improved outcomes with early mobilization after elbow dislocations, including earlier return to work,[5] earlier resumption of normal activities,[19] and decreased disability time.[5] Mobilization has also been associated with improved functional and pain scores.[4,5]

As Protzman[5] stated regarding elbow dislocations, "While the extremity certainly is more comfortable for the first seven to ten days after injury if it is immobilized, the price to be paid for that short-term comfort is a longer period of disability and increased flexion contracture." Indeed, the development of an elbow flexion contracture is a relatively common sequela of simple elbow dislocations.[2,4,5] The importance of initiating protected early motion to minimize this risk is well known because previous studies have reported correlations between immobilization periods and the development of flexion contractures.[4,5,7] When these exceed 30°, as was seen in 15% in one large series,[4] they may result in major limitations in performing activities of daily living.[20,21] Obtaining a maximal arc of motion should be of high priority when attempting to optimize outcomes, because the flexion-extension arc has been correlated with patient satisfaction, pain, and Disabilities of the Arm, Shoulder, and Hand and Oxford elbow scores.[6]

In this cohort, we initiated motion exercises at an average of 1.3 days after initial evaluation by the treating surgeon. This may explain the favorable terminal extension demonstrated here compared with previous reports on conservative management of elbow dislocations.[2,4–6] This is not the first report on managing simple elbow dislocations with early motion,[5,7] and although the cohort was relatively small, the protocol was successful in preventing recurrent dislocations or instability. In addition, this protocol does not require advanced equipment such as a neuromuscular electrical stimulator in cold water, a swimming pool, or elaborate exercise equipment.[7]

The motion protocol used in this cohort places patients in a supine position with the forearm overhead, thereby minimizing varus and distraction gravitational force and transitioning the triceps into an elbow stabilizer. Early motion maximizes the ability to achieve a full flexion-extension arc, whereas positioning allows the collateral ligamentous complexes to heal in an isometric fashion.

In the studied cohort, no patients had continued instability after completing the overhead motion protocol. This compares favorably with a recent large outcome study following simple elbow dislocations, which reported an 8% prevalence of continued instability among 110 patients managed with a traditional upright rehabilitation program.[6]

This study had limitations. The cohort studied was relatively small, so the possibility of recurrent instability and its prevalence with this protocol could not be fully compared with historical controls. Another limitation was the variability in duration of follow-up. In our practice, not all patients with elbow dislocations were observed for an extended period. When patients were without limitations and had achieved acceptable motion with no symptoms of instability, they were discharged from routine follow-up.

REFERENCES

1. Borris LC, Lassen MR, Christensen CS. Elbow dislocation in children and adults: a long-term follow-up of conservatively treated patients. *Acta Orthop Scand*. 1987;58(6):649–651.
2. Josefsson PO, Johnell O, Gentz CF. Long-term sequelae of simple dislocation of the elbow. *J Bone Joint Surg Am*. 1984;66(6):927–930.
3. McCabe MP, Savoie FH III. Simple elbow dislocations: evaluation, management, and outcomes. *Phys Sportsmed*. 2012;40(1):62–71.
4. Mehlhoff TL, Noble PC, Bennett JB, Tullos HS. Simple dislocation of the elbow in the adult: results after closed treatment. *J Bone Joint Surg Am*. 1988;70(2):244–249.
5. Protzman RR. Dislocation of the elbow joint. *J Bone Joint Surg Am*. 1978;60(4):539–541.
6. Anakwe RE, Middleton SD, Jenkins PJ, McQueen MM, Court-Brown CM. Patient-reported outcomes after simple dislocation of the elbow. *J Bone Joint Surg Am*. 2011;93(13):1220–1226.
7. Ross G, McDevitt ER, Chronister R, Ove PN. Treatment of simple elbow dislocation using an immediate motion protocol. *Am J Sports Med*. 1999;27(3):308–311.
8. Wolff AL, Hotchkiss RN. Lateral elbow instability: nonoperative, operative, and postoperative management. *J Hand Ther*. 2006;19(2):238–243.
9. Lee AT, Schrumpf MA, Choi D, et al. The influence of gravity on the unstable elbow. *J Shoulder Elbow Surg*. 2013;22(1):81–87.
10. Schreiber JJ, Warren RF, Hotchkiss RN, Daluiski A. An online video investigation into the mechanism of elbow dislocation. *J Hand Surg Am*. 2013;38(3):488–494.
11. O'Driscoll SW, Morrey BF, Korinek S, An KN. Elbow subluxation and dislocation: a spectrum of instability. *Clin Orthop Relat Res*. 1992;(280):186–197.
12. Schreiber JJ, Potter HG, Warren RF, Hotchkiss RN, Daluiski A. Magnetic resonance imaging findings in acute elbow dislocation: insight into mechanism. *J Hand Surg Am*. 2014;39(2):199–205.
13. O'Driscoll SW. Classification and evaluation of recurrent instability of the elbow. *Clin Orthop Relat Res*. 2000;(370):34–43.
14. O'Driscoll SW, Bell DF, Morrey BF. Posterolateral rotatory instability of the elbow. *J Bone Joint Surg Am*. 1991;73(3):440–446.

15. Josefsson PO, Johnell O, Wendeberg B. Ligamentous injuries in dislocations of the elbow joint. *Clin Orthop Relat Res*. 1987;(221):221–225.
16. Cyr LM, Ross RG. How controlled stress affects healing tissues. *J Hand Ther*. 1998;11(2):125–130.
17. Akeson WH. An experimental study of joint stiffness. *J Bone Joint Surg Am*. 1961;43:1022–1034.
18. Santosgutierrez L. A contribution to the study of the limiting factors of elbow extension. *Acta Anat (Basel)*. 1964;56:146–156.
19. Maripuri SN, Debnath UK, Rao P, Mohanty K. Simple elbow dislocation among adults: a comparative study of two different methods of treatment. *Injury*. 2007;38(11):1254–1258.
20. Morrey BF, Askew LJ, Chao EY. A biomechanical study of normal functional elbow motion. *J Bone Joint Surg Am*. 1981;63(6):872–877.
21. Sardelli M, Tashjian RZ, MacWilliams BA. Functional elbow range of motion for contemporary tasks. *J Bone Joint Surg Am*. 2011;93(5):471–477.