J Shoulder Elbow Surg (2015) 24, 908-914

ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

Locked plate osteosynthesis of humeral head–splitting fractures in young adults

Ashok S. Gavaskar, MS Ortho[a,*], Naveen C. Tummala, MS Ortho[b]

[a]*Department of Trauma and Orthopedics, Parvathy Hospital, Chennai, India*
[b]*Dhruv Clinics, Chennai, India*

Background: Humeral head–splitting fractures occur in younger patients and can be associated with poor outcome. We decided to study the functional outcome and complications in simple and complex humeral head–splitting fractures. We hypothesized that simple head-splitting fractures will perform better compared with complex head-splitting fractures.

Patients and methods: Records of 16 patients <55 years who underwent locked plating for humeral head–splitting fractures were reviewed. Five fractures were classified as simple (isolated head-splitting fractures) and 11 as complex fractures (associated tuberosity fractures). Union and quality of articular and tuberosity reduction were assessed radiologically. Shoulder and upper limb function was assessed by Constant and Disabilities of the Arm, Shoulder, and Hand (DASH) scores. Complications such as osteonecrosis, nonunion, and arthritic changes were also recorded.

Results: Of 15 fractures, 13 had united at a mean follow-up of 34 months (25-47 months). No osteonecrosis or nonunion was seen in simple fractures. In complex fractures, osteonecrosis was seen in 4 patients ($P = .01$), nonunion in 2 patients, and glenohumeral arthritis in 1 patient. The mean Constant score (66.5 [56-77]) and DASH score (21 [7.5-35.8]) showed significantly better outcomes in simple fractures (Constant score, $P = .02$; DASH score, $P = .029$).

Conclusion: Locked plating achieves satisfactory results in simple head-splitting fractures. Complex fractures are associated with higher rates of nonunion, avascular necrosis, and inferior shoulder function.

Level of evidence: Level IV, Case Series, Treatment Study.

Keywords: Proximal humerus fractures; head splitting; locked plating; osteosynthesis

Neer defined humeral head–splitting fractures as proximal humerus fractures in which the humeral head is split into more than one fragment with the fractured fragments measuring more than 20% of the articular surface.[13] Isolated humeral head–splitting fractures are rare injuries. Head splitting can also occur as a part of complex proximal humerus fractures seen in high-velocity injuries in younger individuals. The glenohumeral joint is often found subluxated or dislocated. There may be associated impaction injuries to the humeral head and the glenoid.[5] Favorable results with osteosynthesis can be difficult to achieve because of the very proximal location of the head fracture and associated poor vascularity. Control of small articular fragments during reduction and maintenance of fixation in a

The Institutional Review Board of Parvathy Hospital approved the study: No. POH/T/UL/117.

*Reprint requests: Ashok S. Gavaskar, MS Ortho, 63A/44, Gandhi Road, Choolaimedu, Chennai 600094, India.

E-mail address: gavaskar.ortho@gmail.com (A.S. Gavaskar).

1058-2746/$ - see front matter © 2015 Journal of Shoulder and Elbow Surgery Board of Trustees.
http://dx.doi.org/10.1016/j.jse.2014.10.003

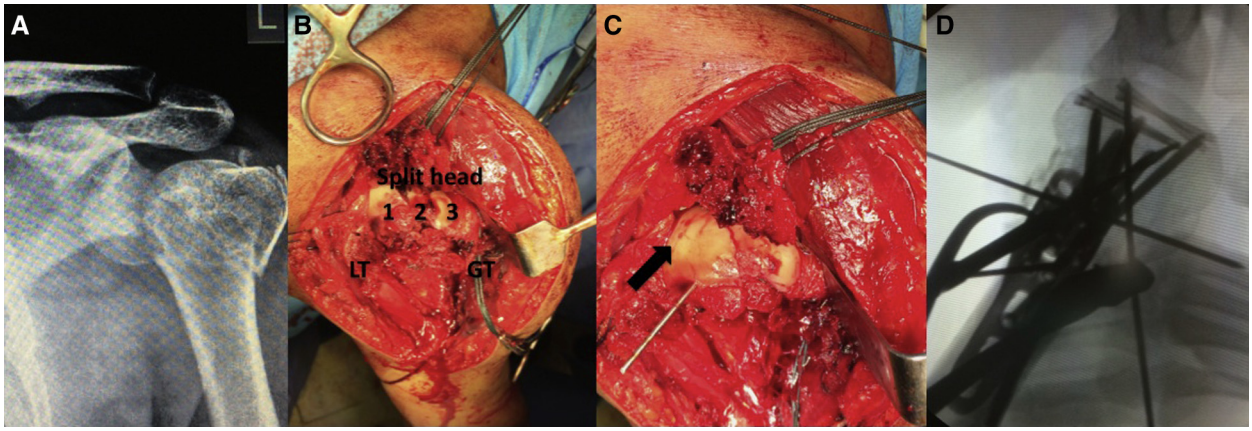

Figure 1 (**A**) Anteroposterior radiograph showing a complex head-splitting fracture with a subluxated head fragment. (**B**) Intraoperative image after reduction of the anteriorly subluxed head fragment shows the head split into 3 fragments and the tuberosities (*LT*, lesser tuberosity; *GT*, greater tuberosity) tagged with sutures. (**C**) After reduction of the head fragments and fixation with headless screws (*arrow*). (**D**) Axial fluoroscopy image shows the anatomic reduction of the head and tuberosities.

small fragment lacking soft tissues may also be difficult. Nevertheless, osteosynthesis is still favored because hemiarthroplasty in younger patients may be associated with an inferior functional outcome in the long term.[15] With this background, we reviewed our results of simple and complex head-splitting proximal humerus fractures in patients <55 years treated by locked plating between 2008 and 2010 with emphasis on functional outcome and complications. We hypothesized that simple fractures will have a better clinical and functional outcome compared with complex head-splitting fractures.

Materials and methods

This was a retrospective single-center study. The medical records of adult patients treated for a head-splitting proximal humerus fracture at our hospital from January 2008 to December 2010 were retrieved from the hospital's prospectively maintained trauma database. Patients younger than 55 years presenting with a humeral head–splitting fracture were included. Patients with open physis and older than 55 years and patients with preoperative evidence of axillary nerve injury or associated brachial plexus injury were excluded. Head splitting was quantified on preoperative computed tomography (CT) scans, and fractures fitting Neer's definition (20% of the articular surface involvement) were included. Small articular fragments attached to the tuberosities and impaction injuries of the humeral head were not considered head-splitting fractures. During the study period, 18 patients with 18 head-splitting fractures were identified; 16 satisfied the inclusion criteria and were included in the study.

Preoperatively, all patients had undergone an anteroposterior radiograph of the injured shoulder and a 3-dimensional CT scan as part of the hospital protocol. Fractures were subclassified as simple (fracture line splitting the humeral head without associated tuberosity fractures) and complex (split humeral head with tuberosity fractures; the humeral head fragment has no residual attachment to the tuberosity fragments). Osteosynthesis with a precontoured fixed angle plate was performed in all patients.

Surgical technique

A deltoid split approach by a shoulder strap incision with superior extension if required[18] was the preferred surgical approach except in patients with an anterior fracture dislocation. Five heavy nonabsorbable sutures (No. 5 Ethibond; Ethicon, Chennai, India) were passed through the cuff to reduce tuberosity fragments and to get the head out of varus. Two sutures each were taken at the posterior and anterior cuff, and 1 suture was passed through the superior portion of the cuff. One anterior and 1 posterior suture were tied together to reduce and to hold the tuberosities together before plating. Remaining sutures were secured to the plate holes to augment the strength of fixation. The articular fragment, if dislocated/subluxated, was reduced into position by direct methods or with a cannulated 6.5-mm tap as a joystick. The split head fragments were reduced and provisionally held in place with threaded K-wires. The split head fragment, if small, was reduced to the main head fragment and fixed with 2.4-mm headless screws before plating. An intramedullary autograft fibula was used in 2 patients in whom the medial metaphysis was found to be comminuted. After reduction and preliminary fixation with K-wires, angle stable fixation was performed with the proximal humerus interlocking system (PHILOS; Synthes Medical Pvt Ltd., Gurgaon, Haryana, India). A minimum of 7 screws were used to fix the proximal portion of the plate, including at least 1 of the 2 inferomedial calcar screws (Fig. 1).

Patients were kept in a sling for 3 weeks. Pendulum exercises were started after control of pain. Passive range of motion exercises were started after 2 weeks, followed by active-assisted range of motion exercises at 4 weeks and active range of motion exercises and strengthening exercises at 6 weeks after surgery. Outpatient clinical and radiographic reviews were performed every 3 weeks until fracture union. Further regular follow-ups were conducted every 6 months until 2 years after surgery. Constant scores[4] and Disabilities of the Arm, Shoulder, and Hand (DASH)[11] scores were assessed at final follow-up. The Constant scores were adjusted for age and gender, and a normalized score was generated as described by Katolik et al.[12]