Outcomes of Nonoperatively Treated Displaced Scapular Body Fractures

Apostolos Dimitroulias MD, Kenneth G. Molinero DO,
Daniel E. Krenk DO, Matthew T. Muffly MS,
Daniel T. Altman MD, Gregory T. Altman MD

Received: 23 April 2010 / Accepted: 1 November 2010 / Published online: 16 December 2010
© The Association of Bone and Joint Surgeons® 2010

Abstract

Background Displaced scapular body fractures most commonly are treated conservatively. However there is conflicting evidence in the literature regarding the outcomes owing to retrospective design of studies, different classification systems, and diverse outcome tools.

Questions/purposes The functional outcome after non-operative management of displaced scapular body fractures was assessed by change in the DASH (Disability of Arm, Shoulder and Hand) score; (2) the radiographic outcome was assessed by the change of the glenopolar angle (GPA); and (3) associated scapular and extrascapular injuries that may affect outcome were identified.

Patients and Methods Forty-nine consecutive patients were treated with early passive and active ROM exercises for a displaced scapular body fracture. We followed 32 of these patients (65.3%) for a minimum of 6 months (mean, 15 months; range, 6–33 months). Mean age of the patients was 46.9 years (range, 21–84 years) and the mean Injury Severity Score (ISS) was 21.5 (range, 5–50). Subjective functional results (DASH score) and radiographic assessment (fracture union, glenopolar angle) were measured.

Results All fractures healed uneventfully. The mean change of glenopolar angle was 9° (range, 0°–20°). The mean change of the DASH score was 10.2, which is a change with minimal clinical importance. There was a correlation between the change in this score with the ISS and presence of rib fractures.

Conclusions Satisfactory outcomes are reported with nonoperative treatment of displaced scapular body fractures. We have shown that the severity of ISS and the presence of rib fractures adversely affect the clinical outcome.

Level of Evidence Level IV, therapeutic study. See the Guidelines for Authors for a complete description of levels of evidence.

Introduction

Scapula fractures are commonly the result of high-energy injuries [4, 25, 37]. Associated injuries are frequent. Most commonly the body of the scapula is involved and non-operative management remains the mainstay of treatment for these fractures [42]. As these patients are usually high-demand young adults, it is important to ensure treatment will have a satisfactory outcome [42].

Although there are numerous studies reporting the results after nonoperative treatment of scapular body fracture, most are retrospective, and use different classification schemes and outcome instruments [1, 4, 15, 25, 26, 28, 36, 39]. For example, one study [28] reported on 129 patients with scapular fractures managed nonoperatively. Nineteen of these were displaced body fractures. Seven were available for clinical evaluation; three were rated as good outcomes and four as fair outcomes. In another study [1], 24 patients with displaced scapular neck and scapular spine fractures were analyzed. In this study a

One or more of the authors (DTA, GTA) have received funding from Allegheny Orthopaedic Associates and Foundation for Orthopaedic Research.

Each author certifies that his or her institution approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

A. Dimitroulias, K. G. Molinero, D. E. Krenk,
M. T. Muffly, D. T. Altman, G. T. Altman (✉)
Department of Orthopaedic Surgery, Allegheny General
Hospital, Federal North Building, 1307 Federal Street,
2nd Floor, Pittsburgh, PA 15212, USA
e-mail: altmangregory@hotmail.com

classification scheme was devised in which most of the fractures classified as scapular neck fractures would be described as body fractures using the current AO/OTA classification scheme. This study included pediatric patients and penetrating injuries. Two recent outcome studies with retrospectively collected data did not use CT scans to map the fracture [15, 36].

Identification of scapular fracture lines and injury classification based on plain radiographs are not reliable owing to significant bony overlap [3, 9]. The outcome after a scapular body fracture may be affected adversely by other simultaneous scapular injuries not identified on radiographs, and only during the last few years has the importance of the superior shoulder suspensory complex been elucidated. To address these issues we conducted a study through a prospectively collected database using a uniform protocol for CT imaging, treatment, and outcome assessment.

The objectives were to (1) determine the functional outcome after nonoperative management of displaced scapular body fractures as assessed by change in the DASH score; (2) determine the radiographic outcome assessed by the change of the GPA; and (3) identify associated scapular and extrascapular injuries that may affect outcome.

Patients and Methods

This prospective cohort study was performed at our Level 1 trauma center between November 2005 and August 2008. The study was approved by our Institutional Review Board and all participants provided written informed consent. During the study period, adult patients presenting to the emergency room with a scapular fracture were enrolled in a database. Exclusion criteria included significant neurologic injury (brachial plexus, cervical cord, traumatic brain injury) or upper extremity amputation. Five patients with a severe traumatic brain injury, one patient with an upper extremity amputation, and one with a brachial plexus injury were not included in the study. On admission, bilateral shoulder (AP, axillary views) and scapular (AP, transscapular Y) radiographs were assessed. When a scapular fracture was identified, a CT scan with coronal, sagittal, and three-dimensional reconstructions was performed to further evaluate the fracture. Patients were asked to rate their preinjury upper extremity function according to the DASH questionnaire. This was done either at the time of initial admission or during the first office visit 2 weeks after discharge from the hospital, depending on the patients' general status and ability to complete the questionnaire. The ISS [5] also was recorded, as obtained from our trauma registry.

Of 124 consecutive patients with scapular fractures, 99 had involvement of the scapular body. Of these, 53 had substantial displacement (defined as a fracture with at least 100% and/or 1 cm displacement). There were four patients with a concomitant glenoid fracture requiring open reduction and internal fixation, and these patients were excluded from the study. Overall, 49 patients with displaced scapular body fractures were treated nonoperatively. There were no patients with bilateral injuries in this group. Fifteen patients were lost to followup and two died within 6 months from the injury, leaving a total of 32 patients for the final analysis. Fractures were classified according to the AO/OTA classification using radiographs and CT scans [24]. This classification system uses an alphanumeric code. Number 14 is the bone designator for scapula; A designates extraarticular injuries, B partial articular, and C articular fractures. The number following the letter specifies the area where the fracture is, and 14-A3 is used for a scapular body fracture. Further subdivision describes comminution (14-A3.1 for noncomminuted and 14-A3.2 for comminuted scapular body fractures). 14-C3 designates a glenoid with a scapular body fracture.

The following data points were recorded: ISS, angulation greater than 20° in any plane, change in GPA as compared with the opposite side, type of fracture according to AO/OTA classification, involvement of the superior border of the scapula (supraspinatus fossa, acromion, spine, coracoid process), presence of superior shoulder suspensory complex (SSSC) injury, presence and number of ipsilateral rib fractures, and presence of ipsilateral clavicle or other upper extremity fractures. Not all clavicle fractures with scapular body fractures create a double disruption of the SSSC. For this to occur, the scapular body fracture line must traverse the lateral scapular body and exit superiorly to the scapular spine or acromion. This fracture pattern can be identified easily on CT scans.

In seven patients, the fracture pattern extended into the suprascapular fossa. Eleven patients had greater than 20° angulation of the body as evident in the transscapular Y view and/or the sagittal CT reconstructions. There were 16 AO/OTA 14-A3.1 (noncomminuted scapular body fracture), 13 14-A3.2 (comminuted scapular body fracture), and three 14-C3 (scapular body and glenoid fractures) with greater than 2-mm displacement of the intraarticular component. Owing to other substantial injuries, these patients with articular fractures were treated nonoperatively and included in the study. As this is not a long-term study, posttraumatic arthritis attributable to the presence of an intraarticular fracture would be unlikely to affect the outcome. We included these patients with glenoid fractures as part of the SSSC injury spectrum, in the same way we included patients with a clavicle or scapular neck fracture.

All but one patient had sustained a closed injury. In our series, nine patients had double disruption of the SSSC (four patients with a fracture of the clavicle and lateral body of the scapula or spine of the scapula; one with fracture of the clavicle, glenoid, and lateral body of the scapula; one with fracture of the clavicle, spine of the scapula, glenoid neck, and acromioclavicular joint disruption; one with a base of coracoid and glenoid fracture; one with a glenoid and lateral scapular body fracture; and one with a base of coracoid and glenoid neck fracture).

Associated injuries were common (Table 1). Overall, 11 patients had a concomitant ipsilateral upper extremity fracture: eight patients had a clavicle fracture (five treated nonoperatively and three with open reduction and internal fixation), one with a proximal humerus fracture (nonoperative treatment), one with a distal radius fracture (nonoperative management), and one with a ring finger extraarticular proximal phalanx fracture (open reduction and internal fixation). Seventeen patients sustained ipsilateral rib fractures. The number of fractured ribs varied from one to nine ribs.

Table 1. Associated injuries for patients with displaced scapular body fractures

Associated injury	Number of patients
Rib fractures	17 (53%)
Pneumothorax	13 (41%)
Closed head injury/cerebral contusion	12 (38%)
Pulmonary contusion	10 (31%)
Hemothorax	8 (25%)
Clavicle fractures	8 (25%)
Cervical spine fractures	6 (19%)
Thoracic spine fractures	6 (19%)
Radius/ulna fractures	6 (19%)
Facial fractures	4 (13%)
Pelvic fractures	4 (13%)
Humerus fractures	3 (9%)
Metacarpal/metatarsal fractures	3 (9%)
Ankle fractures	2 (6%)
Femur fractures	2 (6%)
Lumbar spine fractures	2 (6%)
Renal contusion/laceration	2 (6%)
Splenic contusion/laceration	2 (6%)
Tibia/fibula fractures	2 (6%)
Knee dislocation	1 (3%)
Liver laceration	1 (3%)
Patella fractures	1 (3%)
Sacral fractures	1 (3%)
Skull fractures	1 (3%)
Traumatic amputation	1 (3%)

The minimum followup was 6 months (mean, 15 months; range, 6–33 months). The mean age of the patients was 46.9 years (range, 21–84 years), and the mean ISS was 21.5 (range, 5–50). There were 19 polytraumatized patients (ISS > 18) [8, 19, 31, 33].

All patients had formal physical therapy that started 2 weeks after discharge from the hospital. After 2 weeks of immobilization in a sling, passive and active ROM exercises were initiated. Strengthening exercises started 8 weeks from the injury. There was variability in our rehabilitation protocol involving the time to ROM exercises which in turn depended on the length of hospital stay owing to other associated injuries.

Repeat radiographs and the self-administered DASH questionnaire were obtained at 6 and 12 months postinjury and at the time of last followup. The DASH has the ability to detect changes corresponding to the patients' perception before and after an intervention in various upper extremity disorders [16]. Studies have examined the validity of the DASH questionnaire to measure a self-rated health change [16]. A 10-point difference in DASH score generally is considered a change with minimal importance, a 15-point difference can distinguish between patients with improvement and those without improvement, and a 19-point score change signifies a much better or much worse outcome [16].

The change in GPA (GPA opposite side – GPA affected side) was calculated on an AP plain radiograph in the scapular plane during the last followup. This angle is defined by three points: the inferior-most part of the body and the superior and inferior points of the glenoid. This angle measures the obliquity of the glenoid articular surface in relation to the scapular body [6, 35]. Either a glenoid neck fracture or a displaced fracture of the body of the scapula can alter this angle, and in turn, this may cause shortening of the lever arm of the rotator cuff muscles with loss of the mechanical advantage and cuff dysfunction.

A linear regression analysis was used to determine whether an association between the change in the patient's DASH score and the following independent variables existed: patient's age, ISS, extension of the fracture to the suprascapular fossa, presence of a fracture only in the body of the scapula, presence of scapular body comminution, angulation greater than 20°, change of GPA, fracture of the ipsilateral extremity, fracture of the ipsilateral clavicle, and presence of ipsilateral rib fractures. A one-sample *t* test was used to determine if there was a difference in the outcome between patients with and without injury to the SSSC. A linear regression test was conducted to determine if side of injury and hand dominance had a correlation with change in DASH score. Analysis was done using SPSS (SPSS Inc, Chicago, IL, USA).

Results

All fractures healed uneventfully. One patient required an additional procedure (manipulation under anesthesia for arthrofibrosis of shoulder).

The mean change in GPA (compared with the contralateral side) was 9° (range, 0°–20°). The mean preinjury DASH score was 1.5. The mean change in DASH score (last DASH – preinjury DASH) was 10.2. The mean change in DASH score in the subgroup with SSSC injury was 12.4 whereas the respective value for patients without this injury was 9.4. These values of DASH score do not signify any clinically important change. Statistical analysis revealed an association between the change of DASH score and two of the independent variables: ISS ($p = 0.02$) and presence of rib fractures ($p = 0.01$). Those two variables were independent of each other.

There was no association between the final clinical outcome and the following variables: age ($p = 0.091$), hand dominance ($p = 0.185$), presence of scapular body comminution ($p = 0.079$), magnitude of change of the GPA ($p = 0.672$), angulation ($p = 0.485$), extension of the fracture to the suprascapular fossa ($p = 0.326$), fracture only in the body of the scapula ($p = 0.278$), and presence of a clavicle or other ipsilateral extremity fracture ($p = 0.274$).

Discussion

Displaced scapular body fractures occur most commonly in the context of a polytraumatized patient and traditionally have been managed nonoperatively. Outcomes have been reported but most studies are retrospective, and use different classification schemes and outcome instruments [1, 4, 15, 25, 26, 28, 36, 39]. We therefore used a prospectively collected database and a uniform CT protocol to (1) evaluate the functional outcome after nonoperative management of displaced scapular body fractures as assessed by change in the DASH score; (2) determine the radiographic outcome assessed by the change of the GPA; and (3) identify associated scapular and extrascapular injuries that may affect outcome.

Shortcomings of our study include the lack of objective measures of shoulder function such as strength and ROM. Our intention was to evaluate the functional outcome of patients with displaced scapular body fractures as this is more clinically meaningful. Moreover, the DASH score has been found to correlate with shoulder strength and external rotation ROM [13]. Another limitation of this study is the absence of MR images to assess the rotator cuff integrity or any subacromial impingement. Nevertheless, during the course of the study, none of the patients required any additional diagnostic or therapeutic procedures to address

rotator cuff disorders. We did not measure glenoid medialization in this study. There is a theoretical concern that medialization of the glenoid causes dysfunction secondary to shortening of the effective muscle length [9]. However, this has not been proven in clinical studies. Moreover, there is evidence supporting that medial translation of the glenoid does not occur, but rather lateralization of the scapular body takes place [29]. Absence of a control group (patients treated operatively) is another shortcoming. Finally, weaknesses of the study are the low and short followup rates and therefore a selection bias cannot be excluded.

In a recent systematic review of the literature, the average age of patients with scapular fractures was 38 years [42]. In our study this was 46.9 years. This difference probably is attributable to the fact that some studies include pediatric patients with skewing of the mean age [1, 15, 25, 26, 40]. In our study, mean age compares with those in other studies not including pediatric patients [35, 36].

We found satisfactory clinical outcomes with nonoperative management of these fractures with a mean change in DASH score (last DASH – preinjury DASH) of 10.2. The DASH questionnaire has been used for patients with upper extremity trauma [12, 14, 20, 27, 34], and is the most validated measurement tool of function in upper extremity disorders [10].

Nonsurgical management avoids general surgical risks (painful hardware [22], infection, brachial plexus palsy [2], hematoma [17, 29]) and risks associated with the posterior Judet approach especially when excessive dissection for exposure of the infraspinatus fossa is required (risk of iatrogenic damage of the infraspinatus branch of the suprascapular nerve and scar formation along soft tissue planes [12, 18]). Other authors have reported good outcomes with nonoperative management of scapular body fractures [4, 25, 26]. In a systematic review of 123 scapular body fractures treated nonoperatively, it was found that excellent or good results were achieved in 86% of cases [42].

There are published studies in which patients with scapular neck fractures and a GPA less than 20° had less favorable outcomes (more pain and reduced activities of daily living) [7, 35]. In our study the change of GPA did not affect these parameters as tested with the DASH questionnaire. This is because in our patients, the change of GPA is attributed more to rotation of the inferior scapular body than a true malrotation of the glenoid cavity and therefore the lever arm of the rotator cuff is less affected.

The importance of the SSSC has been recognized. It is a bony-soft tissue ring formed by the acromion, distal clavicle, coracoid, glenoid and acromioclavicular, coracoclavicular, and coracoclavicular ligaments. The ring is between two bony struts: the midclavicle (superiorly) and lateral scapular body and scapular spine (inferiorly) [41].

Disruptions at two or more osseoligamentous structures may create a “floating shoulder.” There is insufficient evidence regarding the best practice for double disruptions of the SSSC. Biomechanical data suggest fracture of the clavicle and scapula neck does not produce instability unless there is disruption of the coracoacromial and acromioclavicular ligaments or the coracoacromial and coracoclavicular

ligaments [41]. However, the possible combinations of a double disruption of the SSSC are numerous and there are only small clinical series available [11, 12, 21, 23, 30, 32, 38]. Most of these studies examined the clinical scenario of the clavicle with a scapula neck fracture. Results were satisfactory with operative and nonoperative approaches. In our study, the subgroup of patients with a SSSC injury had a

Fig. 1A–D (A) Anteroposterior and (B) Y radiographic views of the right scapula of a 21 year-old man show a 100% displaced scapular body fracture. (C) Anteroposterior and (D) Y radiographic views of the right scapula obtained at the 6-month followup show a healed fracture. The fracture was treated nonoperatively, and the patient had an excellent outcome

12.4-point change in DASH score which is a change with minimal clinical importance. As the patterns of double disruption of the SSSC are numerous, we suggest that treatment decisions should be made on a case-by-case basis, assessing the injury pattern, the overall status of the patient, age, and functional demands.

The combination of a displaced scapular body fracture and underlying multiple rib fractures implies greater soft tissue damage, more scarring, and impeded scapulothoracic motion. This may explain the worse outcome in this subset of patients.

We found that patients with a greater ISS on admission had a worse functional outcome. This is not an unexpected finding. A patient with severe associated injuries is likely to have suboptimal rehabilitation of the extremity injury [26]. Our results are in agreement with those of a recent retrospective study on outcomes of nonoperatively treated scapular body fractures in which polytraumatized patients had worse outcomes than patients with isolated scapula injuries [15]. Similarly in another study of conservative treatment of scapular neck fractures, associated injuries were associated with worse functional outcome [7].

In our patient group, there were no nonunions or secondary procedures to correct malalignment of the scapular body. One of the patients with a clavicle fracture treated with open reduction and internal fixation had shoulder arthrofibrosis develop and required manipulation under anesthesia. Even in cases with severe displacement or angulation, patients had only minimal complaints of a grinding sensation with no compromise of function (Fig. 1).

Our experience suggests that satisfactory functional outcomes can be achieved after nonoperative management of displaced scapular body fractures. High ISS and presence of rib fractures are associated with a less favorable outcome. Future studies comparing conservative versus operative treatment will help clarify which fracture characteristics would benefit from surgical intervention.

Acknowledgments We thank Lauren O'Keefe, Research Assistant, and Yiota Louka, BS, for technical support during preparation of the manuscript.

References

1. Ada JR, Miller ME. Scapular fractures: analysis of 113 cases. *Clin Orthop Relat Res*. 1991;269:174–180.
2. Adam FF. Surgical treatment of displaced fractures of the glenoid cavity. *Int Orthop*. 2002;26:150–153.
3. Armitage BM, Wijdicks CA, Tarkin IS, Schroder LK, Marek DJ, Zlowodzki M, Cole PA. Mapping of scapular fractures with three-dimensional computed tomography. *J Bone Joint Surg Am*. 2009;91:2222–2228.
4. Armstrong CP, van der Spuy J. The fractured scapula: importance and management based on a series of 62 patients. *Injury*. 1984;15:324–329.
5. Baker SP, O'Neill B, Haddon W Jr, Long WB. The injury severity score: a method for describing patients with multiple injuries and evaluating emergency care. *J Trauma*. 1974;14:187–196.
6. Bestard EA, Schoene SH, Bestard EH. Glenoplasty in the management of recurrent shoulder dislocation. *Contemp Orthop*. 1986;12:47–55.
7. Bozkurt M, Can F, Kirdemir V, Erden Z, Demirkale I, Başbozkurt M. Conservative treatment of scapular neck fracture: the effect of stability and glenopolar angle on clinical outcome. *Injury*. 2005;36:1176–1181.
8. Charash WE, Fabian TC, Croce MA. Delayed surgical fixation of femur fractures is a risk factor for pulmonary failure independent of thoracic trauma. *J Trauma*. 1994;37:667–672.
9. Cole PA. Scapula fractures. *Orthop Clin North Am*. 2002;33:1–18, vii.
10. Dowrick AS, Gabbe BJ, Williamson OD, Cameron PA. Outcome instruments for the assessment of the upper extremity following trauma: a review. *Injury*. 2005;36:468–476.
11. Edwards SG, Whittle AP, Wood GW 2nd. Nonoperative treatment of ipsilateral fractures of the scapula and clavicle. *J Bone Joint Surg Am*. 2000;82:774–780.
12. Egol KA, Connor PM, Karunakar MA, Sims SH, Bosse MJ, Kellam JF. The floating shoulder: clinical and functional results. *J Bone Joint Surg Am*. 2001;83:1188–1194.
13. Getahun TY, MacDermid JC, Patterson SD. Concurrent validity of patient rating scales in assessment of outcome after rotator cuff repair. *J Musculoskelet Res*. 2000;4:114–127.
14. Gofton WT, Macdermid JC, Patterson SD, Faber KJ, King GJ. Functional outcome of AO type C distal humeral fractures. *J Hand Surg Am*. 2003;28:294–308.
15. Gosens T, Speigner B, Minekus J. Fracture of the scapular body: functional outcome after conservative treatment. *J Shoulder Elbow Surg*. 2009;18:443–448.
16. Gummesson C, Atroshi I, Ekdahl C. The disabilities of the arm, shoulder and hand (DASH) outcome questionnaire: longitudinal construct validity and measuring self-rated health change after surgery. *BMC Musculoskelet Disord*. 2003;4:11.
17. Hardegger FH, Simpson LA, Weber BG. The operative treatment of scapular fractures. *J Bone Joint Surg Br*. 1984;66:725–731.
18. Herscovici D Jr, Robert CS. Scapula fractures: to fix or not to fix? *J Orthop Trauma*. 2006;20:227–229.
19. Johnson KD, Cadambi A, Seibert GB. Incidence of adult respiratory distress syndrome in patients with multiple musculoskeletal injuries: effect of early operative stabilization of fractures. *J Trauma*. 1985;25:375–384.
20. Jupiter JB, Ring D. Treatment of unreduced elbow dislocations with hinged external fixation. *J Bone Joint Surg Am*. 2002;84:1630–1635.
21. Labler L, Platz A, Weishaupt D, Trentz O. Clinical and functional results after floating shoulder injuries. *J Trauma*. 2004;57:595–602.
22. Lapner PC, Uhthoff HK, Papp S. Scapula fractures. *Orthop Clin North Am*. 2008;39:459–474, vi.
23. Leung KS, Lam TP. Open reduction and internal fixation of ipsilateral fractures of the scapular neck and clavicle. *J Bone Joint Surg Am*. 1993;75:1015–1018.
24. Marsh JL, Slongo TF, Agel J, Broderick JS, Creevey W, DeCoster TA, Prokuski L, Sirkin MS, Ziran B, Henley B, Audigé L. Fracture and dislocation classification compendium-2007: Orthopaedic Trauma Association classification, database, and outcomes committee. *J Orthop Trauma*. 2007;21(10 suppl):S1–S133.
25. McGahan JP, Rab GT, Dublin A. Fractures of the scapula. *J Trauma*. 1980;20:880–883.
26. McGinnis M, Denton JR. Fractures of the scapula: a retrospective study of 40 fractured scapulae. *J Trauma*. 1989;29:1488–1493.

27. McKee MD, Wild LM, Schemitsch EH. Midshaft malunions of the clavicle. *J Bone Joint Surg Am.* 2003;85:790–797.
28. Nordqvist A, Petersson C. Fracture of the body, neck, or spine of the scapula: a long-term follow-up study. *Clin Orthop Relat Res.* 1992;283:139–144.
29. Obrebsky WT, Lyman JR. A modified judet approach to the scapula. *J Orthop Trauma.* 2004;18:696–699.
30. Oh W, Jeon IH, Kyung S, Park C, Kim T, Ihn C. The treatment of double disruption of the superior shoulder suspensory complex. *Int Orthop.* 2002;26:145–149.
31. Pape HC, Auf'm Kolk M, Paffrath T, Regel G, Sturm JA, Tscherne H. Primary intramedullary fixation in polytrauma patients with associated lung contusion: a cause of posttraumatic ARDS? *J Trauma.* 1993;34:540–547; discussion 547–548.
32. Ramos L, Mencía R, Alonso A, Ferrández L. Conservative treatment of ipsilateral fractures of the scapula and clavicle. *J Trauma.* 1997;42:239–242.
33. Reynolds MA, Richardson JD, Spain DA, Seligson D, Wilson MA, Miller FB. Is timing of fracture fixation important for the patient with multiple trauma? *Ann Surg.* 1995;222:470–478; discussion 478–481.
34. Ring D, Perey BH, Jupiter JB. The functional outcome of operative treatment of ununited fractures of the humeral diaphysis in older patients. *J Bone Joint Surg Am.* 1999;81:177–190.
35. Romero J, Schai P, Imhoff AB. Scapular neck fracture: the influence of permanent malalignment of the glenoid neck on clinical outcome. *Arch Orthop Trauma Surg.* 2001;121:313–316.
36. Schofer MD, Seher AC, Timmesfeld N, Störmer S, Kortmann HR. Fractures of the scapula: long-term results after conservative treatment. *Arch Orthop Trauma Surg.* 2009;129:1511–1519.
37. Thompson DA, Flynn TC, Miller PW, Fischer RP. The significance of scapular fractures. *J Trauma.* 1985;25:974–977.
38. van Noort A, te Slaa RL, Marti RK, van der Werken C. The floating shoulder: a multicentre study. *J Bone Joint Surg Br.* 2001;83:795–798.
39. van Noort A, van der Werken C. The floating shoulder. *Injury.* 2006;37:218–227.
40. Wilber MC, Evans EB. Fractures of the scapula: an analysis of forty cases and a review of the literature. *J Bone Joint Surg Am.* 1977;59:358–362.
41. Williams GR Jr, Naranja J, Klimkiewicz J, Karduna A, Iannotti JP, Ramsey M. The floating shoulder: a biomechanical basis for classification and management. *J Bone Joint Surg Am.* 2001;83:1182–1187.
42. Zlowodzki M, Bhandari M, Zelle BA, Kregor PJ, Cole PA. Treatment of scapula fractures: systematic review of 520 fractures in 22 case series. *J Orthop Trauma.* 2006;20:230–233.