A Comparison of Nonoperative and Operative Treatment of Type II Distal Clavicle Fractures

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Abstract

A retrospective study was performed to compare nonoperative and operative treatments of Type II distal clavicle fractures. From a total of 30 diagnosed patients, 16 were identified as receiving nonoperative treatment and 14 open reduction and coracoclavicular stabilization. The average follow-up was 53.5 months for the nonoperative group and 59.8 months for the operative group. All patients were evaluated postoperatively for pain, range of motion, function, and fracture healing as well as for isokinetic strength. Fractures treated surgically achieved union within six to ten weeks. Nonoperative treatment resulted in seven nonunions. There were no significant differences between the two groups in the mean UCLA, Constant, and ASES scores. Nonunion had no significant effect on functional outcome or strength. This study suggests that Type II distal clavicle fractures can be successfully managed nonoperatively. The high incidence of nonunion does not impede a clinical outcome comparable to that achieved by surgical treatment.

In general, most clavicle fractures can be managed successfully by nonoperative means with the anticipation of an excellent functional outcome. Neer was the first to recognize the inherent difficulty in treating fractures of the distal clavicle. Neer distinguished the stable Type I fracture from the unstable Type II fracture in which the coracoclavicular ligaments are detached from the medial fragment. Based upon his review, in which he identified an unacceptably high incidence of nonunion with Type II fractures following nonoperative treatment, open reduction and internal fixation was recommended for these injuries. Many investigators have subsequently supported primary operative treatment for unstable distal clavicle fractures. There have, however, been many reports in which a low incidence of symptomatic nonunion and residual shoulder disability has been observed following nonoperative treatment. A retrospective study was therefore performed to compare the results of nonoperative and operative treatment of Type II distal clavicle fractures.

Materials and Methods

The medical records of patients with distal clavicle fractures treated at the Hospital for Joint Diseases between 1989 and 1997 were reviewed. Thirty-seven patients who presented with acute Type II fractures were identified, and of these, 30 patients were available for analysis including interview, physical examination, radiographic evaluation, and isokinetic strength testing. These patients form the basis of this review.

The study population was divided into two groups. Group A consisted of 16 patients treated nonoperatively. There were ten males and six females with an average age of 47.1 years (range: 26 to 68 years). Group B patients were treated surgically and consisted of 14 patients including eight males and six females with an average age of 35.5 years (range: 22 to 47 years). The average duration of follow-up was 53.5 months (range: 30 to 90 months) and 59.8 months (range 12 to 107 months) for Group A and Group B, respectively.

The mechanisms of injury included motor vehicle accidents (eight), falls (eight), cycling accidents (four), softball injuries (three), football injuries (two), martial arts injuries (two), skiing injuries (two), and a direct blow to the shoulder (one).
Treatment

Patients in Group A were treated initially with sling immobilization for six weeks. During this period active range of motion of the elbow, wrist, and hand was encouraged. Active and assistive range of motion exercises of the shoulder were initiated at six weeks, followed by strengthening exercises which were introduced between eight and twelve weeks following the injury. Patients were allowed to resume all of their usual activities including work and sports once shoulder discomfort was minimized and range of motion and strength had been restored, regardless of the presence of radiographic healing.

Group B patients were treated by open reduction and approximation of the fracture fragments by coracoclavicular stabilization. Surgery was performed within seven to ten days from the time of injury in all cases. The procedure was performed under general or regional anesthesia with the patient in the semi-sitting or beach-chair position. A strap incision was made from approximately two to three centimeters posterior to the fracture site and extended to the tip of the coracoid process.

The fracture fragments were then exposed by dividing the soft tissues longitudinally in line with the superior cortices. Full-thickness flaps overlying the fracture fragments were created in order to ensure adequate soft tissue envelopes for closure. In several cases, the medial fragment was found to have “button-holed” through the fascia and was located in a subcutaneous position. The fracture site was then cleared of all interposed soft tissue to allow re-approximation of the fragments. The anterior deltoid was then divided in line with its fibers to expose the coracoid process. The coracoclavicular ligament was left undisturbed and no attempt was made to repair the avulsed coracoclavicular ligaments.

A curved suture passer was then used to direct two to three number five nonabsorbable braided sutures around the base of the coracoid process in a medial to lateral direction in order to minimize the risk of neurovascular injury. A 3.2 mm drill hole was then created through the mid-portion of the medial fracture fragment in a superior to inferior direction in line with the coracoid process. The ends of the sutures from the lateral side of the coracoid were then passed through this drill hole. The fracture was then held reduced as each of the sutures was tied. The anterior deltoid and posterior trapezius flaps were then re-approximated over the superior aspect of the clavicle followed by closure of the split in the anterior deltoid. The subcutaneous tissue and skin were then closed in routine fashion. An intraoperative radiograph was then obtained to assess the adequacy of the reduction.

A sling was then applied and the arm was secured to the chest wall with two six inch elastic bandages placed in a criss-cross manner – one around the forearm and chest, the other around the elbow and opposite shoulder. These elastic bandages were then removed on the evening or morning following surgery. Rehabilitation initially consisted of hand gripping exercises and active range of motion exercises for the elbow, wrist, and hand. Shoulder range of motion exercises were begun at three to six weeks following surgery. This consisted of active-assistive range of motion with forward elevation limited to 90° to minimize clavicular rotation, external rotation limited to 30°, and internal rotation allowed only to the chest wall. The sling was discontinued at six weeks at which time active range of motion exercises were begun. Once full active range of motion was regained a strengthening program was begun. This was usually at about 12 weeks from the time of surgery. Strenuous use of the arm, including heavy lifting and contact sports was not begun for six to nine months following surgery.

Clinical Assessment

The University of California at Los Angeles (UCLA) Shoulder Rating Scale for Pain and Function of the Shoulder, the rating system of Constant and Murley, and the shoulder index of the American Shoulder and Elbow Surgeons (ASES) were used to assess all patients in the study population. In order to eliminate bias, these tests were administered by one of the investigators who had not been involved in the treatment of these patients and who was blinded to the radiographic findings.

The UCLA rating scale assigns a maximum of 10 points each for pain and function and 5 points each for range of motion, strength of forward flexion, and overall patient satisfaction for a total possible score of 35 points. The rating system of Constant and Murley assigns a maximum of 15 points for pain, 20 points for function, 40 points for active range of motion, and 25 points for strength for a total possible score of 100 points. The ASES score consists of pain and function components. The patient provides a self-assessment of pain using a 10-point visual analog scale in which 0 points indicate no pain and 10 points, unbearable pain. This number is subtracted from 10 with the resulting number multiplied by 5 for a total possible score of 50 points. The ten activities of daily living that comprise the function component of this scale are each scored form 0 to 3 (with 0 indicating that the patient is unable to perform the task and 3 indicating normal function). These ten scores are added together with the resulting number then multiplied by 5/3 for a total possible score of 50 points. The pain and function scores are then summed together for a maximum possible score of 100 points.

Radiographic Evaluation

A trauma series including anteroposterior glenoid, axillary, and scapular Y radiographs were obtained for all patients.
in the study population. In addition, a 45° cephalic tilt view was obtained in order to better delineate the entire clavicle. Finally, anterior and posterior 45° oblique views as described by Neer12 were also performed to evaluate the distal portion of the clavicle. A fracture was considered to be a nonunion if there was no evidence of osseous union.

**Isokinetic Strength**

Isokinetic strength testing was performed on all patients in the study population. Testing was done by one of us who was blinded to the radiographic findings, with a modified Biodex dynamometer (Biodex Corp., Shirley, New York) using a standardized protocol. The instrument was interfaced with an NEC 386 computer (Biodex Corp., Shirley, New York) and a software package that supplies torque and displacement signatures. The software allowed for normalization of the maximum gravity effect caused by the weight of the arm. The patients were tested at 60 degrees/second in three axes of motion: flexion/extension and abduction/adduction in a sitting position and external/internal rotation in a standing position.

The axis of rotation for flexion/extension was set at the acromion and positioned to align with the pivot point of the input arm of the dynamometer. The range of motion stops were set at 0° and 120°. The elbow of the extremity being tested was maintained in full extension with the forearm in a position of neutral rotation. The axis of rotation for abduction/adduction approximated the axis of the acromioclavicular joint and was aligned perpendicular to the coronal plane. The range of motion stops were set at 0° and 90°. External/internal rotation was tested with the shoulder in a position of neutral abduction/adduction and the elbow in 90° of flexion and the forearm in neutral rotation. The limb was supported by an elbow pad. The range of motion stops were set at 30° of internal and 45° of external rotation. Stabilization straps were secured and foot markers were placed during all testing to ensure a standardized and reproducible protocol.

Three submaximal effort trials were performed in each axis to acquaint the subject with the testing conditions. This procedure was followed by a five-minute rest period. Three maximal effort trials were then performed in each axis. A five-minute rest period was allowed between each testing sequence. Peak torque scores were recorded for the three repetitions in each axis of motion. The contralateral shoulder was tested in an identical manner. The mean and standard deviation for the three repetitions were then determined for each axis for each shoulder. Values for peak torque as a percentage of the uninvolved contralateral shoulder were then calculated.

**Statistical Analysis**

The Mann-Whitney U test was used to determine the statistical significance of the differences in the distributions of strength and the clinical outcomes as per the UCLA, Constant and Murley, and ASES scoring systems between the two groups of patients. The Mann-Whitney U test is a non-parametric alternative to the Student’s t-test. A p-value

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Scores for the Shoulder Rating Systems*</th>
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<tbody>
<tr>
<td></td>
<td>Group A (points)</td>
</tr>
<tr>
<td><strong>Rating Scale of the University of California at Los Angeles</strong></td>
<td></td>
</tr>
<tr>
<td>Total Score</td>
<td>31.1</td>
</tr>
<tr>
<td>Pain</td>
<td>7.8</td>
</tr>
<tr>
<td>Function</td>
<td>8.9</td>
</tr>
<tr>
<td>Flexion</td>
<td>4.9</td>
</tr>
<tr>
<td>Strength</td>
<td>5.0</td>
</tr>
<tr>
<td>Satisfaction</td>
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</tr>
<tr>
<td><strong>Shoulder Index of American Shoulder and Elbow Surgeons</strong></td>
<td></td>
</tr>
<tr>
<td>Total Score</td>
<td>89.9</td>
</tr>
<tr>
<td>Pain</td>
<td>1.1</td>
</tr>
<tr>
<td>Function</td>
<td>27.2</td>
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<tr>
<td><strong>Rating System of Constant and Murley</strong></td>
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<tr>
<td>Total Score</td>
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<tr>
<td>Pain</td>
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<tr>
<td>Function</td>
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<td>Elevation</td>
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</tr>
<tr>
<td>Abduction</td>
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</tr>
<tr>
<td>External Rotation</td>
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</tr>
<tr>
<td>Internal Rotation</td>
<td>9.5</td>
</tr>
<tr>
<td>Strength (pounds)</td>
<td>22.7</td>
</tr>
</tbody>
</table>

*Values are reported as means. The differences between the scores for Groups A and B were not significant (p > 0.05), according to the Mann-Whitney U test.
the scores for the ten activities of daily living included light activities. There was no significant difference in activity, and one patient (7%) was only able to perform patients (29%) had slight restriction in their level of ac-

(64%) reported having normal shoulder function, four

work, shopping, and driving. For Group B, nine patients

and two patients (12%) were able to perform most house-

of their normal activities without limitation, five patients

UCLA rating scale was 8.8 points for both groups. For

In terms, of function, the average score according to the

scores for Groups A and B according to the shoulder

index of the American Shoulder and Elbow Surgeons

were 44.6 and 42.5 points, respectively (p = 0.77).

For Group A, according to the UCLA rating system,

seven patients (44%) had an excellent result (34 to 35 points), six patients (37%) had a good result (29 to 33 points), and three patients (19%) had a fair or poor result (less than 29 points). For Group B, five patients (36%) had an excellent result, eight patients (57%) had a good result, and one patient (7%) had a fair or poor result.

Pain

At final follow-up there was no significant difference between the two groups when the pain components for each of the scoring systems were compared. The mean pain scores according to the UCLA rating system were 7.8 and 7.2 points for Groups A and B, respectively (p = 0.39). According to the system of Constant and Murley, the mean pain scores for Groups A and B were 12.1 and 11.5 points, respectively (p = 0.66). In Group A, ten patients (62%) had no pain, four (25%) had mild pain, and two (13%) had moderate pain. In Group B, seven pa-
tients (50%) had no pain, five (36%) had mild pain, and two (14 %) had moderate pain. Finally, the average pain scores for Groups A and B according to the shoulder index of the American Shoulder and Elbow Surgeons were 44.6 and 42.5 points, respectively (p = 0.77).

Function

In terms, of function, the average score according to the UCLA rating scale was 8.8 points for both groups. For Group A, nine patients (56%) were able to perform all of their normal activities without limitation, five patients (31%) reported having only slight activity restriction, and two patients (12%) were able to perform most house- work, shopping, and driving. For Group B, nine patients (64%) reported having normal shoulder function, four patients (29%) had slight restriction in their level of activity, and one patient (7%) was only able to perform light activities. There was no significant difference in the scores for the ten activities of daily living included in the shoulder index of the American Shoulder and Elbow Surgeons when Groups A and B were compared (p > 0.34). The mean function scores for Groups A and B were 45.3 and 40.3, respectively.

Range of Motion

In reference to range of motion, the average scores for active forward elevation were 4.9 and 4.8 points for Groups A and B, respectively (p = 0.59) as per the UCLA scoring system. Fifteen patients (94%) in Group A had 150° or more of active forward elevation (as measured with the patient in the sitting position) and one patient (6%) had 120° to 150° of active forward elevation. For Group B, eleven patients (79%) had 150° or more of active forward elevation and three patients (21%) had 120° to 150° of active forward elevation. Similarly, there was no significant difference in the range of motion scores for the two groups using the system of Constant and Murley. The average scores for Groups A and B were 38.9 and 38.4 points, respectively (p ≥ 0.39).

Strength

For Group A, the average peak torque in flexion, abduc-
tion, and external rotation were 96%, 90%, and 90% of the contralateral side, respectively. Similar results were found for Group B in which the average peak torque in flexion, abduction, and external rotation were 91%, 81%, and 92% of the contralateral side, respectively. There were no significant differences between the two groups when each plane of motion was considered separately (p ≥ 0.48).

Satisfaction

Fifteen patients in Group A and all patients in Group B reported that they were satisfied and better at final assessment. One patient in Group A was not satisfied with the results of treatment. This patient had acceptable objective measurements in terms of function, strength, and range of motion when each of the scoring systems was analyzed separately. The fracture had healed and no reason could be identified to account for this patient’s dis-
satisfaction.

Radiographic Evaluation and Analysis of Nonunions

In Group A, osseous union was achieved by eight to twelve weeks in nine patients (56%). Seven patients (44%) in Group A had radiographic evidence of non-union (Fig. 1) while all of the fractures in Group B had healed by six to ten weeks following surgery (Fig. 2). Five of the patients with nonunion reported having no pain, one had mild pain, and one had moderate pain. When considering this group of patients separately, the mean UCLA, Constant, and American Shoulder and Elbow Surgeons scores were 31.1, 94.8, and 89.9 points,
respectively. There were no significant differences when
these scores were compared to those of the other two
groups as a whole (p ≥ 0.46). Similarly, the presence of
a nonunion did not affect strength. The mean torque in
flexion, abduction, and external rotation were 99%, 91%,
and 94% of the contralateral side, respectively. Once
again, there were no significant differences when these
scores were compared to those achieved for Groups A
and B (p ≥ 0.95).

Complications
There were no intraoperative or postoperative compli-
cations encountered in this series. When asked, none of
the patients in Group A regretted not having surgery and

Figure 1 A. Injury radiograph of a 28-year-old aerobics instructor treated nonoperatively. B. Post-treatment radiograph depicting
nonunion obtained three years after injury. The patient is asymptomatic and has returned to teaching aerobics.

Figure 2 A. Preoperative radiograph of a 31-year-old attorney treated surgically. B. Radiograph obtained two years after surgery
demonstrating healed fracture.
none of the patients in Group B opted for additional surgery.

**Discussion**

Neer distinguished the Type II distal clavicle fracture as one in which there is some degree of disruption of the coracoclavicular ligaments.\(^{11,12}\) Displacement occurs due to the action of four deforming forces: 1. the weight of the arm; 2. the pull of the latissimus dorsi and the pectorals major and minor muscles; 3. scapular rotation, and 4. the pull of the trapezius muscle. The first three forces act to draw the distal fragment downward and medially, and to rotate it and tilt it with movement of the arm. The trapezius muscle acts to pull the medial fragment upward and backward. Neer attributed the high incidence of nonunion observed with these fractures to these deforming forces.\(^{10-12}\) Distal clavicle fractures account for approximately 15% of all clavicle fractures.

In 1963, Neer reported the results of 23 patients with Type II distal clavicle fractures.\(^{11}\) Of the twelve patients treated nonoperatively, a delayed union developed in eight and a nonunion in four. Only one of the four nonunions, however, had sufficient symptoms to warrant surgical intervention. Of the seven patients treated surgically with open reduction and transacromial wire fixation, all had healed within six weeks. Neer consequently recommended this as the preferred method of treatment for these fractures.

Since Neer’s report there have been several series that support the routine operative treatment of Type II distal clavicle fractures.\(^{12-19}\) These studies for the most part, however, are retrospective reviews of small numbers of patients treated by a variety of methods including transacromial wires, interfragmentary screws, coracoclavicular stabilization with sutures and screws, intramedullary pins, and tension band wires. Few studies have compared the results of nonoperative and operative treatment of these fractures.

Kavanagh and colleagues\(^{18}\) reported the results of 30 Type II fractures, half of which were treated nonoperatively and the other half treated by open reduction and internal fixation using a coracoclavicular screw. Among the patients treated nonoperatively, there were six nonunions (40%) and six delayed unions (40%). Five of the six patients with nonunion were asymptomatic and one required surgery. All of the patients with delayed union were symptomatic and one required a distal clavicle excision. Eskola and coworkers\(^{19}\) examined the results of the surgical treatment of 23 fresh lateral clavicle fractures. Fixation was accomplished with two Kirschner wires that did not cross the acromioclavicular joint in 19 cases and by plating in four cases. The subjective outcome was good or satisfactory for 22 patients with only one nonunion.

Edwards and associates\(^{14}\) reported a series of 43 Type II fractures in which 20 were treated nonoperatively and 23 were treated by open reduction and internal fixation using coracoclavicular screws, transacromial wires, or intramedullary pins. There was a 30% nonunion and 45% delayed union rate in the nonoperative group while union occurred by six to ten weeks following surgery in all patients treated surgically. Hessmann and coworkers\(^{17}\) proposed a protocol for the treatment of lateral clavicle fractures based upon fracture stability. The authors accept the view that stable fractures should be treated nonoperatively, while unstable fractures (i.e., Type II injuries) should be treated surgically to prevent delayed or nonunion. In their series of 39 unstable fractures of the distal clavicle, 35 were treated surgically by PDS-banding or plate fixation and four were treated nonoperatively. Fracture healing was achieved in all surgically treated cases and in all but one of the fractures treated nonoperatively. The UCLA rating system was used to evaluate those patients who could be re-examined. In the surgical group, the results were excellent in fourteen and good in ten cases, with a poor result in one case. In the nonoperative group the results were fair in two cases and poor in one case.

Recently, there have been several reports that support at least an initial nonoperative approach to displaced distal clavicle fractures.\(^{20,22,26}\) Kona and colleagues\(^{26}\) retrospectively reviewed the results of 19 cases treated surgically by a variety of methods. Nine patients had an unsatisfactory result with a high incidence of complications including symptomatic nonunion and infection. These investigators recommended nonoperative treatment for these fractures except in cases where the skin was at risk. Nordquist and associates\(^{21}\) identified 23 Type II distal clavicle fractures treated nonoperatively. At follow-up, 17 patients were asymptomatic including three of the five nonunions. Yoshida and coworkers\(^{22}\) reviewed the results of 73 fresh distal clavicle fractures. Thirty-nine of these were Type II fractures of which 13 were treated surgically. At follow-up, only two patients were symptomatic, one of whom having sustained a Type III injury. Eight patients had developed a nonunion, six of whom sustained Type II fractures (five of the six were treated nonoperatively). In this report the investigators suggest that with Type II distal clavicle fractures there are varying degrees of ligamentous injury. Even when nonunion does occur, functional healing of the coracoclavicular ligaments can render these patients asymptomatic.

Our retrospective review of 30 patients with Type II distal clavicle fractures treated by both nonoperative and operative means compares well with the studies cited above. We present a comparatively large series of patients treated with standardized nonoperative and operative treatment protocols. This study differs from others in that the surgical group of patients was treated with open reduction and coracoclavicular stabilization using...
suture material. Similar rates of satisfactory results were achieved in both groups. Although a high incidence of nonunion (44%) was demonstrated in the group treated without surgery, the rate of symptomatic nonunion was considerably lower than expected from previous reports. This can perhaps be explained by the stability achieved through “functional healing” of the coracoclavicular ligaments, as suggested by Yoshida and colleagues,22 or by injuries in which the trapezoid ligament remains intact and thus are inherently more stable. Due to the retrospective nature of this study, we were unable to determine which injuries involved one or both of the coracoclavicular ligaments. Although not needed in this series, if a symptomatic nonunion does develop, several investigators have suggested that an acceptable outcome can be achieved by open reduction and bone grafting or by distal clavicle excision and coracoclavicular stabilization.20,26,27

If primary operative treatment for these fractures is chosen, open reduction and approximation of the fracture fragments by coracoclavicular stabilization with nonabsorbable sutures yields good results with a low complication rate. We agree with previous reports that the routine use of metallic hardware for these fractures should be avoided when possible due to the relatively high rate of complications associated with its use.

A number of limitations exist in a study of this type. As with other reports of this relatively uncommon injury, this is a retrospective review and as such it suffers from selection bias. Although there was no strict criteria for determining which form of treatment each patient should undergo, several factors including age, activity level, and degree of fracture displacement were carefully considered. In general, there was a trend to surgically treat younger, more active individuals with complete displacement of the fracture fragments. Fracture displacement and healing potential were assessed from both a clinical and radiographic standpoint. Those fractures with significant displacement in which the medial fragment was felt to have button-holed through fascia tended to be treated surgically. Nonoperative treatment was more often reserved for younger, less active patients whose clinical exam and radiographs suggested a more stable fracture pattern.

It would seem that a prospective, randomized study is needed to establish criteria for operative treatment of these fractures. With regard to isokinetic strength testing, it is difficult to differentiate true weakness from pain-related weakness. This is important, as pain has been shown to adversely affect shoulder strength. Another limitation relates to the issue of effort-dependency, as the effort put forth by the subject being tested would have a direct impact on the results of strength testing. Finally, the length of follow-up is a concern as it is certainly conceivable for patients who sustain these injuries to develop late onset symptoms of pain or dysfunction with overhead activity or manual labor. We did not specifically examine whether patients with nonunions were able to perform the same sporting activities as they did prior to injury. This is obviously a concern, especially in young, active individuals who sustain this injury. For this subpopulation careful consideration should be given to operative intervention as would be the case for complete acromioclavicular joint injuries.

**Conclusion**

A satisfactory outcome can be achieved after operative and nonoperative treatment of Type II distal clavicle fractures. Operative and nonoperative treatment yield similar results with regards to pain, function, and strength. Open reduction with coracoclavicular stabilization yields a satisfactory outcome with a low complication rate. A successful clinical outcome can be achieved with nonoperative treatment even if a nonunion occurs. If nonoperative treatment is elected, however, patients need to understand and accept the possibility of prolonged sling-wear to achieve union, as well as the high probability of nonunion that may be associated with a cosmetic deformity. Furthermore, delayed surgery may be required for those fractures that do not heal, thus prolonging the duration of overall morbidity. Operative intervention should be considered for those cases in which the fracture fragments are significantly displaced or button-holed through the fascia and in young, active individuals involved in overhead sports or manual labor.

**References**

11. Neer II CS: Fractures of the distal clavicle with disrup-