Management of Scapular Fractures

Abstract

With the exception of displaced articular glenoid fractures, management of scapular fractures has largely consisted of benign neglect, with an emphasis on motion as allowed by the patient’s pain. Better understanding of this injury has resulted in greater acceptance of surgical management of highly displaced variants. However, little agreement exists on indications for surgery, and there is no clear comparative evidence on outcomes for surgically versus nonsurgically managed fractures. Scapular fractures are the result of high-energy mechanisms of injury, and they often occur in conjunction with other traumatic injuries. In addition to performing meticulous physical and neurologic examination, the surgeon should obtain plain radiographs, including AP shoulder, axillary, and scapular Y views. Three-dimensional CT is used to determine accurate measurements in surgical candidates. Surgical approach, technique, and timing are individualized based on fracture type and other patient-related factors.

With regard to documenting and surgically managing scapula fractures, the French have historically dominated the field, with important contributions by Paré, Petit, Desault, Du Verney, Lenormant, Dujarier, Malgaigne, Basset, Dupont, Judet, and Evrard, among others. The first depiction of a scapula fracture was published in 1579 by Ambroise Paré in a description of a battle injury: “When the fracture involves the neck of the scapula, the prognosis is almost always fatal.” Perhaps the fatality resulted from what we now know to be commonly associated injuries such as pneumothorax or head and neck injury.

The first classification of scapula fractures was developed by Jean-Louis Petit, who divided scapula fractures into body, neck, and process. He further subdivided fracture of the scapular body into longitudinal, transverse, and oblique.

In 1913, Albin Lambotte of Belgium was the first to describe internal fixation of the scapula. He included preoperative and postoperative radiographs as documentation. However, it was Grune and Plagemann who, in 1911, presented the first radiographic series detailing fracture characteristics in 13 and 19 cases, respectively. Several documented cases of surgical management of scapula fractures existed by the early 1900s. In 1916, Hitzrot and Bolling published a history of treatment in the latter half of the 1800s and reported on eight cases of their own, which was the largest surgical series to date. The first documented scapula fracture operation in the United States was performed by Longabaugh in 1924. In 1938 and 1939, respectively, Reggio and Fischer were the first and second per-

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Decoulx et al14 (26 patients) and documented larger surgical series by thought leaders such as Rowe12 and Schnepp et al,13 despite critically documented larger surgical series by Decoulx et al14 (26 patients) and Tondeur15 (38 patients), as well as Judet,16 who described the well-known extensile posterior approach for internal fixation of scapula neck fractures.

The management of scapular fractures has changed based on greater understanding of the injury, peri-, scapular anatomy, surgical approaches, and fracture fixation strategies.17-23 Additionally, there is new recognition of dysfunction associated with scapula malunion, and diagnostic strategies have been developed to better understand fracture morphology and deformity.21,22,26-29

Although there is increased recognition that certain scapular fractures warrant fixation, controversy exists regarding surgical indications. This controversy stems from the recognition that most extra-articular scapular fractures heal with nonsurgical management, with little measurable dysfunction, in part because most are moderately displaced, at most, and because the shoulder has a great capacity for compensatory motion. Additionally, there are no clear evidence-based guidelines for surgical indications, and the decision when to operate must be based on expert opinion. Only recently have accepted definitions of displacement with validated criteria for measuring deformity become available in the literature.29

**Patient Evaluation**

Scapular fracture is a rare injury. However, these high-energy injuries are being seen more often likely because of improved emergency response and trauma resuscitation. Two recent reports on the subject found the mean age of patients with scapular fractures to be 42 years20 and 35 years.31

Scapular fracture occurs in the setting of high-energy trauma, and patients must be carefully examined for other injuries. In most cases, the vector of energy is directed from lateral to medial, often from a position cephalad to the plane of the shoulder.20 This mechanism of injury is associated with high rates of injury, including concomitant injury in approximately 90% of patients,30,31 ipsilateral extremity injury in 50%,31 thoracic injury in 80%,17 and associated head injuries and spinal fractures in 48% and 26%, respectively.31 A retrospective review of the National Trauma Database found scapula fractures to be an important marker for ipsilateral upper extremity injuries, pelvic ring injuries, and thoracic injuries even after adjusting for injury severity.32 It has been speculated that although there is a high injury association rate between thoracic injury and scapula fracture, the energy of trauma is absorbed through the thorax, where often multiple rib fractures occur, which may explain why associated mortality is approximately 10% lower in multiply injured patients with scapular fracture than in patients with similar injury severity but without scapular fractures.17

The rate of thoracic injury and the severity of injury may also underscore the reason for missed or delayed diagnosis of scapula fractures, which was noted to be 12.5% in one study.13 Because life-threatening injuries are typically prioritized over upper extremity fractures and because the scapula is enveloped in an abundant soft-tissue envelope, scapular fractures are often detected late, typically after the patient has been extubated and can respond to a tertiary injury survey. The examiner should specifically look for scapular fractures in the setting of hemopneumothorax and multiple rib fractures (Figure 1).

Identifying the mechanism of injury is helpful in determining other possible injuries. The examiner also should document pain in the patient’s neck or back as well as numbness and tingling in the upper extremity. Cervical spine injuries and brachial plexus lesions occur in 7% of patients with scapular fracture, and these injuries can greatly influence overall outcome.34 The physical
examination should include a detailed neurologic examination of the ipsilateral upper extremity, and symmetry of pulses should be assessed. The patient should be disrobed for skin inspection because severe abrasions are common, most frequently over the acromion (Figure 2). The presence of severe abrasions influences the timing of surgery. To mitigate the risk of infection, shoulders with abrasions or scabs should be cleansed daily until they have completely reepithelialized. This process may take a few weeks. Herrera et al.35 reported excellent outcomes in badly displaced scapula fractures even when surgery was not performed until ≥3 weeks after injury.

A standard chest radiograph should be obtained to evaluate for pneumothorax, and a trauma lateral cervical spine radiograph should be obtained to assess the patient for associated spinal fractures. Additionally, the radiographic workup should include AP shoulder, axillary, and scapula Y views. If marked displacement has occurred, such that there is a possibility of meeting surgical indications, a three-dimensional (3D) CT scan should be obtained.27 The 3D CT can be rotated to the optimal AP plane and to the lateral plane (ie, scapula Y) for more accurate measurement of displacement and angular deformity (Figure 3).

Prior to the use of 3D CT, it was difficult to comprehend the common variations of scapula fracture patterns and specific fragment deformity. Armitage et al.27 evaluated 90 3D CT scans of fractured scapulae with neck and/or body involvement and reported that, in more than two thirds of patients, the fracture line entered or exited just inferior to the glenoid and through the vertebral border just caudad to the base of the acromial spine. Seventeen percent of fractures had articular involvement, and 22% entered the spinoglenoid notch. The articular fractures in this study did not follow predictable patterns. Instead, they demonstrated the highest variability in trajectory, with a wide distribution of exit points along the vertebral border.

### Management

Many authors have suggested surgical criteria for scapula fractures based on personal experience and case series outcomes.36-39 Commonly used terms to describe the radiographic characteristics of scapula fractures include displacement, medialization, angulation, and shortening (Figure 4). Only recently have explicitly defined and validated measures of these fracture characteristics been published.28 Historically, these measures were seldom clearly reported.

Historical recommendations, such as those of Hardegger et al.,36 Ada and Miller,37 Nordqvist and Persson,38 and Romero et al.,39 inform the surgical indications cited in the recent literature. These authors based their surgical recommendations on findings that indicated a significant
relationship between persistent shoulder disability and residual radiographic deformity (ie, significant displacement and glenoid neck malalignment). Patients with the most severe injuries were most likely to have outcomes such as residual pain and functional complaints following nonsurgical treatment.37

Contemporary series with defined surgical indications are listed in Table 1.22,34,35,37,40-51 Four studies report the use of radiologic criteria to measure displacement and angulation to guide surgical management of isolated extra-articular fractures as well as combined injury of the superior shoulder suspensory complex (SSSC).22,35,37,40 In contrast, most studies report surgical indications only as “unstable” or “displaced.” Goss52 coined the term “superior shoulder suspensory complex” to describe the osseoligamentous ring made up of the glenoid, coracoid, clavicle, and acromion process, as well as the connecting soft tissues between these structures, the coraco-clavicular ligament, and the acromioclavicular joint capsule. According to Goss,52 the interruption of two structures in this ring constitutes a “double disruption,” resulting in an interruption in the suspension between the axial and appendicular skeleton.

The most explicit recent surgical indications include medial displacement of the lateral border >25 mm, shortening >25 mm, angular deformity >45°, concomitant intra-articular step-off >3 mm, or displaced double disruption of the SSSC.22 Indications for surgery are based on type of scapula fracture (ie, intra-articular, extra-articular, double lesions of the SSSC process). Although 3D CT has recently been advocated to identify displacement, angulation, and fracture pattern, techniques for capturing these data points have only recently been defined.21,22,29,35

With the exception of unstable and displaced glenoid fossa fractures, all surgical indications should be considered relative given the lack of definitive proof regarding the benefits of surgery. Management must be individualized for each patient (Figures 5 and 6).

Nonsurgical
The minimally or moderately displaced scapular fracture that does not meet surgical criteria should be managed with a sling for 2 to 3 weeks until the fracture begins to consolidate and the pain subsides. Patients often experience pseudoparalysis during healing and report that
their injured shoulders do not work or that they have no control over them.

Progressive deformity of the scapular fracture during the early postinjury phase is a concern, and serial radiographs should be obtained on a weekly basis for up to 3 weeks. Such deformity likely is the result of the combination of fracture instability and gravitational stress when patients are upright and mobile. Some patients may require surgery to repair displacement and/or angular deformity. It seems likely that fractures more at risk for progressive displacement in the early postinjury phase are those with instability, such as scapular fractures associated with multiple consecutive rib fractures, which thus do not have the underlying support of the thorax, or scapular fractures associated with double lesions of the SSSC.

In the absence of fracture displacement, subsiding pain corresponds with clinical healing. Once pain has subsided, progressive, full, passive range of motion is allowed. A physical therapist should demonstrate techniques with pulleys, partners, and/or opposite handheld guide sticks. At 1 month after injury, full active range of motion can be initiated for the next 4 weeks (through postinjury week 8). This is followed by a progressive strengthening program, starting with 3-lb weights and resistive bands, with the goal of no restrictions at 3 months after injury. Endurance training is begun, emphasizing rotator cuff strength to avoid long-term weakness in external rotation, forward elevation, abduction, and internal rotation.

### Surgical

**Isolated Process Fracture**

Little has been published on fractures of the scapula processes (ie, acromion, coracoid). Prior to relatively recent surgical series by Ogawa and Naniwa (acromion), Ogawa et al (coracoid), and Anavian et al (acromion and coracoid), only small case reports could be found. In his own practice, the senior author (P.A.C.) has established the following surgical indications for scapular process fractures: painful nonunion, concomitant ipsilateral operative scapula fracture requiring long-term weakness in external rotation, forward elevation, abduction, and internal rotation.

<table>
<thead>
<tr>
<th>Fracture Type</th>
<th>Study</th>
<th>No. of Patients</th>
<th>Explicit Surgical Indications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extra-articular</td>
<td>Ada and Miller, et al</td>
<td>8</td>
<td>Medial displacement &gt;1 cm or angular deformity &gt;40°</td>
</tr>
<tr>
<td></td>
<td>Khallaf et al, et al</td>
<td>14</td>
<td>Medial displacement &gt;1 cm, angular deformity &gt;40°</td>
</tr>
<tr>
<td></td>
<td>Herrera et al, et al</td>
<td>22</td>
<td>Medial displacement &gt;15 mm, angular deformity &gt;25°, articular step-off &gt;4 mm, or double lesion of the SSSC</td>
</tr>
<tr>
<td></td>
<td>Jones et al, et al</td>
<td>37</td>
<td>Medial displacement &gt;25 mm, shortening &gt;25 mm, angular deformity &gt;45°, articular step-off &gt;3 mm, or double lesion of the SSSC</td>
</tr>
<tr>
<td>Double lesions of the SSSC</td>
<td>Leung and Lam, et al</td>
<td>15</td>
<td>Unstable shoulder girdle</td>
</tr>
<tr>
<td></td>
<td>Rikli et al, et al</td>
<td>12</td>
<td>Unstable shoulder girdle</td>
</tr>
<tr>
<td></td>
<td>Egol et al, et al</td>
<td>7</td>
<td>Displaced double lesion of the SSSC</td>
</tr>
<tr>
<td></td>
<td>van Noort et al, et al</td>
<td>4</td>
<td>Significant clavicular displacement and a displaced scapular neck</td>
</tr>
<tr>
<td></td>
<td>Oh et al, et al</td>
<td>10</td>
<td>Unstable shoulder girdle</td>
</tr>
<tr>
<td></td>
<td>Hashiguchi and Ito, et al</td>
<td>5</td>
<td>Unstable shoulder girdle</td>
</tr>
<tr>
<td></td>
<td>Labler et al, et al</td>
<td>17</td>
<td>Displaced neck fracture &gt;25 mm and/or reduction of glenopolar angle &lt;30°</td>
</tr>
<tr>
<td>Intra-articular</td>
<td>Kavanagh et al, et al</td>
<td>10</td>
<td>Displacement &gt;2 mm</td>
</tr>
<tr>
<td></td>
<td>Leung et al, et al</td>
<td>14</td>
<td>Displaced fracture of the glenoid</td>
</tr>
<tr>
<td></td>
<td>Mayo et al, et al</td>
<td>27</td>
<td>Displacement &gt;5 mm or displacement associated with subluxation</td>
</tr>
<tr>
<td></td>
<td>Adam, et al, et al</td>
<td>10</td>
<td>Displaced fracture of the glenoid</td>
</tr>
<tr>
<td></td>
<td>Schandelmaier et al, et al</td>
<td>22</td>
<td>Displaced fracture of the glenoid</td>
</tr>
</tbody>
</table>

SSSC = superior shoulder suspensory complex
surgery, displacement ≥1 cm as seen radiographically, or two or more disruptions of the SSSC.56

Anavian et al56 reported on 13 acromion fractures and 14 coracoid fractures managed with open reduction and internal fixation (ORIF) using 2.7- or 3.5-mm compression screws with and without bone plates. Fracture locations were analyzed on 3D CT scans, and the authors recommended the use of 3D CT to assess fracture characteristics and establish whether surgical criteria have been met. At a mean follow-up of 11 months (range, 2 to 42 months), all fractures had united, and all patients recovered full motion with no pain. Three patients underwent hardware removal because of prominence and irritation.

Two separate retrospective studies reported on 35 coracoid fractures managed with bone screws55 and 8 acromion fractures managed with Kirschner wires or tension band wiring.54 All fractures united. In a systematic review of surgically managed scapula fractures, Lantry et al57 described as apophyseal 20 fractures (8.2%), including acromial, coracoid and/or scapular spine fractures, of the 243 cases studied. These apophyseal fractures were surgically managed in 13 cases, with screws alone in 5 (38.5%), plates and screws in 4 (30.8%), tension band wiring in 2 (15.4%), and Kirschner wires in 2 (15.4%).

Painful nonunion of the acromion and the coracoid has been reported. Impingement syndrome (in acromion fracture) and neurologic compression (in coracoid fracture) have been reported, as well. However, we recommend surgery for displaced fractures (Figure 7).

**Intra-articular Glenoid Fracture**

Management of intra-articular glenoid fractures (Figure 8) is less controversial than that of extra-articular fractures. However, few authors have reported explicit, measurable...
surgical indications (Table 1). Kavanagh et al\(^48\) reported the outcomes following surgical management of intra-articular fractures displaced >2 mm. Later, Mayo et al\(^34\) reported follow-up on 27 patients from a series of 31 surgically treated patients in which displacement of the articular fragments was defined as being >5 mm. Currently, there are no agreed-on surgical indications for intra-articular glenoid fractures.

Reports regarding long-term outcomes following surgical and non-surgical management are limited, and they typically consist of level IV evidence and use subjective surgeon outcome assessment. Kavanagh et al\(^48\) reported on nine patients treated surgically for intra-articular fractures with displacement >2 mm. All patients were pain free, and seven regained normal strength. Mayo et al\(^34\) reported good to excellent outcomes in 22 of 27 patients at an average follow-up of 43 months (range, 25 to 75 months). These outcomes were assessed using a subjective surgeon rating system that took into account pain, strength, and motion. Complications included hardware removal in three patients, marked infraspinatus weakness in two, and wound dehiscence in one. In both studies, poor outcomes were attributable to associated brachial plexus injuries.\(^34,48\)

In the past decade, only two published series have reported on outcomes in patients with intra-articular glenoid injuries.\(^30,51\) Surgical management led to good outcomes in these
Schandelmaier et al.\textsuperscript{51} reported a mean shoulder Constant score of 79\% (reported as a percentage of the contralateral uninjured shoulder) at a mean follow-up of 10 years.

Double Lesions of the Superior Shoulder Suspensory Complex

Double lesions of the SSSC are referred to as “floating shoulder” injuries when the double disruption involves a fractured scapular neck and concomitant ipsilateral clavicular fracture. Ipsilateral acromioclavicular dislocation and coracoid fracture is a less common double disruption of the SSSC. Although several case studies have been published on surgical and nonsurgical management of these injuries, no study provides measurable surgical indications beyond the simple presence of the double lesion. This is often referred to as an unstable shoulder girdle (Table 1).

The largest series to report functional outcomes following surgical management of double lesions of the SSSC was published in 1993 by Leung and Lam.\textsuperscript{41} They performed ORIF on 15 patients with scapular and clavicular fractures. At a mean follow-up of 25 months (range, 14 to 47 months), 14 patients had good to excellent results according to the scoring system of Rowe.

Since the publication of that initial series, disagreement has arisen regarding whether to fix both fractures or only the clavicle fracture, or whether nonsurgical management is most appropriate for satisfactory outcomes. In several studies, only the clavicle was repaired.\textsuperscript{42,44,46,58} Notably, three studies reported scapular malunion and drooping in some patients, as well as conversion to surgical treatment in patients with unsatisfactory nonsurgical outcomes.\textsuperscript{44,46,58}

Other series combined results of ORIF of the clavicle only with ORIF of both clavicular and scapular frac-

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**Figure 7**

A, Preoperative posterior three-dimensional CT scan of an isolated displaced fracture at the base of the acromion. The displacement is better appreciated on the superior view of the scapula (inset). B, AP scapula radiograph obtained 5 weeks after open reduction and internal fixation demonstrating anatomic alignment that was achieved with a 2.7-mm reconstruction plate and a small-fragment T-plate.

**Figure 8**

A, Preoperative scapular Y three-dimensional CT reconstructions of an intra-articular glenoid fracture involving the base of the coracoid and extending into the scapular body (top inset). Bottom inset, Two-dimensional axial CT scan demonstrating 9 mm of articular step-off. B, Postoperative AP radiograph of a different patient treated surgically to manage intra-articular glenoid fracture. A combined anterior/posterior approach was required to address the many fractures. Open reduction and intramedullary fixation with intramedullary implants was performed on ribs six through eight to address the considerable displacement of the thorax.
tures, thereby making it difficult to assess differential outcomes with or without a concomitant clavicle fracture.43,45,47

Currently, no evidence exists to suggest that fixation of the clavicle fracture alone reduces the scapula and glenohumeral joint. Fixation of both the clavicular and scapular fractures does restore stability, thereby allowing for potentially faster rehabilitation and a reduction in the number and magnitude of symptoms related to malunion. However, fixation of either or both bones is indicated only when both are significantly displaced. There appears to be no role for surgical fixation of minimally or nondisplaced fractures of double lesions.

Isolated Extra-articular Fractures of the Scapular Neck or Body

Management of isolated fractures of the scapular neck and body remains controversial. In most cases, union is achieved with nonsurgical management; the shoulder has tremendous capability for compensatory motion. However, whether this compensation leads to increased dysfunction or symptoms is not well understood.

Few studies stratify outcomes by degree of displacement or deformity. However, Bozkurt et al18 demonstrated a strong positive correlation between a decreased glenopolar angle (GPA) (Figure 4) and Constant scores in 18 extra-articular scapula fractures that were managed nonsurgically ($P < 0.05$). Romero et al19 demonstrated significantly poorer outcomes in patients who healed with a GPA <20° ($P < 0.05$). In a small study, Kim et al10 demonstrated statistically significant improvements in Constant score in patients with a GPA >30° compared with patients with a GPA <30° ($P < 0.05$). Not all scapular malunions are asymptomatic. Not all patients treated nonsurgically do well, regardless whether there are associated brachial plexus lesions (Figure 9).

In the most rigorous study to date assessing function in surgically managed extra-articular fractures, Herrera et al15 recorded a mean Disabilities of the Arm, Shoulder and Hand score of 14 at 26-month follow-up, as well as symmetric motion and near-complete recovery of strength. Other surgical series report good outcomes based on less rigorous outcome assessments.37,40 Additionally, Jones et al22 reported mean forward flexion of 158° in 37 patients following ORIF to manage medialization >25 mm or angular deformity of the scapula measuring 45°.

Surgical Approaches and Postoperative Rehabilitation

It is important to choose the correct operation for the specific fracture pattern (Figure 10). For example, an anterior deltopectoral approach should be used to address glenoid fossa fractures involving the anterior and inferior glenoid. In general, it is best to manage such injuries with minimfragment fixation with 2.0-mm screws and a plate used in a buttress mode.61

Wiedemann62 described a lateral approach through the midaxial region of the upper thorax just caudal to the axilla for inferior glenoid fractures. This approach eases the process of hardware fixation along the scapular neck. Another common fracture pattern is the superior glenoid fracture, which extends into the coracoid process and causes displacement of it. In this scenario, the deltopectoral approach should be extended proximally to the clavicle to allow access to the coracoid and coracoclavicular ligaments. Typically, coracoid fractures can be fixed with 2.7- or 3.5-mm screws; a one-quarter tubular plate may be needed, as well, depending where the fracture extends in relation to the base.56

Fractures involving the neck and body of the scapula make up approximately 80% to 90% of surgical injury patterns.63,64 They are addressed through a posterior approach. A straight posterior approach overlying the glenohumeral...
joint is warranted for fracture displacement that is isolated to the posterior glenoid, scapula neck, and/or lateral border. However, a Judet incision should be used if the surgeon wishes to access multiple scapula borders, such as the acromial and vertebral spines, in addition to the lateral border. The Judet incision courses along the spine of the scapula, beginning at the acromion and angling down along the vertebral border as far distal as necessary to address the fracture pattern. With the Judet incision, either the infraspinatus muscle can be elevated along with the teres minor off the infraspinatus fossa, or intermuscular intervals can be developed to specific access sites along the scapular perimeter where fixation and reduction can be obtained. Several posterior approaches have been described for accessing the posterior glenoid and the posterior scapular neck and body. In general, the trend is toward use of smaller plates (eg, 2.7-mm rather than 3.5-mm) for fixation of the scapular neck and body through a posterior approach. Locking plates are advantageous given the thin bone available for fixation, especially along the vertebral border. Locked plates are particularly helpful in circumstances in which there is little per-screw purchase in bone, especially along the thin vertebral border.

Postoperative care should proceed...
as described for nonsurgical management, with one exception. If the surgeon feels that adequate stability has been achieved, immediate and full passive and active-assisted range of motion should be emphasized. In the clinical experience of the senior author (P.A.C.), this rehabilitation protocol allows for immediate range of motion. Strengthening and resistance with 3- to 5-lb weights is begun 5 weeks postoperatively, followed by strength and endurance training beginning in week 9. At week 13, all restrictions are lifted, and the patient may return to normal activities.

Summary

Indications for surgical management of scapular fractures continue to change with greater understanding of symptomatic malunions, improved technology, and higher numbers of patients who survive high-energy trauma with highly displaced scapular fractures. Surgical indications for scapular fracture typically are based on angular deformity and displacement. In some cases, surgical indications are based on associated lesions in the upper extremity. These indications should be considered to be relative until comparative functional outcome data emerge to clarify surgical criteria. Indications for surgery often include such parameters as medialization (≤2.5 mm), 25° to 45° angulation on a lateral radiograph, GPA <20°, and displaced double lesions of the SSSC. Three-dimensional CT has advanced our understanding of fracture morphology and allows accurate measurement of such displacement and angulation.

No rigorous studies have compared surgical and nonsurgical cohorts, and controversy persists regarding which patients are best managed surgically. Suspected and confirmed scapular fractures warrant meticulous evaluation and management. Orthopaedic surgeons should proceed to surgery only after careful practice and preparation.

References

Evidence-based Medicine: Levels of evidence are described in the table of contents. In this article, references 17, 30, 32, and 57 are level III studies. References 18, 19, 21-24, 27-29, 31, 33-51, 53-56, 58-60, 63, and 64 are level IV studies. References 20, 25, 52, 61, 62, and 65 are level V expert opinion.

References printed in **bold type** are those published within the past 5 years.


