CHAPTER 20
FRACTURES OF THE SCAPULA

CHARLES D. NEWTON

- History
- Surgical Anatomy
- Surgical Approaches
- Fracture of the Scapular Spine
- Scapular Body Fracture
- Acromial Fracture
- Fractures of the Scapular Neck
- Supraglenoid Tubercle Fracture
- Glenoid Fracture
- Scapular Luxation

HISTORY
Prior to the discovery of antibiotics, asepsis, and open fracture reduction, most references to treatment of scapular fractures indicated the rarity of such fractures and the use of coaptation to provide comfort for the animal. With the advent of radiography and more comprehensive orthopaedic training, surgeons became aware of the need to anatomically reduce fractures of the glenoid in order to avoid the occurrence of severe disability or degenerative joint disease. As more sophisticated forms of internal fixation became available, their application to the scapula as well as to other major long bones was successful. Today fractured scapulae are still treated by coaptation when appropriate and by rigid internal fixation when necessary.

SURGICAL ANATOMY
The canine scapula is a large, flat bone composed of a body with a longitudinally running, flat spine; a neck; and the glenoid, or articular surface. The flatness of the body and spine and lack of medullary cavity make fixation with standard intramedullary rods and pins impossible. Because of its prominence at the ends of the scapular spine, the acromion can fracture or avulse. The acromion process does not lie below the level of the shoulder joint in a normal animal. The neck is more oval in the cross section and has sufficient medullary bone to accept pins or screws. The glenoid surface is a shallow bony concavity that articulates with the humeral head. The cranial margin of the glenoid forms the supraglenoid tubercle (scapular tuberosity), the origin for the biceps brachii muscle. In the dog, the coracoid process is insignificant (Figs. 20-1 and 20-2)(6).

The feline scapula is similar to the canine in overall anatomical appearance; however, it is a shorter bone. Dorsoventrally, a metacromion process extends caudally from the spine and acromion process, and this coracoid process of the supraglenoid tubercle is a significant
bony process extending from the medial side of the supraglenoid tubercle. It is significantly large to be at risk of fracture (Fig. 20-3).

The scapula is formed by multiple separate centers of ossification in immature animals. Of great importance is the supraglenoid tubercle because its growth plate may be mistaken for a fracture line.

FIG. 20-1 Radiographic appearance of a normal canine scapula: medial-lateral view (A) and cranial-caudal view (B).

SURGICAL APPROACHES
APPROACH TO SCAPULAR BLADE AND SPINE
Complete surgical exposure can be accomplished by incising along the scapular spine. Sharp dissection of the dense fascia along the cranial and caudal edges of the spine will allow the trapezius muscle, supraspinatus muscle, and the infraspinatus muscles to be retracted, exposing the body and spine. Sharp elevation with a periosteal elevator can bring the entire body and spine into view. Closure following surgery requires suturing of the heavy fascia over the scapular spine.

FIG. 20-2 Normal anatomy of the canine scapula: German shepherd scapula lateral view (A) and ventral view (B); dachshund scapula lateral view (C) and ventral view (D). Figures illustrate comparative anatomy and are not drawn to the same scale.

APPROACH TO THE SCAPULAR NECK
The most effective method of exposure is acromial osteotomy. Care should be taken to cut a fragment large enough to facilitate reattachment during closure. Further exposure will be gained by muscular retraction of the supraspinatus muscle and retraction of the infraspinatus muscle or transection of its tendon and retraction. A portion of the teres minor muscle may also require retraction.

The surgeon must be aware of and protect the suprascapular nerve, artery, and vein, which course from cranial to caudal over the scapular neck.

FIG. 20-3 Normal anatomy of a feline scapula: lateral view (A) and ventral view (B).
APPROACH TO THE SCAPULAR TUBEROSITY
Surgical exposure is difficult because the process lies below the supraspinatus muscle. A direct lateral approach necessitates osteotomy of the humeral greater tubercle to allow for proximal retraction similar to that of the supraspinatus muscle.

A cranial approach requiring transection of the insertion of the superficial and deep pectoral muscles is also effective. This allows for direct visualization of the supraglenoid tubercle and the biceps brachii muscle. Closure requires reattachment of the muscular insertions.

APPROACH TO THE GLENOID CAVITY
Surgical exposure of intra-articular fractures requires muscular exposure in addition to arthrotomy. Most glenoid fractures are adequately exposed via acromion osteotomy and infraspinatus tenotomy as described above, followed by arthrotomy. Greater exposure cranially may require osteotomy of the humeral greater tubercle to allow adequate retraction of the supraspinatus muscle. Greater exposure of the caudal glenoid may require partial transection and retraction of the teres minor muscle. Exposure of the medial glenoid rim is extremely difficult but may be accomplished. It requires a cranial approach to the shoulder via transection of the pectoral muscle insertions. Extreme external rotation is needed to bring the medial scapula into view. Further transection of the insertion of the subscapularis muscle from the humeral lesser tubercle and arthrotomy will facilitate medial glenoid exposure. Closure requires reinsertion of all transected muscle insertions.

SCAPULAR BODY FRACTURE
SIGNS AT PRESENTATION
Most animals show marked forelimb lameness. Usually the limb or shoulder will hang lower than normal, the forelimb will be carried with the carpus flexed, or the carpus may be dragged on the ground.

Palpation may or may not demonstrate crepitus, although generally the animal will display pain on palpation. Palpation should demonstrate asymmetry when compared with the opposite normal scapula. With complete fracture of the scapular body, the normal dorsal scapular prominence will be less apparent, since the fracture will deform or lay against the chest wall. Incomplete fractures may displace toward the chest wall or in a different direction. Palpation of the scapular spine will then give more definitive signs as to the location and direction of the fracture.

RADIOGRAPHY
Radiography will assist in confirmation of the presence and extent of fracture. Two views are necessary to evaluate the degree of displacement.

ASSOCIATED SOFT TISSUE INJURIES
Usually there are no soft tissue injuries of significance associated with scapular body fractures; however, injuries to the brachial plexus can occur and should be checked. Since most scapular body fractures occur from direct lateral trauma, intrathoracic injury may also occur.

CLOSED REDUCTION AND FIXATION
Closed reduction and fixation is frequently the method of choice. The scapular fragments will displace to conform to the body wall and remain relatively stable in this position. Reduction via limb traction improves alignment but is rarely necessary. Fixation is accomplished by placing the limb into a Velpeau sling, which prevents further fragment displacement by relieving the limb of weight bearing. Usually 3 to 4 weeks of external immobilization is sufficient. Although union may be incomplete, it will be sufficient to prevent pain or further displacement. The shoulder must be returned to normal function within 3 to 4 weeks or serious contracture of the triceps or loss of range of motion may occur.

Prognosis for complete return to normal function is very good. Cosmetic deformity may be apparent in short-haired animals, but function should be normal. Owners who are unsatisfied with the likelihood of cosmetic deformity should be advised to consider an open method of reduction and fixation.

**OPEN REDUCTION AND FIXATION**

Surgical exposure and reduction can be uncomplicated in two- or three-part fractures; however, it is impossible in cases of severe comminution. In severe cases, repair by previously mentioned closed reduction and fixation produces a more satisfactory result. Two- or three-part fractures are aligned and reduced using gentle traction on the bone fragments, which are held with bone forceps.

Internal fixation must be adapted to best suit the complexity of the fracture encountered. Since no medullary cavity exists, intramedullary fixation is impossible. Simple wire sutures to maintain reduction are adequate; however, they will rarely prevent medial displacement of the fragments against the chest wall. Therefore, wire sutures are sufficient to maintain reduction but will rarely result in cosmetic realignment. Similarly, screws placed in bony fragments may be laced together but will result in the same cosmetic defect.

Bone plates of stainless steel or plastic have been used very successfully when rigid fixation and perfect cosmesis are desired. The implants may be placed over the scapular body or attached to the scapular spine. Either or both methods may be necessary depending on the extent of the fracture. Because the bones of both the scapular body and spine are very thin, screws do not have a great holding ability compared with placement in normal cortical bone. Therefore, it may be wise to supplement internal fixation with a Velpeau sling for the first 2 to 4 weeks postoperatively or to place nuts over the ends of the screws when plating the scapular spine. Obviously nuts cannot be placed on the medial surface of the scapula if plates are placed on the body.

If a Velpeau sling is unnecessary, postoperative management should include cage confinement or close owner supervision and leash walking for at least 4 weeks. The prognosis for return to normal function is excellent. An excellent cosmetic result can be achieved with plate and screw fixation.

Complications associated with open or closed reduction and fixation of scapular body fractures are rare.

Pathologic fracture associated with neoplasms of the scapular body is possible. Fibrosarcoma and hemangiosarcoma are often responsible for bony destruction; however,
the tumors are generally found prior to actual fracture.

FRACTURE OF THE SCAPULAR SPINE
SIGNS AT PRESENTATION
Most animals will display points of tenderness over the fracture site and only mild lameness unless there is a scapular body fracture also. Very often the scapular spine fracture will be independent of a scapular body fracture and require immobilization and fixation.

Palpation usually allows the examiner to move the spine freely if the fracture is complete or from a fixed point if the fracture is incomplete. Radiography will provide visualization of the extent of the fracture. (12)

ASSOCIATED SOFT TISSUE INJURIES
Very few problems are associated with this fracture. Occasionally if the spine fractures cleanly from the body at the scapular neck, the suprascapular nerve, artery, or vein may become trapped between bony fragments. This is a rare finding.

CLOSED REDUCTION AND FIXATION
Generally this fracture requires a Velpeau sling to minimize discomfort. However, most animals require no treatment.

OPEN REDUCTION AND FIXATION
Open reduction and fixation is necessary only in those animals in whom cosmetic realignment is of the utmost importance. In these instances wire sutures or small plates attached to the cranial surface of the spine will provide adequate fixation(15) In animals in whom the spine has fractured from the scapular body at its base, internal fixation may be difficult; Kirschner wires placed through the spine into the scapular body have proven successful.

Postoperative management of scapular spine fractures regardless of the method of fixation does not require external fixation. Free use of the limb will result in the quickest return to normal. Prognosis is excellent for a full return to complete function.
ACROMIAL FRACTURE

SIGNS AT PRESENTATION Since the acromion serves as the point of origin of the acromial head of the deltoid muscle and the point of insertion of the omotransversarius muscle, fracture results in displacement and dysfunction. Animals will present with obvious lameness, often erythema or bruising over the acromion and obvious shoulder asymmetry. Palpably the acromion may not be found, although a sharp scapular spine is present. Further careful palpation will find the acromion displaced either distally or distally and cranially. The displacement will indicate the size of the fragment (a small fragment will be displaced by only the acromial head of the deltoid whereas a larger fragment will be displaced by the deltoid and omotransversarius muscles).

Crepitus is rarely palpable, since the bony fragments are not in proximity. Radiographs confirm the size of the fracture fragment and its location.

ASSOCIATED SOFT TISSUE INJURIES
It is rare for other injuries to occur with the fracture. If the fracture is a minimal result of great trauma, the thoracic contents should be evaluated for signs of trauma as well.

CLOSED REDUCTION AND FIXATION
All methods of closed reduction and fixation will be inadequate, since this fracture is displaced by a strong muscle or muscles. Splints or slings cannot result in reduction, and it is highly unlikely that any form of bony union would result.

OPEN REDUCTION AND FIXATION
Open reduction is necessary to properly counter the pull against the contracted deltoid muscle or omotransversarius muscle and accomplish reduction. Usually a bone forceps will facilitate this reduction.

FIG. 20-6 Line drawing demonstrates placement of a tension band wire for fixation of an acromial fracture.

Fixation can be accomplished in a variety of ways depending upon the size of the bone fragment. The constant pull of the attached muscles must be considered, or they may force fragment distraction and fixation failure. Wire sutures have been used successfully either as one or two simple interrupted sutures or as one horizontal mattress suture. Kirschner wires can be used successfully; however, if they are parallel, muscle pull will probably displace the acromial fragment; therefore, the wires should be crossed. The most stable method is the tension band wire (Fig. 20-6). This method is secure and prevents fragment displacement; however, this technique may be difficult to use in very small dogs or cats in whom the acromial fragment is small.

Fracture of the metacromial process in the cat rarely requires fixation, but if internal fixation is desired, a simple interrupted wire suture is sufficient. Postoperative management of animal fractures requires no special precautions. Animals are capable of full weight bearing shortly after surgery. Should the surgeon question the strength of the
internal fixative, cage confinement or the use of a Velpeau sling for 1 to 3 weeks may be necessary. The prognosis for union and complete return to normal function is very good.

**FRACTURES OF THE SCAPULAR NECK**

**SIGNS AT PRESENTATION**

Most animals present with complete dysfunction of the involved limb and hold the limb in a position of dropped shoulder, extended elbow, flexed carpus, and dragging the dorsum of the paw. Palpation over the shoulder results in severe pain but rarely in crepitus. If the fracture is 48 hours old, palpable atrophy of the supraspinatus and infraspinatus muscles will be present. Radiography will confirm the fracture and assist in determining whether there is displacement. Frequently, the glenoid fragment will displace medially and proximally. The resulting pain demonstrated with this fracture probably is the result of the fragment displacing into the brachial plexus.

**ASSOCIATED SOFT TISSUE INJURY**

The fracture is commonly associated with injury to the suprascapular nerve, resulting in permanent atrophy of the supraspinatus and/or infraspinatus muscles. Vascular tears of the suprascapular artery or vein occur; however, collateral circulation prevents serious consequences. Occasionally the sharp edge of the distal-most fragment may cause temporary or permanent injury to individual nerves of the brachial plexus if complete medial displacement occurs. As with any scapular fracture the possibility of chest trauma must be considered.

**CLOSED REDUCTION AND FIXATION**

Closed reduction is very difficult once the fragments are displaced completely. If displacement is incomplete or alignment is acceptable, it is advantageous to avoid manipulation of the fracture and the risk of complete displacement.

Closed immobilization can be accomplished using rigid coaptation of the entire limb, shoulder, and scapula. Immobilization of this fracture must include spica coaptation. A Velpeau sling may afford adequate immobilization; however, because a Velpeau sling tends to rotate the shoulder internally as well as flex it, it is very likely that the fractured scapular neck will heal in a varus position or completely displace the sling.

**OPEN REDUCTION AND FIXATION**

Open reduction may involve only realignment of the fracture fragments but more typically requires levering the distal fragment from behind the proximal. A bone forceps on the glenoid fragment may be required for better purchase to accomplish reduction. The location of the suprascapular nerve and artery should always be noted.

Fixation can be accomplished using most forms of implants, since this fracture is through cancellous bone. Crossed Steinmann pins or Kirschner wires work well; it is best to have one pin enter the supraglenoid tubercle and the other enter caudal to the glenoid (Fig. 20-7, A). One or two bone screws may be used in a similar fashion, although if only one screw is used, it should enter through the supraglenoid tubercle (Fig. 20-7, B). Depending on the technique used for screw insertion, either cortical or cancellous screws are appropriate. Very large dogs may require the greater stability afforded by a small bone plate. This plate should be contoured to fit and be placed cranial to the scapular spine. The use of plates for
this fracture is rarely necessary.

Postoperatively, animals should be allowed normal activity while on a leash or in the house for 2 to 4 weeks. Because all forms of internal fixation suggested are very stable, there is no need for ancillary external support. The prognosis for return to normal function is good.

FIG. 20-7 Line drawings demonstrate methods of internal fixation for a scapular neck fracture: crossed Steinmann fixation (A), lag screw fixation (B).

COMMON COMPLICATIONS
Any trauma to the suprascapular nerve or entrapment by bony callus may result in loss of function. This will result in moderate to severe muscular atrophy in the supraspinatus and infraspinatus muscles. This complication tends to be more cosmetic than functional; however, some lameness will result.

SUPRAGLENOID TUBERCLE FRACTURE

SIGNS AT PRESENTATION
Most animals will present with mild to moderate lameness associated with supraglenoid tubercle fracture. Flexion and extension of the shoulder will exacerbate the animal's discomfort; however, it is unlikely that crepitus will be palpable. Deep palpation medial to the greater tubercle along the biceps brachii tendon may cause pain or discomfort. A slight cranial-caudal instability may be palpable. Radiography will demonstrate the fractured supraglenoid tubercle. Frequently, it will be displaced distally owing to contraction of the biceps brachii muscle. If the fracture is incomplete or the periosteum has remained intact, it is possible for the fracture to stay in anatomical alignment. In the immature animal it is important that the fracture line not be confused with a growth plate.

ASSOCIATED SOFT TISSUE INJURIES
Rarely are there additional injuries.

CLOSED REDUCTION AND FIXATION
With complete fractures, closed reduction and fixation is impossible; however, immobilization in a straight-legged coaptation spica may result in successful union. Any external device that flexes the shoulder, such as a sling, will tend to further distract the supraglenoid tubercle or change an incomplete fracture into a complete fracture.

OPEN REDUCTION AND FIXATION
Open reduction requires complete surgical exposure and extension of the shoulder. The fragment rarely displaces more than 5 mm to 10 mm distally, since it cannot pull beneath the intertubercular ligament. Reduction is accomplished by placing a small pin through the tubercle and using the pin and chuck as a handle to reduce the fracture. Since one smooth pin is inadequate fixation, a second may be placed in a cross-pin fashion. An improved method of fixation would include the use of a lag screw through the tubercle in addition to
the first pin or placement of a second parallel pin and a tension band wire (Fig. 20-8)(14). The surgeon must be aware of the constant distractive force from the biceps brachii muscle and counteract it with adequate internal fixation.

While fracture of the feline coracoid process is possible, there is no literature describing the problems. It seems unlikely that any form of internal fixation could be used, since the process, although prominent, is very small.

Postoperatively the animal may be allowed normal activity. With internal fixation, there should be complete return to normal function. The prognosis for success is excellent.

FIG. 20-8 Line drawings demonstrate methods of internal fixation for a supraglenoid tubercle fracture: lag screw fixation (A), tension band wire fixation (B).

COMMON COMPLICATIONS
Nonunion of the supraglenoid tubercle results from improper closed fixation or inadequate internal fixation. Most nonunions are painful, result in lameness, and require surgical correction.

GLENOID FRACTURE
SIGNS AT PRESENTATION
Intra-articular fracture results in complete limb dysfunction or severe lameness. Palpation demonstrates crepitus as the fracture fragment or fragments ride against the humeral head. The shoulder will be unstable and the humeral head will freely displace toward the fracture fragment. Radiography will demonstrate the extent of the intra-articular fracture. The cranial half may fracture and displace distally owing to the biceps brachii muscle, the caudal half may fracture and displace distally owing to the teres minor muscle contraction, both may fracture and displace, resulting in a scapular neck fracture as well, or the glenoid may be comminuted. Occasionally small fragments of the lateral or medial glenoid rim may fracture off also. Following radiography to confirm the fracture type and displacement, the surgeon must begin to organize a plan for reduction and fixation.

ASSOCIATED SOFT TISSUE INJURIES
The trauma necessary for this fracture to occur may damage the brachial plexus, the brachial vessels, or the chest contents. Associated muscle bruising or laceration is not uncommon over the fracture site.

CLOSED REDUCTION AND FIXATION
Closed reduction and methods of closed fixation are inadequate for routine intra-articular fracture. Anatomical reduction and rigid fixation are needed to rehabilitate a joint, and neither of these can be accomplished by closed reduction or fixation.

There is, however, a small area for closed reduction and fixation. In a severely comminuted glenoid, that is, more fragments than can possibly be aligned or fixed
internally, external splinting may help to salvage a limb. In this instance, the shoulder should be placed in a midrange position and placed in a long-leg coaptation and spica. The glenoid should go on to union and provide adequate bone for subsequent arthrodesis of the shoulder. The resulting healed glenoid will be extremely irregular and filled with bony callus. Degenerative arthritis will occur rapidly, necessitating constant analgesia or arthrodesis.

OPEN REDUCTION AND FIXATION
Cranial or caudal half glenoid fracture reduction is achieved by placing a small pin through the fragment and then using the pin to aid in reduction. The articular surface must be observed and reduced as perfectly as possible if good joint function is expected postoperatively. Since a cranial or caudal half fracture is distracted by muscle pull, more fixation is needed. A second crossed pin, a tension band wire, or a lag screw are equally adequate.

SIMULTANEOUS CRANIAL AND CAUDAL HALF GLENOID FRACTURES
Of great importance is anatomical reduction of the articular surface; therefore, it should be reduced first. Reduction will be facilitated by using bone forceps to compress the fragments together. The articular surface should be smooth and reduced in as regular a manner as possible. Fixation can be accomplished using one lag screw or two crossed pins. One pin is inadequate because the fragments will rotate. Once the glenoid has been reestablished, the resulting scapular neck fracture can be reduced in any of the methods listed above—pins, screws, or a plate (Fig. 20-9, A and B).

GLENOID RIM FRACTURE
The glenoid rim is critical to joint stability and its loss may result in shoulder dislocation. Medial or lateral rim fractures are best reduced and fixed using small multiple Kirschner wires. If the fragment is very large, a small interfragmentary screw is also adequate. In extreme instances in which the rim is comminuted and cannot be repaired, prosthetic rims may be cut from the iliac crest, shaped to closely approximate the comminuted rim, and attached in the prescribed manner. While this may be less than perfect anatomically and may lead to subsequent degenerative joint disease, it is preferable to continued dislocation.

COMMINUTED GLENOID FRACTURE
In cases of comminution, the surgeon must attempt to rebuild the articular surface using fixation deemed appropriate. Free fragments of cartilage must be discarded because they cannot incorporate into the fixation. Cancellous bone grafts may be necessary to fill bony defects but should not be used to fill articular defects. The resulting union may be functional or may serve merely as the foundation or an arthrodesis.

In a severely comminuted glenoid fracture, removal of all the bony fragments in a fashion similar to excision arthroplasty of the femoral head has been used with moderate success. The resulting false joint may be more functional than an arthrodesis and less painful than a helical. (Fig. 20-9)
POSTOPERATIVE MANAGEMENT
Normal weight bearing on the affected limb should minimize the formation of bony callus in the joint, promote early use, and result in a near-normal range of motion.

A severely comminuted fracture with inadequate internal fixation may require additional external fixation to achieve union. Severe loss of shoulder motion is the end result in these fractures.

The prognosis for return to normal function in a simple glenoid fracture is very good. In a comminuted fracture the prognosis is poor.

COMMON COMPLICATIONS
As in any intra-articular fracture, the common complications include diminished range of motion; discomfort associated with mild, moderate, or severe degenerative arthritis; pain; lameness; or limb dysfunction. The typical dog or cat will have slight degenerative joint disease and minor complications.

SCAPULAR LUXATION
Scapular luxation describes a problem seen in both dogs and cats following trauma. Severe trauma results in a tearing of the muscular support for the scapula, the serratus ventralis, trapezius, and rhomboideus muscles.

CLINICAL PRESENTATION
Dogs or cats present with the affected scapula protruding prominently above the normal anatomical location. The skin is tented dorsally over the affected scapula. Most animals are not in severe pain or discomfort beyond that associated with muscle tearing. Gait is affected, since the involved limb has poorer muscular support; however, animals are willing to walk without undue discomfort. With each step the scapula will rise beneath the skin and fall ventrally when weight is removed from the limb. While radiography may assist in documenting the scapular malposition, it cannot document muscular etiology.

ASSOCIATED SOFT TISSUE INJURY
The basis for this injury is soft tissue avulsion or tearing. There may be other associated soft tissue injuries as well. Although no reported cases exist, the likelihood of brachial plexus injury is high. With each step the nerves are stretched dorsally and then return to normal. Similarly the brachial artery and vein are stretched.

CLOSED REDUCTION AND FIXATION
In acute cases, specifically in cats, the limb may be positioned, corrected, and placed in a tight Velpeau sling. The intent is to maintain normal anatomical alignment and allow the torn muscles to heal and scar back into the scapula. In two cases I have treated, the approach has been successful. If closed reduction fails or if the patient is a large dog, internal fixation may be necessary.
INTERNAL REDUCTION AND FIXATION
Open reduction necessitates surgical exposure of the caudal edge of the scapula. This is accomplished by dissecting between the infraspinatus muscle and the teres major muscles. Once the caudal edge has been exposed and the scapular blade exposed more completely, two holes are drilled through the caudal border of the scapula, approximately 1 cm apart. Appropriately heavy orthopaedic wire is introduced through one hole, looped around the fifth, sixth, or seventh rib and passed back through the second hole. The wire is tightened, thus securing the scapula effectively (Fig. 20-11). Reattachment of the obviously torn muscles, the rhomboideus and the trapezius, can also be accomplished. The serratus ventralis cannot be reattached surgically. (8,10) Postoperatively the limb should be supported in a long-leg coaptation spica for 3 to 5 weeks. The prognosis for success is good following surgery and fair if treated in a closed fashion.

COMMON COMPLICATIONS
The most common complication is failure of fixation due to inadequate bandaging, premature full weight bearing, or wire failure. Although the wire will eventually break, hopefully muscle healing will be reached before this occurs. The broken wire may result in pain or discomfort at the time of breakage, although its removal is generally unnecessary.

REFERENCES