Scapulothoracic Dissociation

William F. Lavelle, MD; Richard Uhl, MD

Stability of the scapula comes from the scapulothoracic articulation aided by support from the clavicle strut. In the case of a simple clavicle fracture or acromioclavicular joint separation, an intact scapulothoracic articulation alone is sufficient to support the scapula. Disruption of the clavicle strut and the scapulothoracic articulation leads to scapular instability.

Complete scapulothoracic dissociation with vascular disruption and brachial plexus injury is an infrequent but devastating injury. Oreck et al\(^1\) first described this injury with a 3-patient case series in 1984. Two factors may account for what seems to be an increased prevalence of these injuries in the modern trauma setting. The first factor is the ever-increasing popularity of motorcycles and recreational activities that place patients at risk for such a devastating injury.\(^2\) The second is the technical improvements in our trauma system, which have allowed patients with such devastating injuries to survive.\(^3\)

Despite the apparent increase, scapulothoracic dissociation remains a rare injury. The potentially life-threatening nature of the injury makes proper identification and treatment critical to the orthopedic surgeon staffing a level I trauma center.

**COMMON MECHANISMS OF INJURY**

Although various injury accounts have been described, a massive traction force applied to the upper extremity is the common cause of scapulothoracic dissociation. It has been reported elsewhere that approximately half of the scapulothoracic dissociations described in the literature involve a motorcyclist.\(^4\) One particular series found that 60% of patients with scapulothoracic dissociation were motorcycle drivers.\(^5\) The most logical mechanism involves a motorcycle driver attempting to hold onto the handlebars while being forcibly thrown.\(^5,6,8\) Injuries to all-terrain vehicle riders would likely occur in a similar manner and may become more commonly encountered due to their increasing popularity.\(^2,9,10\)

INJURY PATTERNS AND CLASSIFICATION

All types of scapulothoracic dissociations involve a complete loss of the integrity of the scapulothoracic articulation. An additional musculoskeletal injury to the shoulder is nearly requisite for scapulothoracic dissociation. An anteriorly based shoulder injury such as an acromioclavicular joint separation, sternoclavicular joint separation, or most...
commonly a clavicle fracture is seen (Figures 1, 2). In fact, a clavicle fracture accompanied 80% of the 25 injuries reviewed by Zelle et al.12

The violent forces that disrupt the scapulothoracic articulation often disrupt the neurovascular structures. With the rare exception of children, whose tissue elasticity may protect them from a severe neurological or vascular injury,13,14 scapular displacement is normally accompanied by a significant soft tissue injury. Complete or partial avulsions of the brachial plexus that leave the patient severely debilitated may be seen. In the acute setting, vascular injuries maintain precedence, as these are the components of the injury that are life threatening.

Damschen et al13 proposed a simple classification system based on the presence or absence of either a vascular or neurological injury. A type 1 injury involves an isolated musculoskeletal injury (Figure 1A), a type 2 injury involves a musculoskeletal injury with either a vascular injury or a neurological injury (Figure 2A), and a type 3 injury includes a patient with a musculoskeletal injury and both a vascular and a neurological injury.11 Despite the fact that type 2 and 3 injuries would intuitively represent more devastating and disabling injuries, functional outcome data do not to correlate with Damschen’s classification system.12 Zelle et al12 found that the completeness of the brachial plexus injury was most predictive of patient’s functional outcome. The authors found that although a vascular injury was more life threatening, the patient’s neurological injury was the most life altering as determined by long-term SF-36 scores. The authors proposed adding a fourth type of scapulothoracic injury to include all patients with a complete brachial plexus avulsion.12

**Vascular Findings**

On physical examination, the injured limb should be compared to the contralateral extremity. The peripheral vasconestriction caused by hypovolemia and shock may make a reliable examination difficult. The arm should be inspected for mottling and examined for a temperature difference between the contralateral, and presumably uninjured, extremity. Pulses should be palpated at the wrist (radial and ulnar), elbow (antebrachial), and upper arm (brachial and axillary). Perhaps the most common mistake is to attribute a pulseless extremity from scapulothoracic dissociation to a more distal musculoskeletal injury as these patients often have concomitant upper extremity trauma.13

**ANCILLARY TESTING**

**Chest Radiograph**

On chest radiographs, the presence of a large soft tissue separation. The scapula is completely dissociated from the thoracic cage (A). The distance from the medial border of the scapula to the spinous process is measured. The authors found that the completeness of the brachial plexus injury was most predictive of patient’s functional outcome. The authors found that although a vascular injury was more life threatening, the patient’s neurological injury was the most life altering as determined by long-term SF-36 scores. The authors proposed adding a fourth type of scapulothoracic injury to include all patients with a complete brachial plexus avulsion.12

**Neurological Findings**

Based on the combination of motor and sensory deficits, a general location of the injury may be determined as either at the spinal roots, within the brachial plexus, or in a peripheral nerve. A Horner’s syndrome or paralysis of the serratus anterior, rhomboids, supraspinatus or diaphragm are suggestive of a preganglionic lesion.15-17 Some authors recommend early amputation for patients with a complete preganglionic neurological injury in the upper extremity.12,13,18

**Figure 1:** A 48-year-old woman was injured when thrown from a motorcycle. She was neurovascularly intact (Type 1 scapulothoracic dissociation). Upright chest radiograph showing a clavicle fracture, glenoid fracture, and multiple rib fractures (A). Upright chest radiograph taken 3 days after Figure 1A showing further collapse of the thoracic cage and inferior displacement of the scapula. The patient began having brachial plexus symptoms (pain, numbness) as the collapse progressed (B). The patient underwent plating of the clavicle, which helped support the scapula. Four months after the injury, the patient returned to work (C). Following plate removal, the position of the acromioclavicular joint and the scapula are maintained.

**Figure 2:** A 23-year-old man involved in a motorcycle accident sustained a Type 2 scapulothoracic dissociation with post-ganglionic injury to the brachial plexus. Right shoulder radiograph showing a complete AC separation. The scapula is completely dissociated from the thoracic cage (A). The distance from the medial border of the scapula to the spinous process is measured. The larger value either A or B is divided by the smaller value. This patient’s ratio was calculated to be 1.6, which is abnormally wide (B). The scapula and acromioclavicular joint were reduced and a tibial plateau locking plate was contoured to fit the clavicle and acromion to hold the reduction. The plate was left in place for 3 months, at which time the patient underwent brachial plexus exploration and plate removal (C). Following plate removal, the position of the acromioclavicular joint and the scapula are maintained. Note the surgical clips following brachial plexus exploration and repair. The patient ultimately gained some incomplete return of upper extremity function (D).
density along the border of the scapula may represent a hematoma and should raise suspicion for a scapulothoracic dissociation and an associated vascular injury. The radiograph may demonstrate lateral displacement of the scapula along with any of the other accompanying musculoskeletal injury patterns such as an acromioclavicular joint separation, sternoclavicular joint separation, or clavicle fracture (Figure 2A).1

Specific radiographic criteria for the diagnosis of a scapulothoracic dissociation have been described by Kelbel et al.8 On a nonrotated chest radiograph of 50 uninjured patients, the authors measured the distance from the medial borders of both scapulas to the spinous process (Figure 2B). These 2 distances were then divided to obtain their ratio, which averaged 1.07. Kelbel et al8 recommended this method and value as a reproducible measurement to establish the presence of an injury as shown in Figure 2B. For the patient with a scapulothoracic dissociation, Zelle et al12 reported an average scapula index of 1.29.

Chest radiographs were also found to be a valuable tool in assessing scapular stability. Serial upright chest radiographs obtained to assess for scapular droop have been found to be a significant problem for patients, which is not always identified on an initial imaging series (Figures 1A, 1B).18

Computed Tomography/Magnetic Resonance Imaging

On the computed tomography (CT) scan, a chest wall or paraspinal hematoma may be identified. An excessively large hematoma may be suggestive of a serious vascular injury.19 Separation of the scapula from the chest wall may be identified on axial images.

In the post-injury setting, CT may be even more valuable. A cervical myelography may show the appearance of a pseudomeningocele, which is indicative of a spinal root avulsion. The presence of ≥3 pseudomeningoceles is felt to be diagnostic of an irreparable neurological injury. In the case of an incomplete brachial plexus injury, magnetic resonance imaging (MRI) may offer more detailed information regarding the injury.20

Immediate Post-Injury Treatment

When a patient with scapulothoracic dissociation presents to the emergency department, standard Advanced Trauma Life Support protocols should be followed, including a thorough and organized primary and secondary survey. After the establishment of 2 large bore intravenous lines, the patient should be adequately resuscitated with crystalloid and blood as needed. Observance of proper Advanced Trauma Life Support protocol may be paramount to patient survival.

Immediate Surgical Treatment

The decision of whether to revascularize the upper extremity or to perform an immediate above-elbow amputation is often difficult and should involve the collaboration of the patient’s treating physicians. Surgeons should be mindful of the risks of preserving an injured arm that has been ischemic in light of the functional disability imposed by the loss of an upper extremity.

An urgent surgical exploration is mandatory for patients with an active hemorrhage, an expanding hematoma, or severe hand ischemia. If vascular exploration is warranted, the trunks of the brachial plexus should be inspected. If a complete disruption is found, a primary amputation should be considered, as the possibility of a useful limb is so small that it may not merit subjecting the patient to the risks of maintaining an extremity that has been ischemic for an extended or unknown period of time. These risks are substantial and include myoglobinuria, hyperkalemia, vascular thrombosis, infection, and sepsis. In addition, many patients and their families refuse secondary amputation despite possessing a numb and nonfunctional upper extremity.12,18,21

Patients with a partial brachial plexus injury have been found to have some potential for a functional recovery.12 Direct repair of nerve injuries may be considered in this instance provided the patient is stable. In such cases, urgent revascularization of the ischemic upper extremity is recommended. Some authors have recommended following the patient’s fluid balance carefully and considering an amputation if the fluid balance is >3 L positive, although this recommendation is based primarily on literature that evaluated threatened lower extremities.18

Shoulder Stabilizing Procedures

Debate exists in the literature as to the indications for shoulder stabilizing procedures. As is often discussed with “floating shoulder” type injuries, the shoulder is comprised of a complex combination of articulations known as the superior shoulder suspensory complex. The superior shoulder suspensory complex may be thought of as a ring consisting of the middle and distal clavicle, coracoclavicular and acromioclavicular ligaments, acromion, coracoid process, and glenoid.22,23 Injuries that disrupt 2 components of the ring are defined as unstable potentially requiring stabilization.22,23 With the scapula dissociated from the chest, an associated musculoskeletal injury such as an acromioclavicular joint separation, sternoclavicular joint separation, or a clavicle fracture would make for an unstable shoulder.

In light of this fact, some authors recommend that for a patient with an arterial injury, the orthopedic injury should be stabilized before a vascular repair is attempted. Similar to lower extremity trauma, a stable limb is required so as not to disrupt a vascular repair once it has been completed. Additionally, the shoulder should be stabilized to determine the appropriate length of an interposition graft.18 In this situation, open reduction and internal fixation of the clavicle, acromioclavicle-
lar, or sternoclavicular joints is recommended.

In the extremity that does not require a vascular repair, a conservative approach has been advocated by some authors such as Damschen et al who recommends external bracing and shoulder support.11,13 As these patients often have an extensive amount of soft tissue injury, a stabilization procedure performed through a zone of injury bears a significant measure of risk to the patient. Stabilization procedures may be considered for significant scapular droop or as a part of a definitive reconstructive procedure once the zone of injury has improved as a part of the late post-injury reconstruction (Figures 1, 2).

LATE POST-INJURY TREATMENT

In the post-injury setting, it is important to delineate the extent of the neurological injury. A full neurological examination should be repeated and a suspected injury level again identified. If there is a suspicion of a root level injury based on physical examination, a CT myelogram is recommended to evaluate for the presence of a pseudomeningocele. If 3 pseudomeningoceles are present on CT myelogram, irreparable damage has been done and nerve repair is not a recommended option.18

An upper extremity electromyography (EMG) is another useful aide in delineating the location of the neurological injury. This study should be completed at 3 weeks as Wallerian degeneration will have occurred and the EMG of the affected area will demonstrate evidence of denervation. A combination of limb EMG and paraspinal EMG is necessary as this will allow a preganglionic injury to be differentiated from a postganglionic injury.15 Patients with a complete neurological injury by EMG should be followed clinically as it is our experience that some patients may develop some functional recovery.

If nerve reconstruction is to be attempted, it should be performed no later than 3 to 6 months from injury to avoid muscle atrophy and fibrosis (Figure 2D). Once the muscle has atrophied and become fibrotic, even with successful reinnervation, the result would not be clinically useful.4,24

If a diagnosis of preganglionic is made, nerve repair techniques should be abandoned and other reconstructive options considered. Upper extremity reconstructive priorities in the setting of trauma are similar to those used for birth-related brachial plexus palsies. The first priorities of reconstruction include elbow flexion and shoulder abduction/stabilization. One treatment option that may be considered is neurotization. This is where an uninjured nerve is transferred from its native muscle to another, higher priority muscle that is injured. In this process, the nerve from the donor muscle is either directly grafted to the remnant of the injured nerve or connected via a nerve graft.4 This technique is typically only useful for avulsions that are isolated to the upper cervical roots as more extensive injuries leave patients without substantial donor nerves.25

Muscle and tendon transfers represent another avenue for reconstruction. Unfortunately unlike peripheral nerve injuries, common donor muscles are often left injured making transfer options limited. Although muscle transfers for birth palsies have been well described, no similar series exists in the literature for traumatic brachial plexus injuries in the adult.13

Shoulder stability may be an issue for these patients, therefore arthrodesis remains a viable option. Patients may note symptomatic scapular instability and pain while attempting to rehabilitate the affected arm. A scapulothoracic arthrodesis has been found to yield satisfactory clinical results for properly selected patients.26 Although attempts are often made to stabilize the associated acromioclavicular joint separation, sternoclavicular joint separation or clavicle fracture as these are much simpler injuries to treat, persistent and symptomatic scapulothoracic instability has been described and may lead to significant shoulder pain and additional functional limitation. Neurological injury of associated scapulothoracic muscles such as serratus anterior, trapezius, and rhomboids may rarely necessitate a procedure such as a scapulopexy.27

CONCLUSION

Scapulothoracic dissociation, although a rare injury, may be life threatening. Priority should be placed on resuscitative measures, as these patients have sustained significant trauma. As threatening ischemia is rare, careful observation is recommended for the nonthreatened limb. For the ischemic limb, inspection of the neurological injury is recommended as complete plexus injuries bear a poor functional prognosis. In these instances, amputation should be considered. Late reconstruction of neurological injuries may be complex, with extensive injury limiting options of nerve repair, nerve transfer, and tendon transfer.26

REFERENCES


