Sternoclavicular Joint Injuries

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Introduction

Structurally, the sternoclavicular joint has little bony stability, yet its strong and extensive ligamentous support makes it one of the most stable joints of the body. For this reason, ligamentous tears and dislocations to joint are thought to be rare. However as such injuries are sometimes missed clinically, the true incidence may be underreported.

The following review examines the anatomy and biomechanics of the sternoclavicular joint, along with the incidence, mechanisms, and pathophysiology associated with injury. Dislocations are classified into anterior, posterior and physeal types. The implications of injury and consequences for management of each type of dislocation are discussed in detail. For the professional managing these injuries, it is essential to be aware of the potential complications of the less common but more problematic posterior dislocation.

The literature regarding the management of sternoclavicular joint dislocation shows that there is a lack of consensus on the ideal management for the different injury types. However there is general agreement that a posterior dislocation that fails to resolve with conservative management should be corrected surgically. Some authors feel that the uncomplicated anterior dislocation should be surgically fixed, as the nature of the injury tends to make its relocation unstable.

Biomechanically, the sternoclavicular joint has received scant attention. The importance of this joint to the movement and function of the shoulder is paramount. This would suggest management that ensures optimal function is critical. Evidence based treatment guidelines for sternoclavicular joint dislocation are currently lacking, and further research is recommended to address this gap in the scientific literature.

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Anatomy & Biomechanics

According to Balcik et al 2013, the clavicle:

1. Functions to support the weight of the upper extremity;
2. Acts as a transition point between the shoulder girdle and the trunk; and
3. Provides protection for the underlying mediastinal structures.

The medial portion of the clavicle is cylindrical, giving it strength, whereas the lateral portion is flattened, which is ideal for the attachment of muscles and ligaments (Balcik et al 2013). The structure and anatomic position of the lateral portion makes it more prone to injury (Balcik et al 2013).

The sternoclavicular (SC) joint is the only articulation between the upper extremity and the axial skeleton (Balcik et al 2013, Bontempo & Mazzocca, 2010, Brukner & Khan 2012, Spencer et al 2007). It is a diarthrodial synovial joint (Spencer et al 2007, van Tongel & de Wilde 2011). It could also be described as a double plane joint, similar to a ball and socket (Lewonowski & Bassett 1992). The medial end of the clavicle and clavicular notch of the sternum are covered in fibrocartilage (Spencer et al 2007), and the joint contains an intra-articular disc which is strongly attached to the sternum (Bontempo & Mazzocca, 2010; Nettles & Linscheid 1968). The disc is thicker at its periphery than centrally, and acts as a shock absorber for forces directed medially through the clavicle (Nettles & Linscheid 1968). The medial clavicle is “enlarged, bulbous & saddle-shaped” relative to the concave shape of the notch of the sternum (Bontempo & Mazzocca, 2010), making the joint incongruent (Bontempo & Mazzocca 2010, Garg et al 2012, 2010, Spencer et al 2007). Due to this incongruity, and because less than one third of the medial clavicular surface articulates with the sternum, it has the least bony stability of all the major joints of the body (Balcik et al 2013, Bontempo & Mazzocca 2010, Spencer et al 2007). However the ligaments compensate for this by providing a very strong connection, making injuries to this joint extremely rare (Balcik et al 2013).

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SC Joint Ligaments:

The SC capsular ligaments provide strong support, and are assisted by the costoclavicular (rhomboid), intra-articular disc and ligament, and interclavicular ligaments (Fig 1).

Capsular ligaments:

the anterior and posterior capsular ligaments are thickenings of the joint capsule. They are the strongest structures stabilising the joint and preventing upward displacement of the medial clavicle (Bearn 1967, Spencer et al 2007). Upward displacement joint forces are produced whenever there is downward force on the distal end of the shoulder (Bearn 1967). The posterior capsular ligament is the heavier and stronger of the two, being twice as thick as the anterior (Lewonowski & Bassett 1992; Spencer et al 2007). The fact that in cadaver specimens the posterior-superior capsule was shown to avulse bone prior to ligament rupture demonstrated the strength of the ligament (Bearn 1967). In all of his five cadaver specimens the capsule was thickest postero-superiorly and thinnest anteriorly (Bearn 1967). The lateral attachment of the capsular ligament is mainly into the epiphysis, with some secondary blending of fibres into the metaphysis (Spencer et al 2007). The SC capsule is under tension with the arms in the dependant position, and so plays an important role in maintaining clavicular poise, the force that holds the shoulder up (Bearn 1967). This poise is due to a locking mechanism of the SC ligaments (Bearn 1967). Through sequential sectioning, Bearn showed that division of the capsular ligaments alone resulted in downward depression of the distal end of the clavicle (Bearn 1967, Spencer et al 2007), and the intra-articular disc ligament tore under only 5lb weight once the capsular ligaments had been sectioned (Bearn 1967). As long as the integrity of the capsule of the joint was maintained, the acromial end of the clavicle remained at all times higher than the sternal end, while division of the capsule meant the clavicle descended under its own weight so that the lateral end was one inch lower than the medial end (Bearn 1967). Prior to Bearn's studies, the trapezius muscle was considered to play a significant role in maintaining clavicular poise, however his electromyographic study showed that when the shoulder was fully depressed the trapezius was electrically silent (Bearn 1961 cited in Bearn 1967). Also, paralysis of trapezius allows some lowering of lateral end of clavicle, but it remains approximately 2 inches higher than medial end (Bearn 1967 quotes Bearn 1964).

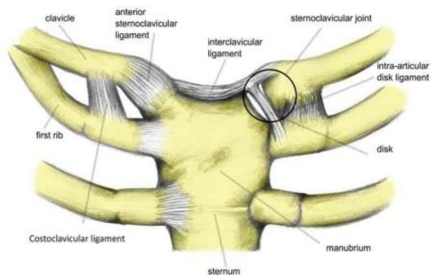

Figure 1. Ligaments of the SC joint. Image courtesy of Sportsinjuryclinic.net

Although capsular rupture would allow for elevation of the medial end of the clavicle, clinically SC dislocations are seen in a relatively anterior or posterior direction (Spencer et al 2007). Depression of the lateral end of the clavicle, due to obliquity of the first rib, tends to push the medial end upwards and posteriorly, and place maximal tension on the postero-superior aspect of the capsule (Bearn 1967).

The primary restraint to both anterior and posterior translation of the clavicle is the posterior capsular ligament, with the anterior capsular ligament providing an important secondary restraint to anterior translation (Spencer et al 2007, van Tongel & de Wilde 2011). The interclavicular and costoclavicular ligaments provide little additional stability (Spencer et al 2007). The SC capsule and ligaments are also the main restraint to clavicular rotation, through a 'screwing-up' of ligament fibres (Bearn 1967).

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The inter-articular disc ligament:

This is described as a dense fibrous structure, arising at the synchondral junction between the first rib and the sternum (Little et al 2008). It spans the SC joint, dividing it into two joint spaces (Fig 2), and inserts onto the superior and posterior aspects of the medial clavicle (Little et al 2008, Spencer et al 2007). It may act as a check-rein against superior and medial displacement of the proximal clavicle (Bontempo & Mazzocca, 2010; Little et al 2008; Spencer et al 2007), although this contribution was described as minor (Bearn 1967). The disc blends into the capsular ligament fibres both anteriorly and posteriorly (Spencer et al 2007). The disc was found to be considerably thicker at its superior aspect, and was thin and easily torn inferiorly where it blended with the superior first costal cartilage (Bearn 1967).

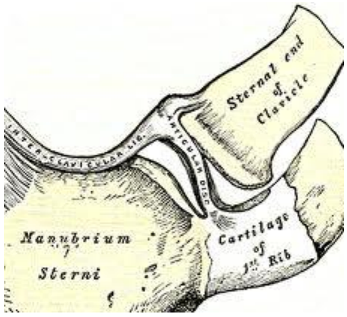

Fig 2. Intra-articular disc ligament. Image courtesy of Wilipedia.

Costoclavicular (rhomboid) ligament:

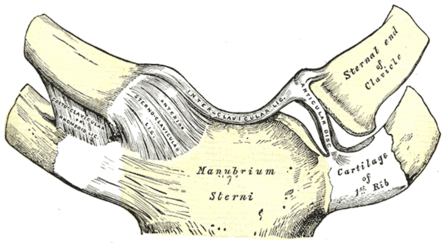

Fig 3. Costoclavicular & capsular ligaments. Image courtesy Wikipedia

This ligament arises from the upper surface of the first rib and its adjacent synchondral junction with the sternum (Fig 3), to attach to the inferior surface of the medial clavicle (Spencer et al 2007). It is a short, strong ligament, consisting of anterior & posterior fasciculi (Spencer et al 2007). The anterior fibres are directed upward and laterally, while the posterior fibres project upward and medially, giving the ligament a twisted appearance (Spencer et al 2007). It limits elevation of the lateral aspect of the clavicle (Bearn 1967; Nettles & Linscheid 1968). The anterior and posterior components together provide stability to the joint during rotation and elevation of the clavicle (Spencer et al 2007). The anterior fibres resist excessive upward clavicular rotation (Spencer et al 2007), and possibly lateral and superior dislocation (Franck et al 2003; Nettles & Linscheid 1968), while the posterior fibres are thought to resist excessive downward rotation (Spencer et al 2007) and medial and inferior dislocation (Franck et al 2003). As SC dislocations often have a superior and medial component, it would be expected the posterior fibres would also oppose movement in this direction. The costoclavicular ligaments attach to the periosteum of the medial clavicular metaphysis, unlike the SC ligaments which mainly attach to the epiphysis, (Zaslav et al 1989).

While some authors felt this ligament was an important restraint to dislocation, and of considerable strength (Rockwood & Odor 1989, cited by Franck et al 2003; Nettles & Linscheid 1968), Bearn 1967 felt this ligament played a minor role in stability. While he found that the anterior fibres tension in upward rotation, and the posterior fibres in downward rotation, severing the ligament did not allow any increase in rotation. He felt this ligament had a ‘cruciate nature’, providing a point about which the clavicle can rotate. Sectioning of the costoclavicular ligament, even in conjunction with the disc ligament, did not significantly affect scapular poise if the SC ligaments were intact (Bearn 1967). Similarly, if inferior loading was applied to the distal clavicle, this did not create tension in the costoclavicular ligament. Rather, this seemed to result in compression between the clavicle and first rib (Bearn 1967). As a bursa was found between the anterior and posterior fibres, Bearn (1967) felt this ligament acted as a cushion between the first rib and the clavicle. He suggested the ligament could represent components of a rudimentary joint between clavicle and rib.

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Interclavicular ligament:

This ligament spans between both clavicles and has some attachment to the upper sternum (Fig 3). It has been described as a strong ligament which opposes lateral clavicular forces (Nettles & Linscheid 1968). However Bearn (1967) found the thickness of this ligament to be quite variable, and felt it was more an interconnection between the superior capsule of each SC joint rather than a separate ligament. It seems to play some role in scapular poise (Bearn 1967, Spencer et al 2007), as it becomes tight when the arms hang at the sides (Bearn 1967). Bearn also felt this ligament was somewhat elastic, becoming tense but still allowing further movement. Thus he felt the stabilising role of the interclavicular ligament was limited (Bearn 1967). A proprioceptive rather than stabilising function could be speculated, and one which might even influence muscle tension in muscles such as trapezius. Bearn (1967) uses the example of the elastic supraspinous and interspinous ligaments of the vertebral column, whose tension precedes relaxation of the erector spinae.

Muscular connections and actions at the SC joint:

There is a "curtain" of muscles around the joint which includes the sternocleidomastioid (SCM), the sternohyoid, sternothyroid, and scalenes. Vital structures which lie posterior to the joint (and to these muscles) include the innominate artery, innominate vein, vagus nerve, phrenic nerve, internal jugular vein, trachea and oesophagus. The anterior jugular vein is located between the clavicle and this curtain of muscles.

The clavicular head of SCM (Fig 4) attaches to the medial third of the clavicle (Crouch, 1978; Kendall et al 1993). This point is lateral to the fulcrum of clavicular movement, but the muscle is at a poor mechanical advantage to assist clavicular elevation, or to assist with clavicular poise (Bearn 1967). Nettles & Linscheid (1968) felt the clavicular head of SCM could be a factor in recurrent dislocations to the SC joint, or in poor results of recovery after injury. The sternohyoid attaches partly to the medial end of the clavicle, as well as to the manubrium, while the sternothyroid attaches only to the manubrium (Fig 5) (Crouch, 1978). The scalenus anterior and medius attach to the first rib, and scalenus posterior to the second rib (Crouch 1978), with the scalenus anterior located just posterior to the medial clavicle, but lateral to the SC joint.

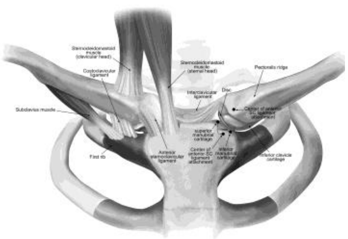

Figure 4. Sternomastoid attachments. Courtesy Lee et al 2014, JBJS.

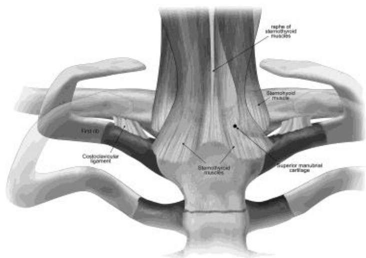

Figure 5. Sternohyoid & sternothyroid attachments. Courtesy Lee et al 2014, JBJS.

While some of the muscles described above attach at or near the SC joint, it is unlikely they play a significant role in clavicular (thus SC joint) motion. As the distal clavicle pivots and swings on a relatively fixed SC joint, muscles acting distally possess a much greater mechanical advantage. According to Ludewig & Braman (2011), lower trapezius, middle trapezius to a lesser degree, and serratus anterior, are the prime movers for scapular upward rotation. Coupled with this is clavicular posterior rotation and a degree of elevation. Upper trapezius may play a minor role in assisting this action. However because it partially attaches to the distal clavicle, it is likely that in healthy subjects upper trapezius produces clavicular retraction, a movement which occurs in part to prevent excessive scapular internal rotation (Ludewig & Braman,

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2011). Excessive upper trapezius activation is associated with increased clavicular elevation, and coupled with this, increased scapular anterior tilt (Ludewig & Braman, 2011).

Pectoralis major, having direct attachment to the medial half of the clavicle, and through reverse-origin-insertion action, has an influence on clavicular motion. It contributes to clavicular protraction, and also in controlling or restricting clavicular retraction (Ludewig & Braman, 2011). Indirectly, through its effect on scapular anterior tilt and internal rotation, pectoralis minor may also act to limit clavicular retraction (Ludewig & Braman, 2011). It could be argued that pectoralis major plays a small role in SC joint stability, as its fibres are aligned to resist superior and medial clavicular displacement.

Epiphysis of the medial clavicle:

The clavicle is the first long bone to ossify (van Tongel & de Wilde 2011), however the medial clavicular epiphysis is the last epiphysis of the long bones of the body to appear and the last to close (Spencer et al 2007; van Tongel & de Wilde 2011). The epiphysis is only a few millimetres in thickness (Lewonowski & Bassett 1992). It does not ossify until the 18th to 20th year of life, and fuses with the shaft of the clavicle around the 23rd to 25th year. (Fieishier & Ludwig 2010, Spencer et al 2007, Gobet et al 2004, Lewonowski & Bassett 1992). In some cases, complete union may not occur until 31 years of age (Gilot et al 2006). Most, if not all so-called SC dislocations are in-fact fractures through the physeal plate (Franck et al 2003; Garg et al 2012; Gilot et al 2006; Gobet et al 2004; Lewonowski & Bassett 1992; Spencer et al 2007; Van Tongel & De Wilde, 2011).

Range of Motion:

Clavicular motion at the SC joint functions in conjunction with AC joint motion, to position the scapula during scapulothoracic motion (Ludewig & Braman, 2011). Spencer (2007) described the SC joint as the “most frequently moved joint of the long bones in the body” and felt “almost any motion of the upper extremity is transferred proximally to the SC joint”. The joint is freely movable, functioning almost like a ball-and-socket joint, having motion in almost all planes (Culham & Peat, 1993; Spencer et al 2007). The movements afforded by this joint are 60° frontal plane movement (elevation & depression), 20° to 35° of anterior to posterior translation, and 30° to 50° of rotation around the long axis of the clavicle (Bontempo & Mazzocca; 2010; Nettles & Linscheid 1968; Spencer et al 2007). Anterior to posterior translation occurs between the disc and sternum, while elevation and depression occurs between the medial end of the clavicle and the disc (Culham & Peat, 1993). Within the first 90° of arm elevation the clavicle elevates 4° for every 10° of arm elevation, with negligible motion after 90° (Inman 1944, quoted by Spencer et al 2007). More specifically, during elevation of the arm in any plane (except extension) there is 30° clavicular posterior rotation and 15° of posterior translation (retraction) (Ludewig & Braman, 2011). However there will be a degree of ‘adjustment’ of retraction range, such that overall there is less retraction during flexion than during abduction (Ludewig & Braman, 2011).

The importance of the SC joint to overall shoulder movement is highlighted by studies examining the implications of SC joint disease. In cases of SC hyperostosis, leading to fusion or significant restriction of joint motion, shoulder motion is severely restricted , and this may even lead to secondary dislocation of the AC joint (Spencer et al 2007). As the SC joint is utilised so often, it is not surprising that 90% to 100% of cadaver specimens over 70 years had significant SC joint degenerative changes (Silberberg et al 1959; Spencer et al 2007).

Posture may also affect SC joint motion. Bearn (1967) showed that when the clavicle is depressed, the obliquity of the first rib restricts horizontal plane protraction and retraction. Rotation around the long

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axis of the clavicle was also found to be minimal in terminal depression, as well as in terminal elevation (Bearn 1967). This was most likely because the main restraint to rotation, the SC joint capsule, is already under tension in elevation and depression (Bearn 1967). This has implications for rehabilitation after injury, or in people with posturally depressed shoulders. SC injury which results in medial clavicular elevation (thus lateral shoulder depression), will likely lead to restricted SC joint motion. This in turn will lead to restriction of overall shoulder mobility. Postural shoulder protraction and/or depression could have similar but possibly less significant consequences. Unfortunately there are no known studies that have looked at the effects of posture on SC motion, or the long-term implications of posture for SC joint degenerative changes.

Incidence of SC Joint Injury

Non-traumatic:

While discussion of non-traumatic or degenerative SC joint pathology is beyond the scope of this review, some interesting research findings are described. Downward and forward droop of the shoulder after radical neck surgery can lead to SC compression and OA, and in one case this reportedly led to posterior SC dislocation (Spencer et al 2007). Post-menopausal related SC joint arthritis has also been described, (Spencer et al 2007) and the mechanism may be similar. It is reasonable to presume that postural shoulder protraction / depression would increase loading through the SC joint, and may lead to symptoms and possibly early degenerative changes.

Traumatic:

SC joint injuries are reported to be rare. In a review of 1603 shoulder girdle injuries, 85% were to the glenohumeral joint, 12% to the acromioclavicular joint, and only 3% were SC joint injuries (Bontempo & Mazzocca, 2010; Spencer et al 2007). Nettles & Linscheid (1968) reported that the incidence of AC compared to SC dislocations was 10:1. SC dislocation represents 1% of all dislocations in the body (Salvatore 1968). The reported proportion of posterior to anterior dislocations varies between 5% to 27% (Glass et al 2011). van Tongel & de Wilde 2011 say anterior dislocations are two to three times more common than posterior. In children, less than 1% of fractures occur at the medial end of the clavicle (Gobet et al 2004; Lewonowski & Bassett 1992).

Degree of Injury

According to Franck et al (2003) Allman classified SC dislocation with regard to the extent and direction of dislocation. As with any joint sprain, SC injuries are graded I to III:

- Grade I: This is a mild sprain, with no ligament laxity or joint irregularity. There will be tenderness over the joint with or without swelling, and pain on movement of the involved upper extremity. Treatment involves ice for two days, and immobilisation in a sling for 3-4 days, followed by gradual return of normal movements (Spencer et al 2007). This injury is frequently missed, as the pain due to the SC joint is often poorly localised (personal observation).
- Grade II: This represents a subluxation. There is partial ligament disruption, and there may be palpable joint laxity with stress applied to the clavicle. However the joint does not dislocate. There will be moderate to strong pain with movement and palpation, and usually swelling over the joint. If it remains subluxed, the joint may be reduced as for a dislocated SC joint (see below). A clavicular strap can be used for 1 week, followed by a sling for a further week, and

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the joint should be protected for 4-6 weeks (Spencer et al 2007). Allman felt with grade II injury the anterior or posterior capsule was torn but the costoclavicular ligaments were intact (Franck et al 2003).

- Grade III: there is complete joint dislocation, which will generally be anterior or posterior. The pain is often severe and exacerbated by any movement of the involved limb, which may be supported by the opposite arm. The ipsilateral shoulder may appear shortened and protracted, and supine lying will be uncomfortable due to the shoulder not lying flat on the table (Bontempo & Mazzocca, 2010, Spencer et al 2007). Grade III injuries are described in detail below.

Mechanisms of Injury to the SC Joint

Dislocations to the SC joint can arise through atraumatic/spontaneous or more commonly, traumatic mechanisms:

Atraumatic:

1. Anterior Dislocation:

Spontaneous subluxations and dislocations are most commonly seen in patients under 20 years, and more often in females (Spencer et al 2007, van Tongel & de Wilde 2011). However, cases are also reported in middle-aged females (Spencer et al 2007). The cause is often felt to be related to the presence of generalised ligamentous laxity (Spencer et al 2007, van Tongel & de Wilde 2011). However in three patients aged 15 to 17 years with SC joint instability, none were found to be hypermobile (Nettles & Linscheid 1968). In most instances, the dislocation will be apparent with elevation of the arm and reduce when the arm is returned to the side (Spencer et al 2007, van Tongel & de Wilde 2011). Pain is not a common feature in these patients (Sadr & Swann, 1979; Spencer et al 2007), and most sought help due to concerns about an asymptomatic lump. The authors felt the condition was self-limiting (Sadr & Swann, 1979; Spencer et al 2007) In one study comparing conservative to surgical management, the non-operated patients were doing well at 8 years, while those treated with reconstruction generally reported poor results (Rockwood & Odor, 1989 quoted by Spencer et al 2007). In another study 22 patients managed non-operatively with analgesia, education & reassurance had complete resolution of symptoms (Sadr & Swann, 1979).

2. Posterior Dislocation:

Spontaneous posterior dislocation is much less common, and non-operative management was used successfully in 2 out of 3 cases cited in the literature (Spencer et al 2007).

Traumatic Instability:

As stated previously, the ligamentous support to the SC joint is very strong, and dislocation to this joint is rare. This may be an indication of why a significant number of reported cases are in patients under 25 years, who fracture the weaker physeal plate. Tremendous forces are required to cause ligament rupture, so not surprisingly the most common traumatic causes of SC joint injuries are motor vehicle accidents and contact sporting injuries. 80% of SC injuries are related to these two factors, while falls from a height is another reported mechanism (Balcik et al 2013; Waters et al 2003). Other uncommon reported mechanisms were a fall onto the outstretched arm, and chiropractic manipulation (Nettles & Linscheid 1968). There were also rare cases of injury due to heavy lifting, all in patients greater than 60 years of age (Nettles & Linscheid 1968).

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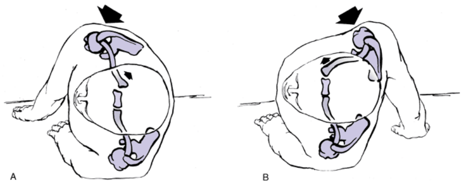

Fig 6: Mechanisms of posterior & anterior dislocation. Courtesy Spencer et al 2007, in Iannotti, J et al (eds). Disorders of the Shoulder: Diagnosis and Management, 2nd ed. Lippincott, Williams & Wilkins. Volume 2

For traumatic contact mechanisms, more specific causes were having the shoulder hit from behind and forcing it anteriorly – resulting in posterior dislocation (Fig 6A), or hit from the front forcing it posteriorly and resulting in anterior dislocation (Fig 6B) (Gilot et al 2006; Spencer et al 2007). Other mechanisms were a sudden lateral force to the shoulder forcing it medially, or a blow to the front or top of the shoulder (Balcik et al 2013; Spencer et al 2007). In theory, an opponent landing on the upper shoulder of a side-lying player could result in bilateral SC injury, and these have been reported in the literature. The diagnosis is frequently missed initially, particularly with posterior dislocations (Spencer et al 2007), and patients usually present with normal posture and general appearance (Nettles & Linscheid 1968).

Although subluxations and dislocations can have an inferior or superior component, the majority of SC displacements occur in an anterior or posterior direction (Spencer et al 2007). Anterior dislocation is thought to be significantly more common, however it is unclear what proportion of dislocations are posterior. In one study of 60 dislocations the proportion was around 20:1 anterior to posterior (Nettles & Linscheid 1968), while in their series of 185 cases the proportion was 2.7: 1 (Spencer et al 2007). Two cases in the literature were described as true superior dislocations (Levinsohn et al 1979; Little et al 2008).

1. Anterior dislocation:

The most common direction of dislocation is antero-superior or antero-inferior (Franck et al 2003). This is because the posterior capsular ligament is much stronger than the anterior (Lewonowski & Bassett 1992; Nettles & Linscheid 1968; Spencer et al 2007). This injury is unlikely to result from direct clavicular trauma. Most commonly, an anterolateral force to the shoulder results in medial compression and anterior shear to the SC joint. (Bontempo & Mazzocca, 2010, Spencer et al 2007). The mechanism of a force directed to the abducted shoulder was suggested by Balcik et al (2013). Posteriorly and medially directed forces to the lateral shoulder are compounded by the fulcrum action of the first rib on the medial clavicle, pushing it forward (Nettles & Linscheid 1968). The medial end of the clavicle will be visibly prominent anterior to the sternum (Fig 7A). This may be easier to visualise with the patient supine and observing from the end of the bed (Fig 7B).

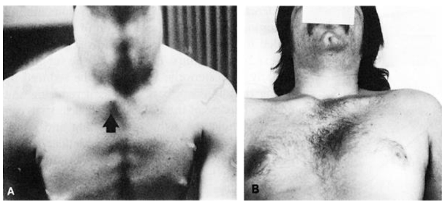

Fig 7: Visualisation of the anteriorly displaced clavicle. Courtesy Spencer et al 2007, in Iannotti, J et al (eds). Disorders of the Shoulder: Diagnosis and Management, 2nd ed. Lippincott, Williams & Wilkins. Volume 2

2. Posterior dislocation:

Around 120 cases of posterior SC dislocation have been reported in the last 75 years, and very few have been reported in children (Garg et al 2012). Superior and posterior dislocations have been described (Leighton et al 1989). These injuries often go unrecognised at the time of presentation due to their infrequency, paucity of examination findings and difficulty interpreting plain radiographs (Waters et al 2003). The amount of force required to dislocate the SC joint posteriorly is more than

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1.5 times that required for anterior dislocation (Balcik et al 2013). There is conjecture in the literature as to whether posterior dislocation occurs more commonly from direct or indirect trauma. Bontempo & Mazzocca (2010) felt direct force was the more common mechanism, while the review of Spencer et al (2007) reported indirect force was more common. Direct force involves a blow directly to the medial end of the clavicle, such as hitting a steering wheel, or the shoulder of a defender in contact sport. An indirect mechanism is most commonly described as a posterolateral force to the shoulder causing it to roll forward, causing SC compression and posterior shear (Bontempo & Mazzocca, 2010; Gilot et al 2006; Spencer et al 2007). This could occur with a side-on collision in a vehicle, or a football player's shoulder being driven in to the ground with the arm at the side. Less commonly, a fall onto an outstretched abducted arm could drive the clavicle medially and posteriorly (Spencer et al 2007). An anteriorly and inferiorly directed force would, due to first rib leverage, tend to push the medial clavicle postero-superiorly, as shown by Bearn's vertical loading in cadaver specimens (Bearn 1967). The clavicle would then 'hang' from the costoclavicular ligament.
On examination, the normal fullness produced by the medial clavicle will be reduced, and it may be possible to palpate the medial end of the clavicle lying posterior to the sternum. However swelling may render palpation unreliable and even give a false impression of anterior dislocation (Spencer et al 2007). This is why X-ray and particularly CT scan results are important.

Complications of Posterior SC Dislocation:

The incidence of complications associated with posterior dislocation is reported to be around 25% to 31% (Garg et al 2012; Glass et al 2011; Spencer et al 2007; Talac & Smith, 2007; Waters et al 2003), and there have been five reported deaths (Garg et al 2012, Spencer et al 2007). Late complications have been reported, as a result of progressive damage to hilar structures (Fig 8), even if no adverse symptoms were present initially (Zaslav et al 1989). In general, potential signs and symptoms include: venous congestion in the neck or upper extremity, breathing difficulties, shortness of breath, difficulty swallowing, hoarseness, a tightness in the throat, or a choking sensation (Spencer et al 2007). Dysphagia (in 31% of subjects) or odynophagia, were the main symptoms in Waters et al (2003) series. Circulation to the ipsilateral arm may be decreased. Nearly 10% of cases present with compression or laceration of the brachiocephalic vein (Balcik et al 2013; Garg et al 2012). More serious complications are stroke, haemothorax or pneumothorax (Lewonowski & Bassett 1992). Brachial plexopathy with thoracic outlet syndrome has been reported after chronic posterior SC dislocation (Garg et al 2012), as has exertional dyspnea, vascular compression, sepsis, and death (Waters et al 2003). Vital structures which may be compromised include the trachea, oesophagus, brachiocephaic and subclavian veins, pulmonary artery, internal mammary artery, brachial plexus, recurrent laryngeal nerve, lung, and lung pleura (Balcik et al 2013, Jacob et al 2013, Koch & Wells, 2012, Lewonowski & Bassett 1992; Spencer et al 2007). The brachial plexus may be injured directly, or subsequently as a result of pressure by an expanding aneurysm, shown clinically by progressive neurologic loss (Lewonowski & Bassett 1992).

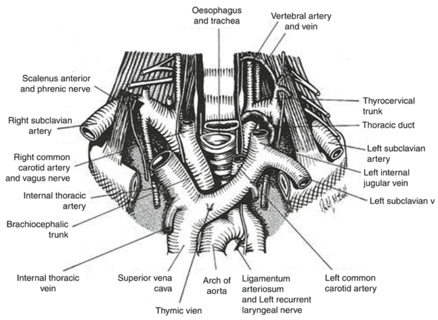

Fig 8. Mediastinal structures related to the SC joint

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3. Superior dislocation:

In their case history assessment of a patient with SC dislocation, Levinsohn et al 1979 describe an injury in a 25 year-old-man who fell directly onto the superior aspect of his left shoulder. On palpation the medial left clavicle was found to be around 8mm higher than the right. A laminogram demonstrated superior dislocation. A CT just above the level of the sternum demonstrated asymmetry of the clavicles proximally, but there was neither anterior nor posterior displacement of the left clavicle (Levinsohn et al 1979). At surgery the CT findings were confirmed, and the inferior ligamentous structures were torn but the superior capsule and interclavicular ligament were intact (Levinsohn et al 1979).

There is also one reported case in the literature of a superior SC displacement in an 18 year-old patient. (Little et al 2008). The injury occurred due to a MVA, where the person was ejected from a vehicle. On examination he had bruising and a hard tender bony swelling over his left SC joint, without anterior or posterior translation. The patient had difficulty moving the shoulder due to pain. Plain radiography and CT scanning revealed a marked superior and medial displacement of the medial aspect of the left clavicle compared to the right, without posterior or anterior dislocation. He was treated with a sling for 3 weeks. At 12 weeks he had a 'cosmetic deformity' of the SC joint, which was non tender and asymptomatic. Radiographs showed a persistent dislocation, but the patient had reported full function of the shoulder. The dislocation was described as superomedial, with the mechanism thought to be an indirect force directed medially from the lateral aspect of the ipsilateral shoulder. The authors felt the ligamentous injury was most likely to the interclavicular and inter-articular disc, with possible minimal disruption of the SC ligaments. They also felt the injury was a true dislocation rather than physeal injury. However this and the ligament injury sustained was not confirmed as the patient was treated conservatively. It would be possible to envisage this injury as a true dislocation, as the medially dislocating clavicle may be inclined to carry the epiphysis with it.

Traumatic Physeal Injury:

When the traumatic SC injury involves a physeal disruption, the clavicle is most commonly displaced in an anterior or anterosuperior direction, similar to the incidence of sternoclavicular dislocation (Fieishier & Ludwig 2010; Zaslav et al 1989). Posterior SC dislocations are "rare injuries in adults and are extremely rare in children" (Garg et al 2012). Koch & Wells, 2012 feel the history of injury is often non-specific, & physical examination findings can be subtle. Because the medial clavicular epiphysis is the last of the long bones to close, and the ligamentous SC joint is comparatively stronger than the physis, many apparent SC dislocations are in fact physeal injuries. In patients younger than 22 to 25 years, separation at the SC joint will generally always result in a Salter Harris Type I or II physeal fracture (Fieishier & Ludwig 2010; Franck et al 2003; Glass et al 2011; Spencer et al 2007; van Tongel & de Wilde 2011). Van Tongel & de Wilde (2011) reported that in all likelihood "a true anterior dislocation in a child does not exist". It is difficult to distinguish between the two injuries using X-ray, physical examination, or even CT scanning (Garg et al 2012; Glass et al 2011).

Some authors claim true SC dislocations can occur in children (Glass et al 2011; Waters et al 2003; Yang et al 1996 quoted by Gobet et al 2004). It is possible that in some of the studies quoted, the CT findings were misinterpreted, as the physis is not easily visualised on imaging. For instance, in the case history described by Garg et al (2012) a 13 year old boy with an apparent dislocation on CT scanning was found to have a Salter-Harris type I injury on subsequent open reduction. The true nature of the injury can only be verified during open reduction (Garg et al 2012) However Waters et al (2003) in

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their operative series of 13 skeletally immature patients (average age 14.6 years) with posterior displacements, reported that two patients (a 17 and a 14 year old) had true dislocations. These were diagnosed under direct visualisation during open reduction. In 11 of their 13 patients, the injuries were sports related.

With a physeal injury, the medial cartilage epiphysis stays with the sternum. As the majority of SC ligaments attach to the epiphysis, with some connection to the metaphysis, it is possible that minimal ligament injury occurs. The exception would be the costoclavicular ligament, particularly when there is a superior component to the clavicular displacement.

Physical Examination

The patient is initially sitting or standing. Observation from the front may reveal asymmetry of the shoulder or clavicle. The shoulder may appear shortened or protracted. Depending on the degree of injury, there may be swelling over the joint and tenderness to palpation. There may be a palpable step-off at the joint (Bontempo & Mazzocca, 2010). However because of swelling there is often no dimpling of the joint cavity (Franck et al 2003; Koch & Wells, 2012). The pain is often poorly localised, and may be described as being in the neck (Koch & Wells, 2012) or jaw region (personal observation). In the case of posterior dislocation, the patient may describe dyspnoea, difficulty swallowing, or a choking sensation. It is important to check for signs of venous congestion. With vascular compromise there may be evidence of venous congestion in the neck and ipsilateral upper limb (Waters et al 2003). A careful neurological examination should be performed due to the proximity of the brachial plexus (Balcik et al 2013). Pain will be exacerbated by cross-body adduction or lateral compression (Waters et al 2003). Range of motion testing will reproduce moderate to severe pain and limitation with Grade II ti III injuries. Lying supine will also be very uncomfortable, as the protracted shoulder puts pressure on the SC joint. In the supine position, observation from the end of the bed may show the deformity more clearly (Fig 8B) (Spencer et al 2007).

Imaging

X-ray:

X-ray diagnosis is usually unreliable (Franck et al 2003, Garg et al 2012; Talac & Smith 2007). In particular in younger patients, conventional radiology cannot distinguish between fracture and dislocation (Gobet et al 2004), and the presence of an open medial clavicular physis can complicate interpretation of radiographs (Waters et al 2003). Posterior dislocations are often missed on imaging studies (Jacob et al 2013). The most common views to image the SC joint are:

1. AP view. While commonly ordered, these can be difficult to interpret accurately due to the confluence of bony structures. (Balcik et al 2013, Spencer et al 2007). In an AP chest film an inferior clavicle on one side suggests anterior dislocation on that side (Spencer et al 2007).

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2. Oblique views. These are often recommended, but because of distortion of one clavicle over the other, interpretation is difficult (Spencer et al 2007).
3. Serendipity views. This is a bilateral view with the X-ray beam tilted 40° cephalically (Bontempo & Mazzocca, 2010, Spencer et al 2007). This is thought to give the best visualisation and allows for direct comparison of one side to the other. In an anterior dislocation the involved clavicle will appear raised compared to the opposite side, and will appear depressed with a posterior dislocation (Spencer et al 2007). However even these views have poor reported reliability (Talac & Smith 2007).

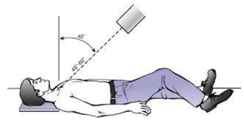

Fig 9: Patient positioning for Serendipity View X-ray. Courtesy Spencer et al 2007, in Iannotti, J et al (eds). Disorders of the Shoulder: Diagnosis and Management, 2nd ed. Lippincott, Williams & Wilkins. Volume 2.

4. Other views: Heinig & Hobbs views are described, with Heinig views favoured by Gobet al at (2004), supplemented by a panoramic view. Waters et al (2003) reported that chest films and panoramic views of the shoulder girdle are more reliable, particularly for anterior dislocation.

CT scan:

This is the best technique to demonstrate injuries to the SC joint, helping to provide a definitive diagnosis (Balcik et al 2013, Lewonowski & Bassett 1992, Spencer et al 2007, Waters et al 2003). Levinsohn et al (1979) published one of the early papers describing the use of CT scanning to more accurately assess this injury. This paper provides a method to visualise anatomic relationships in the anteroposterior dimension (Levinsohn et al 1979). It "clearly distinguishes injuries of the joint from fractures of the medial clavicle, and defines minor joint subluxations" (Spencer et al 2007). The accompanying images show cross section (Fig 10) and 3D CT scan image (Fig 11) of a posterior SC dislocation. However even CT scanning may be unreliable in differentiating between an epiphyseal disruption and a true dislocation (Franck et al 2003; Garg et al 2012; Gobet et al 2004; Lewonowski & Bassett 1992).

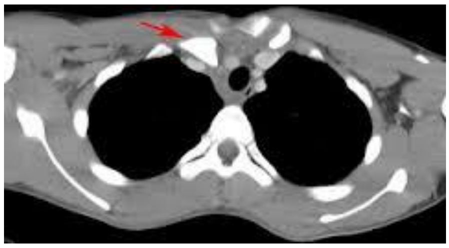

Fig 10: CT image showing a posterior SC dislocation.

CT scanning shows the dislocation in relation to the underlying mediastinal structures (Balcik et al 2013). It is important to request scans of both SC joints and the medial half of both clavicles (Spencer et al 2007). This is taken with the patient supine and axial sections allow side-to-side comparison (Bontempo & Mazzocca, 2010). A CT with intravenous contrast is the technique of choice if a posterior dislocation is suspected because it can assess the direction of dislocation and the underlying vasculature and soft tissues (Gobet et al 2004; Jacob et al 2013; Koch & Wells, 2012). Angiography / venography should be carried out when there is suspicion of vascular injury (Garg et al 2012). When indicated, *combined aortagram-CT scan* has also been recommended to assess for the presence of vascular injuries.

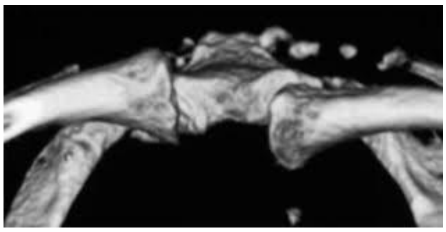

Fig 11: CT with 3D reconstruction demonstrating posterior SC dislocation.

Management

Because SC dislocation is such a rare injury, evidence-based treatment guidelines are lacking (Talac & Smith, 2007). Spencer et al (2007) describe a treatment algorithm for traumatic SC dislocation. Once

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the diagnosis is established, prompt treatment is optimal as functional outcomes for patients with acute dislocations are significantly better than for those with chronic dislocations (Glass et al 2011). In a systematic review, Glass et al (2011) reported 87.9% of traumatic dislocations, and 73% of chronic dislocations had excellent or good results, with the majority treated non-operatively or by closed reduction. 69% of anterior dislocations had good or excellent results with non-operative treatment. Nettles & Linscheid (1968) reported that 70% of 60 patients with general SC dislocation were successfully treated conservatively. 70% of chronic anterior dislocations treated non-operatively had good or excellent results, as did 70% of those treated by open reduction (Glass et al 2011). Posterior dislocations were mostly treated by closed reduction. There were excellent or good results in 96% treated with closed reduction or open reduction after failed closed reduction (Glass et al 2011). These results were irrespective of whether or not the patient's had symptoms of mediastinal compression.

Conservative Management:

For recurrent or persistent dislocation after a traumatic onset, the best management is still debated. Acutely, grade I & II injuries are treated with a short period of immobilisation in a sling (3 days to a few weeks), analgesia & ice (Balcik et al 2013, Bontempo & Mazzocca, 2010). A figure-of-eight bandage or splint can be used if indicated. For grade III injuries a closed reduction should be attempted.

Anterior dislocation:

The management of anterior SC dislocation is controversial. This can be treated initially with closed reduction (Nettles & Linscheid 1968; van Tongel & de Wilde 2011), and reduction is usually straight-forward (van Tongel & de Wilde 2011,). However closed reduction is associated with a recurrence rate of between 21% to 100% (Balcik et al 2013; Spencer et al 2007; Van Tongel & de Wilde 2011). After administration of analgesia &/or muscle relaxants, or alternatively under general anaesthesia, the patient is placed supine with a three to four inch roll centred between the scapulae. Gentle pressure is then applied to the anteromedial clavicle. (Bontempo & Mazzocca, 2010, Spencer et al 2007, van Tongel & de Wilde 2011). It may also be necessary for an assistant to apply anterior pressure over both shoulders to ensure reduction. The patient is then immobilised in a soft figure-of-eight dressing or clavicular strap for four to six weeks (Balcik et al 2013, Bontempo & Mazzocca, 2010, Spencer et al 2007). A sling may also be used during this time. The arm should then be protected for a further two weeks before strenuous activities are recommenced. If closed reduction fails, van Tongel & de Wilde 2011 recommend an ongoing conservative approach, and Garg et al (2012) feel there is "little if any impact of chronic anterior dislocation" (Garg et al 2012). However as the SC joint forms the link between the upper limb and axial skeleton, and so is critical to shoulder mobility, it could be argued that permanent and anatomical reduction is desirable, particularly in young active individuals. The long-term biomechanical consequences of chronic dislocation in the sporting or general population has not been described.

Posterior dislocation:

Even if complications are not present initially with posterior dislocation, late onset of complications are common (Garg et al 2012), so reduction is recommended. Prior to attempting reduction, it is important to exclude injury to mediastinal structures (Bontempo & Mazzocca, 2010). A closed reduction in the case of a tamponade could have devastating consequences (Koch & Wells, 2012). There is a case in the literature where surgery revealed that the displaced clavicle had put a hole in the pulmonary artery, and this had prevented exsanguination. It was felt an attempted closed

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reduction would have been disastrous (Worman & Leagues 1967 quoted by Spencer et al 2007). The reduction should be performed in the operating room with a vascular team on standby and the patient anaesthetised, as pain and muscle spasm makes this near impossible in the conscious patient (Jacob et al 2013).

The success rate following closed reduction in posterior dislocations has been reported at 68% if performed early (Garg et al 2012). Closed reduction is best attempted within 48 hours, but has been performed up to 4-5 days post-injury (Garg et al 2012; Spencer et al 2007), and in one study was performed up to 10 days post injury (Van Tongel & de Wilde 2011). The abduction traction technique is the favoured method of reduction. A roll is placed between the scapulae. Traction is the applied to the abducted arm, which is slowly extended. Traction should always proceed extension of the arm to prevent the anterior aspect of the medial clavicle from binding on the posterior surface of the manibrium (Van Tongel & de Wilde 2011). If the clavicle does not spontaneously relocate, this can be assisted using the fingers or a towel clip (Bontempo & Mazzocca, 2010, Spencer et al 2007, van Tongel & de Wilde 2011). Unlike anterior dislocation, posterior dislocations are usually stable once reduced (Bontempo & Mazzocca, 2010, Spencer et al 2007, van Tongel & de Wilde 2011). Post-reduction, a figure-of-eight brace should be worn for four to six weeks (Bontempo & Mazzocca, 2010). Active assisted range of motion exercises are initiated at 4 weeks, full active motion by 8 weeks, and full return to sport and other activities will be possible by 12 weeks in most cases (Spencer et al 2007). If this technique of reduction is unsuccessful, an alternative adduction traction technique has been described (Spencer et al 2007). With a bolster between the shoulders, traction is applied to the arm in adduction, while downward pressure is exerted on the shoulders. The clavicle is levered over the first rib into its normal position. Other techniques are described in the literature, including placing a knee between the scapulae of the seated patient and drawing backward on both shoulders (Spencer et al 2007).

Physeal injuries:

Because of the high osteogenic potential of the two raw bone surfaces of an epiphyseal separation, these patients are expected to heal more rapidly with better results as the bone is remodelled (Garg et al 2012; Glass et al 2011). Even in posterior physeal disruption, there is good scope for remodelling (Garg et al 2012).

1. Anterior displacement:

While anterior dislocations in children are easily reducible, it is said to be difficult if not impossible to maintain the reduction (Gobet et al 2004; van Tongel & de Wilde 2011). However, some authors have the opinion that these injuries generally remodel without operative treatment, and in time this remodelling process should eliminate any bony deformity or displacement (Spencer et al 2007). The intact periosteum along the anterior aspect of the metaphysis is the site of reactive bone formation (Leighton et al 1989).

2. Posterior displacement:

For these injuries it is generally agreed that a reduction should be attempted to prevent complications due to compression of posterior structures. Because of the possibility of injury to mediastinal organs, this should only be attempted with multidisciplinary surgical facilities on standby (Franck et al 2003). No consensus exists on the recurrence of posterior displacement after closed reduction (van Tongel & de Wilde 2011), however Lewonowski & Bassett (1992) felt closed reduction is usually successful and the joint is stable after reduction. These authors felt all posterior physeal separations should be

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reduced and immobilised (Lewonowski & Bassett 1992). However if reduction is unsuccessful, there is varied opinion on conservative versus surgical management (see operative management below). If the patient has minimal symptoms, one opinion is that observation may be indicated until remodelling occurs (Spencer et al 2007). The authors state: "Open physeal reduction is seldom indicated, except for the irreducible posterior displacement in a patient with significant symptoms" (Spencer et al 2007). For posterior dislocations the periosteal sleeve is still intact anteriorly (Spencer et al 2007). Zaslav et al (1989) state: "…as is the case with other childhood fractures, good remodelling can be expected along an intact periosteal sleeve that remains attached to the epiphysis as long as the physis remains open." The authors presented a case of successful conservative management of a 13-year-old male with a posteriorly displaced medial clavicular physis, where closed reduction failed. CT showed no obstruction of vasculature or trachea, and no symptoms of vascular or respiratory compromise. X-ray at around 14 weeks showed good callus formation, and the clavicular edge was noted to be moving farther from the hilar structures toward its normal position. The sling was removed at that time but contact sports were still restricted. At one year the joint looked normal (Zaslav et al 1989). The authors concluded that the "clavicle will remodel and achieve a near normal, stable sternoclavicular articulation after a reasonable period of protected growth" (Zaslav et al 1989). Prior to this time, complete restriction from contact or throwing sports is necessary.

Arguments for Surgical over Conservative Management:

According to Franck et al (2003), sometimes soft-tissue prolapses into the joint cavity, making a closed reduction impossible, & in such cases they felt open reduction was the method of choice (Franck et al 2003). In three cases of posterior separations Gobet et al (2004) reported that closed reduction under anaesthesia was attempted in all cases, but open reduction & internal fixation was employed when this failed. Many authors recommend open reduction and stabilisation in all cases (Garg et al 2012). Waters et al 2003 found that in three patients treated with closed reduction, follow-up CT scan showed loss of reduction, so they opted to treat all cases with open reduction and internal fixation. Similarly, Koch and Wells (2012) always employed open reduction. They believed that maintaining a closed reduction was difficult, so "open reduction and internal fixation is the preferred mode of treatment for the reduction of all posterior clavicular displacements" (Koch & Wells 2012). In their experience, and contrary to Lewonowski & Bassett (1992), these clavicles regularly dislocate again, and they advocated non-absorbable suture repair (Koch & Wells, 2012). Garg et al (2012) and Waters et al (2003) agreed that post-reduction instability was common. For the choice of conservative versus surgical management, the timing may be critical. Experience suggests that closed reduction may only be possible for up to 5 days post injury (Gobet al 2004).

In all symptomatic cases, the separation must be reduced during surgery (Spencer et al 2007). Post-surgery or closed reduction, the shoulders are held back with a figure-of-eight bandage or strap for three to four weeks. Gentle active assisted range-of-motion exercises are initiated with full active motion started at 6 weeks (Spencer et al 2007). All contact and overhead sporting activity is avoided for at least 12 weeks.

Operative Management:

Franck et al (2003) suggest surgical treatment of all grade III injuries (anterior and posterior).

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Anterior dislocation:

As stated above, the management of these injuries is controversial. Garg et al (2012) believe there is little risk with chronic anterior dislocation, and some authors believe that in the majority of cases the risks of surgery outweigh the benefits (Bontempo & Mazzocca, 2010, Spencer et al 2007). It is argued that the patient will usually do well with non-operative treatment even if the joint remains dislocated. Other authors recommend surgical management. Suturing of capsular and costoclavicular ligaments has been described for acute repair (van Tongel & de Wilde 2011). If the patient develops SC instability, there are numerous surgical options described. Reconstruction of the anterior capsular ligament using autograft is favoured by van Tongel & de Wilde (2011). According to Spencer et al (2007) if the intra-articular disc is torn it should be excised and the capsule repaired.

Posterior dislocation:

For posterior dislocations that fail closed reduction, open reduction may be indicated (Spencer et al 2007; van Tongel & de Wilde 2011). However the optimal method of stabilising the SC joint has not yet been established (Garg et al 2012). Waters et al (2003) believe repair or reconstruction of the costoclavicular and sternoclavicular ligaments is “critical in achieving a stable and congruous…articulation.” van Tongel & de Wilde (2011) state: “tenodesis, suture fixation, and ORIF have the highest percentage of excellent/good results in adults”.

Physeal injury:

No consensus exists on the recurrence of posterior displacement after closed reduction, although Gobet et al (2004) reported this as rare. Contrary to some opinions (above), the majority of reviewed authors advocated surgical management in cases of unresolved anterior or posterior physeal disruptions (Garg et al 2012; Gobet et al 2004; van Tongel & de Wilde 2011; Lewonowski & Bassett 1992; Waters et al 2003). Open reduction and internal fixation is recommended in these instances (Gobet et al 2004; van Tongel & de Wilde 2011; Waters et al 2003). Waters et al 2003 recommended open reduction and internal fixation for all skeletally immature patients with posterior displacement. They claim authors who recommend closed reduction have not used post-reduction CT scanning to assess whether the SC joint will remain stable. They initially treated three patients with closed reduction, but found on follow-up CT scan that this was not maintained. Therefore all patients with known posterior SC joint injuries were treated with open reduction and fixation of the SC joint and medial clavicle. The reason for the persistent instability was proposed to be the severity of ligamentous disruption, deforming muscular forces imparted to the clavicle, or soft tissue or periosteal interposition at the zone of injury (Waters et al 2003).

In Gobet et al (2004) series of 6 patients aged 8-15 years, one with posterior displacement and three with anterior displacement required open reduction and internal fixation due to unstable closed reduction. Follow up was 2 months to 6 years (mean 4 years) with excellent functional results in all cases – full range of motion, no pain, and unrestricted sporting participation. Normal SC anatomy on MRI was demonstrated in the two patients scanned.

According to Gobet et al (2004) anterior displacement is always associated with disruption of the anterior periosteum, resulting in complete lack of structures holding the reduced metaphysis in place. Closed reduction “may fail because of local ligamentous injury and the cephalad pull of the sternocleidomastoid, soft tissue interposed at the fracture site, and the long lever arm of the upper extremity that tends to displace the medial end of the clavicle” (Lewonowski & Bassett 1992). ORIF with the use of non-absorbable sutures is recommended for unreducible anterior displacement by

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Van Tongel & de Wilde (2011), who also state that the overlying periosteum should be repaired in all cases. They described a procedure in which the medial clavicular metaphysis was reapproximated to the epiphysis with sutures passed through drill holes in the anterior epiphyseal fracture fragment and medial metaphysis. The periosteum was also repaired with suture (Van Tongel & de Wilde, 2011). Absorbable sutures were used for fixation of posterior displacement by Garg et al (2012). Reconstruction has also been described, using semitendinosus or subclavius tendons (Bontempo & Mazzocca, 2010; Spencer et al 2007).

A post-op figure of eight sling is worn for 3-6 weeks after closed and open reduction (Gobet et al 2004;). The arm should not be elevated above 60° during the first four weeks (Van Tongel & de Wilde 2011). Waters et al (2003) advocated a sling & swathe for 4 weeks, then a sling for further 2 weeks and physical therapy commenced, for gentle passive and active range of motion exercises. Full sporting activity was allowed at 12 weeks post-operatively (Garg et al 2012; Waters et al 2003). Excellent results were reported in all cases of ORIF in 13 skeletally immature subjects, two reportedly with a true dislocation (Waters et al 2003).

OA of the SC Joint:

If degenerative changes become severe in the SC joint, isolated resection of the medial end of the clavicle has been reported with good results (Spencer et al 2007). However concomitant instability would be a contraindication (Spencer et al 2007). One author reported excellent results in patients who had maintenance or reconstruction of the costoclavicular ligament at the time of resection, and poor results in those who did not (Rockwood et al 1997, cited by Spencer et al 2007). Resection of the medial clavicle was also popular in the past for persistent SC dislocation. However unsatisfactory results were reported in up to 75% of cases (Franck et al 2003). For this reason the procedure is generally not recommended anymore as treatment for SC dislocation (van Tongel & de Wilde 2011). The use of resection for treating OA in active patients is also questionable, considering the poor outcomes reported for dislocation.

Post-operative Complications:

In the past, SC dislocations were repaired using hardware fixation. However the complication rate was found to be unacceptably high (Garg et al 2012; Glass et al 2011; Lewonowski & Bassett 1992; Spencer et al 2007). According to Spencer et al (2007) “through 1992, seven deaths & three near deaths from complications of transfixing the SC joint with Kirschner wires or Steinmann pins were reported…”. The significant movement required by the SC joint resulted in migration of hardware, often to the heart or an artery (Glass et al 2011). Tremendous leverage force were applied to the pins crossing the SC joint, & fatigue breakage of the pins was common. Once hardware fixation was abandoned there were no significant reported complications of SC joint stabilisation. However all four post-open reduction patients with physeal injuries reviewed by Gobet et al (2004) developed “disturbing hypertrophic scars”.

Summary

This review has explored the literature related to traumatic SC joint dislocations. It appears there is a lack of consensus regarding the ideal management for each type of injury. While conservative management is often advocated initially, and surgery for unsuccessful cases, the long-term success of the various treatment approaches has not been reported. As this joint is critical to proper functioning of the shoulder joint, it is suggested that further and longer-term research is required.

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