Textbook of Shoulder Surgery

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Editors

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Preface

Over the last 25 years, significant advances have been made in the understanding of the shoulder biomechanics and treatment of its pathologies. Arthroscopic techniques and instrumentation have enabled many conditions to be treated with low morbidity to the patient. There have been numerous advances in arthroplasty surgery since John Charnley developed the low-friction hip replacement. Improvements in trauma technologies mean patients can expect to return to near-normal function after complex injuries.

There are still many challenges to the modern shoulder surgeon. These include consolidating and comprehending the vast amounts of knowledge available, predicting the long-term outcomes of new technologies, and dealing with new complications (such as glenoid erosions and implant loosening after shoulder arthroplasty). Patients with shoulder problems understandably have higher expectations of returning to high-performance sports, older patients with complex medical co-morbidities demand effective pain relief and independent function, and children born with congenital abnormalities want near-normal shoulder development and function.

This textbook provides the most up-to-date information on shoulder surgery along with practical approaches for patient evaluation and treatment options. The book is divided into key parts, providing coverage on soft tissue disorders of the shoulder, arthritis of the shoulder, the paediatric shoulder and other miscellaneous topics relevant to treating this area. Its strong clinical focus will help practicing shoulder surgeons, residents and medical students to manage patients in a practical way, based on the most recent scientific evidence and the most effective surgical and non-surgical techniques. Thus, we hope it will become a valuable reference and resource for young doctors and students looking to increase their professional skills and knowledge when treating shoulder injuries and disorders in clinical practice.

Ian Trail is the senior upper limb surgeon at Wrightington Hospital. He has extensive experience of complex pathologies in the shoulder and is a leading authority on arthroplasty in the upper limb.

Lenard Funk is an experienced clinician, an expert in arthroscopic shoulder surgery and an authority on sports shoulder surgery in elite athletes. He is a highly regarded surgical trainer and educator for health-care professionals and patients.

Amar Rangan is a leading expert in shoulder conditions, particularly due to trauma. He is a key member on several national research councils and attracts many tertiary referrals for complex shoulder pathologies.

Matthew Nixon won the gold medal for the FRCS (Orth) exam and has since established himself as an authority on shoulder and upper limb pathologies in children. He runs a dedicated paediatric shoulder clinic dealing with congenital, neuromuscular, posttraumatic and tumour pathologies.

These editors, together, with carefully selected international experts aim to bring you a comprehensive review of what is known about shoulder pathologies, together with clinical pearls and operative techniques to help with their management.

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Part I

Trauma

The Sternoclavicular Joint

1

Graham Tytherleigh-Strong

Anatomy

The sternoclavicular joint (SCJ) is formed by the articulation between the medial end of the clavicle and the sternal manubrium and plays a vital role in the attachment of the shoulder girdle to the body. In fact, it is the only true articular connection between the upper limb and the axial skeleton, as the scapulothoracic joint is not a true synovial joint.

The SCJ is a synovial joint with largely incongruent articular surfaces (Fig. 1.1). On the clavicular side the surface is saddle shaped with a concavity in the anteroposterior plane and convexity in the vertical plane [1, 2]. Between the articular surfaces lies a fibrocartilaginous disc, similar to the meniscus of the knee [3]. This separates the joint into a medial and lateral compartment and is attached to the capsule at its periphery, to the superior surface of the medial clavicle and the first costal cartilage inferiorly. Contrary to most classic anatomical texts, a recent anatomical study has shown that the superior part of the disc inserts into the superior third of the medial end of the clavicle. Articular cartilage only covers the lower two-thirds of the medial end of the clavicle [2]. Despite the incongruent articular surfaces and small surface area of the joint, the SCJ is extremely stable owing to the effect of strong static (both intrinsic and extrinsic) and dynamic soft tissue stabilizers (Table 1.1) [4].

The anterior and posterior sternoclavicular ligaments are formed by thickenings in the capsule and are the most important contributors to antero-posterior stability [5]. The intra-articular fibrocartilagenous disc resists medial translation of the clavicle [4]. As a result, the disc can be prone to shearing injury, usually as a degenerate tear but occasionally as an acute incident.

The interclavicular ligament passes between the medial ends of both clavicles via the posterior aspect of the sternal notch and resists clavicular superior translation from gravity or forceful depression of the upper limb [4, 6]. The costoclavicular ligament passes from the inferior aspect of the medial clavicle to the first rib and/or first costal cartilage [7]. It is an important restraint when the clavicle is elevated.

The dynamic stabilizers form a musculotendinous envelope around the joint. The sternocleidomastoid and pectoralis major tendons lie anterior and posterior to the SCJ respectively and play a role in anterior and posterior stability, whilst the subclavius passes from the inferior aspect of the clavicle to the first rib providing superior stability as well as an additional anterior/superior component.

Several vital structures lie posterior to the SCJ including the great vessels of the neck, oesophagus and the trachea. These are at potential risk follow-

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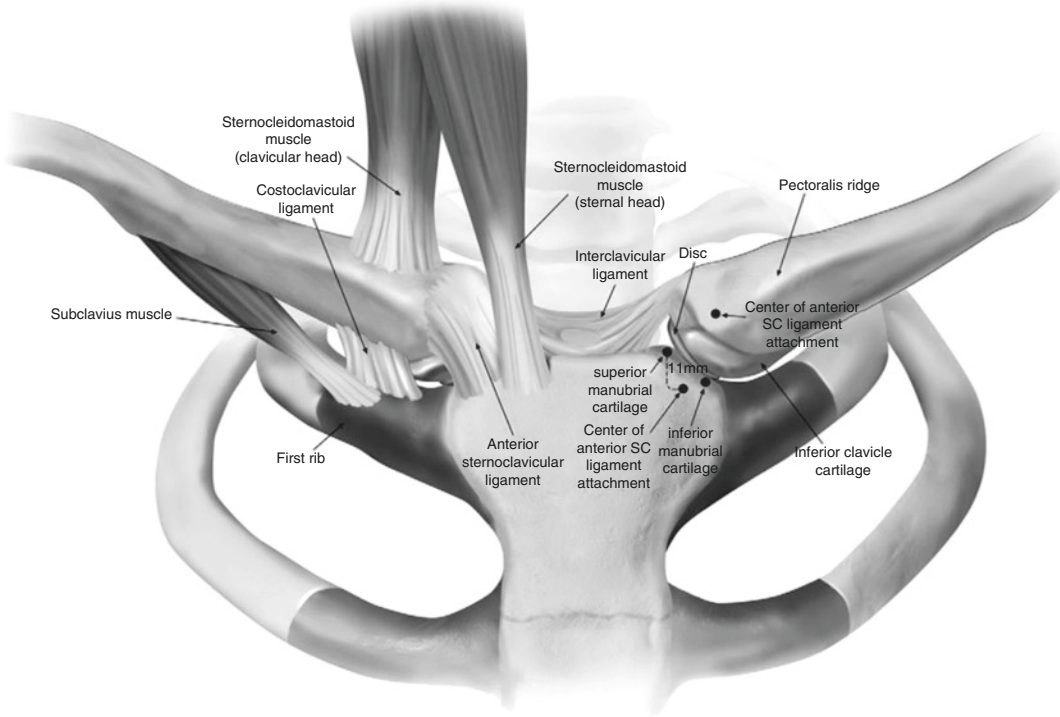

Fig. 1.1 Sternoclavicular joint

Table 1.1 Stabilisers of the SCJ

Static Stabilizers	Dynamic Stabilizers
Capsule	Subclavius muscle
	Sternocleidomastoid muscle
Intrinsic stabilizers Intra-articular disc ligament Anterior sternoclavicular ligament Posterior sternoclavicular ligament	Pectoralis major muscle
Extrinsic stabilizers Interclavicular Costoclavicular	

ing posterior dislocations. A layer formed by sternothyroid and sternohyoid muscles lies between these structures and the joint capsule [1, 2].

The epiphysis of the medial end of the clavicle is the first epiphysis to appear in utero and the last to close [8, 9]. This is of relevance because the physis at the medial end of the clavicle is weaker than the SCJ ligaments. Significant traumatic injuries before physeal closure, under the age of 25 years, may result in a fracture through the physis, Salter-Harris II fracture, rather than a true SCJ dislocation.

The SCJ moves in three planes: retraction/protraction, elevation/depression and rotation [10]. Movement at the SCJ and ACJ allows the scapula to move around the thorax to position the glenoid in the optimal location to maintain glenohumeral joint congruency for upper limb positioning.

History & Examination

As with any upper limb complaint, it is important to consider the age, handedness, sport, aspirations and occupation of the patient. An acute injury typically involves a high-energy mechanism and an SCJ injury may be missed in the presence of more dramatic components. Details of the exact mechanism of injury including direction of impact should be sought. Up to 30% of acute posterior dislocations develop mediastinal compromise, concerning features include dyspnoea, dysphonia, dysphagia, coughing and venous

congestion of the ipsilateral arm and should be considered as a medical emergency. Patients usually present with pain over the SCJ in the presence of a deformity, a prominence of the medial clavicle in anterior dislocations and a defect lateral to the sternum in a posterior dislocation.

In patients presenting with more chronic problems a history of previous trauma or a change of activity preceding the onset of symptoms may be relevant. In younger patients complaints of pain, clicking, a feeling of instability or even recurrent dislocation in the absence of injury may suggest an atraumatic instability. A history of connective tissue disorders such as Ehlers-Danlos Syndrome maybe relevant. Older patients may present with a pain and restriction of movement associated with a swelling over the medial end of the clavicle, in keeping with osteoarthritis.

SCJ examination is predominantly based on comparison and any asymmetry between sides. This requires exposure of the upper trunk to allow for comparison of both shoulder girdles including the clavicles, glenohumeral joints and scapulothoracic movements. There may be obvious asymmetry between the patient's SCJs with a lump present on the affected side. It is important to determine whether this is soft, representing an effusion or synovitis secondary to an inflammatory arthropathy or infection, or hard which could represent either a chronic anterior dislocation of the medial end of the clavicle or an osteophyte secondary to osteoarthritis.

Movements at the SCJ are intimately related to the rest of the shoulder girdle, so that assessment of the ACJ, Glenohumeral joint and scapulothoracic movements are essential to identify any confounding pathology. Both the SCJs should be examined and compared in 3 planes of movement. External and internal rotation with the elbow bent at 90° and the arm at 90° of abduction, protraction/retraction with the arms in extension and elevation with the arms in maximal abduction. Whilst examining the range of motion it is important that the examiner places a hand over the anterior joint to feel for any abnormal movement and clicking. Clicking, popping, or crepitus at the joint during movement may suggest degenerative changes or, in a younger patient, a disc tear. The medial end of the clavicle may sublux or even dislocate anteriorly in patients with instability (Fig. 1.2). In this instance broader assessment of the stabilising soft tissue envelope, particularly looking at sternocleidomastoid and the sternal part of Pectoralis Major, for muscle sequencing over activity should be undertaken.

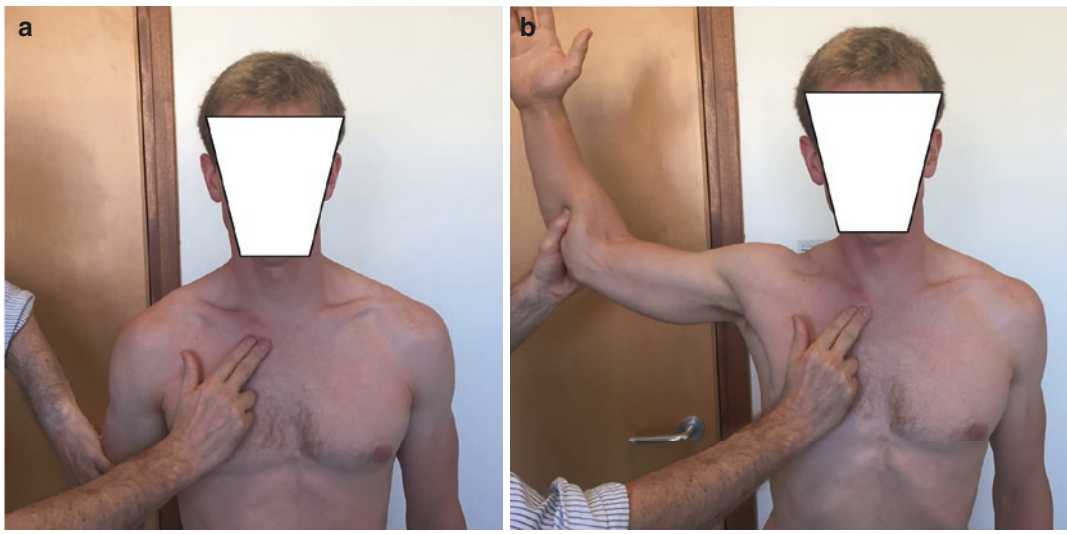

Fig. 1.2 Examination of the SCJ. (**a**) Palpation over the anterior joint line for pain and extruded disk. (**b**, **c**) Exterrnal & internal rotation: with the elbow bent at 90° and the arm at 90° abduction rotate the arm from external to internal rotation feeling for crepitus. (**d**, **e**) Protraction & retraction. (**f**) Elevation

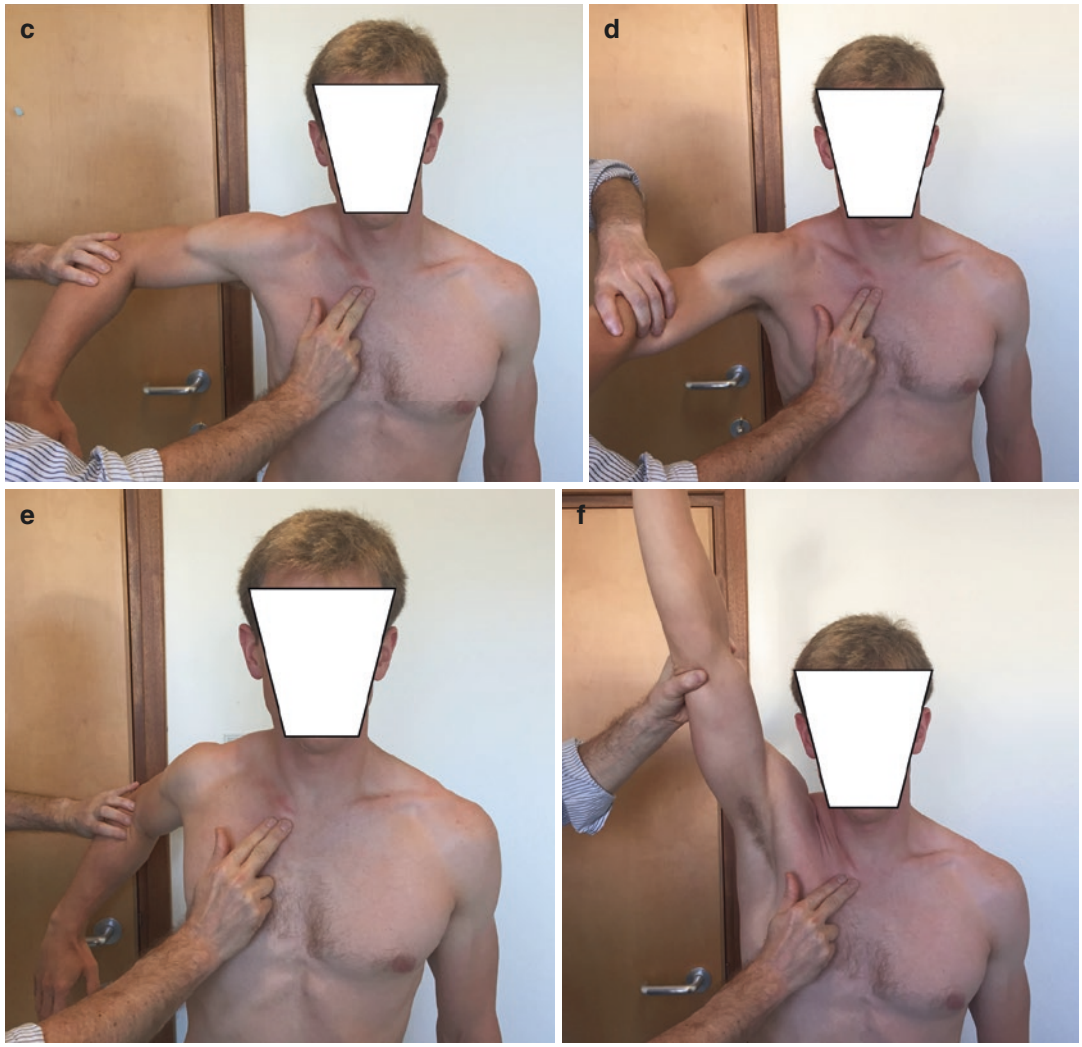

Fig. 1.2 (continued)

Sternoclavicular Joint Instability

Sterno-clavicular joint (SCJ) instability can be classified by direction (anterior or posterior), by severity (sprain, subluxation or dislocation – often referred to as type 1,2 or 3) or by whether it is acute, recurrent or persistent (chronic / unreduced). Whilst these classifications are descriptive none of them are able to take into account the traumatic or atraumatic nature of the instability. However, a classification system, that is a direct derivation of the Stanmore tri-polar instability triangle for the glenohumeral joint, has recently been described for the SCJ [11]. In the Stanmore SCJ instability classification there are three polar groups: type I traumatic structural, type II atraumatic structural and type III muscle patterning (neuromuscular) (Fig. 1.3). The type I traumatic structural group comprises traumatic subluxations and dislocations of the SCJ, as well as medial physeal fracture displacements. The type II atraumatic structural group comprises conditions which lead to laxity of the restraining ligaments, and includes connective tissue disorders (Marfan's, Ehlers Danlos), degenerative arthritis, inflammatory arthritis, infection and clavicular

shortening secondary to previous malunion. The type III muscle patterning group can occur in isolation and is most commonly due to an over active or aberrant pectoralis major muscle but it can also develop secondary to a type I or type II disorder.

A continuum exists between the groups. Therefore, a patient with an initial type II instability can develop secondary muscle patterning (type III) over time; this patient would be then classified as type II/III. The effect of any treatment can also be monitored using the Stanmore SCJ instability classification system. Patients 'migrate' around the triangle, depending on the presenting pathology, and how that changes over time as their treatment progresses.

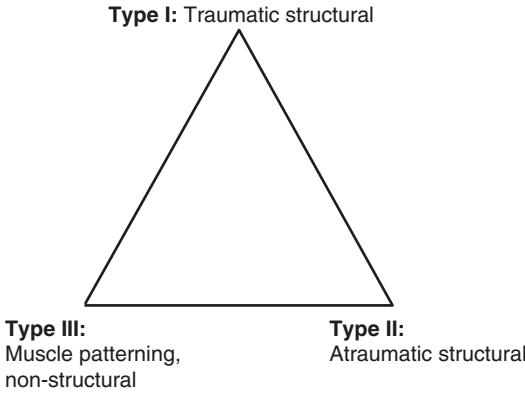

Fig. 1.3 Stanmore triangle

Type I Traumatic Structural

Traumatic SCJ dislocations are rare, accounting for less than 1% of upper limb injuries, and usually occur as the result of a high energy impact. The force is usually indirect and follows an impact either to the front or the back of the humeral head [12]. The force vector is then transferred along the clavicle resulting in disruption of the SCJ's restraining soft tissues. If the scapula is protracted at the time of impact a posterior dislocation is more likely and if the scapula is retracted it is more likely to dislocate anteriorly (Fig. 1.4). Less frequently a direct anterior blow to the clavicle can drive the medial end posteriorly into the mediastinum [13]. Biomechanical studies have shown that the force required to dislocate the SCJ posteriorly is 50% greater than that required to cause an anterior displacement [14].

A metanalysis of one hundred and forty adolescents with posterior SCJ dislocations reported that 71% occurred during sporting activities [15]. Although still rare this requires particular vigilance by pitch side sports physicians and physiotherapists as over 30% of patients following an acute posterior SCJ dislocation develop

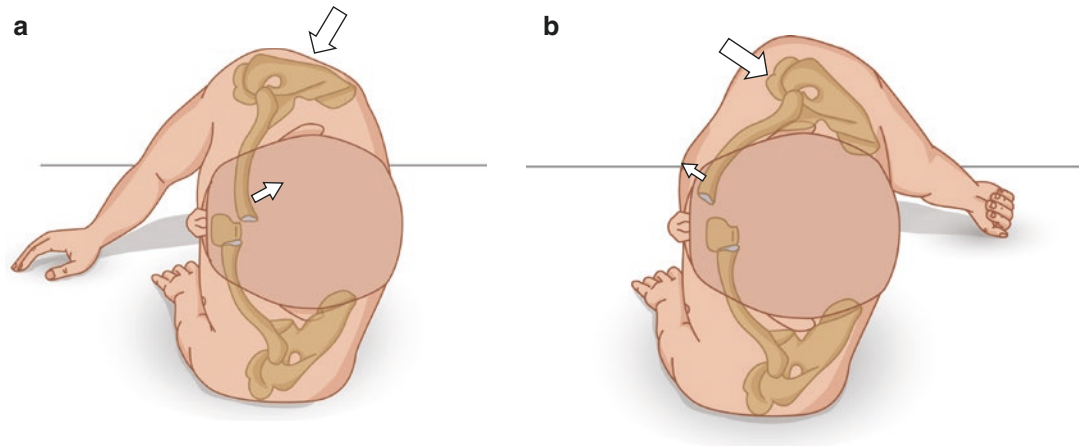

Fig. 1.4 Mechanism of injury. (**a**) Posterior dislocation: the scapula is protracted with an indirect force to the posterior shoulder. (**b**) Anterior dislocation: the scapula is retracted with an indirect force to the anterior shoulder

mediastinal pressure symptoms. Acute symptoms include dyspnoea (14%) and dysphagia (22.5%) due to pressure on the trachea and oesophagus and venous congestion or oedema of the ipsilateral arm due to compression of the vessels (14%). Less common complications of posterior dislocations include mediastinal hematoma, vessel laceration (leading to death), stroke, pneumomediastinum, pneumohemothorax, and venous thromboembolism (0.72–2.90%). As a result, an acute posterior SCJ dislocation should be treated as a medical emergency.

Patients presenting more chronically often complain of pain and deformity over the SCJ. In certain patients, as the medial clavicle has been pushed posteriorly, the whole of the shoulder girdle has rotated anteriorly and superiorly. As a result, the scapular tends to sit in a more superior and protracted position. Patients may complain of problems with glenohumeral function and of asymmetrical scapular protraction which, for example, can make sitting in high backed chairs uncomfortable as the medial scapula adopts a winged position (Fig. 1.5).

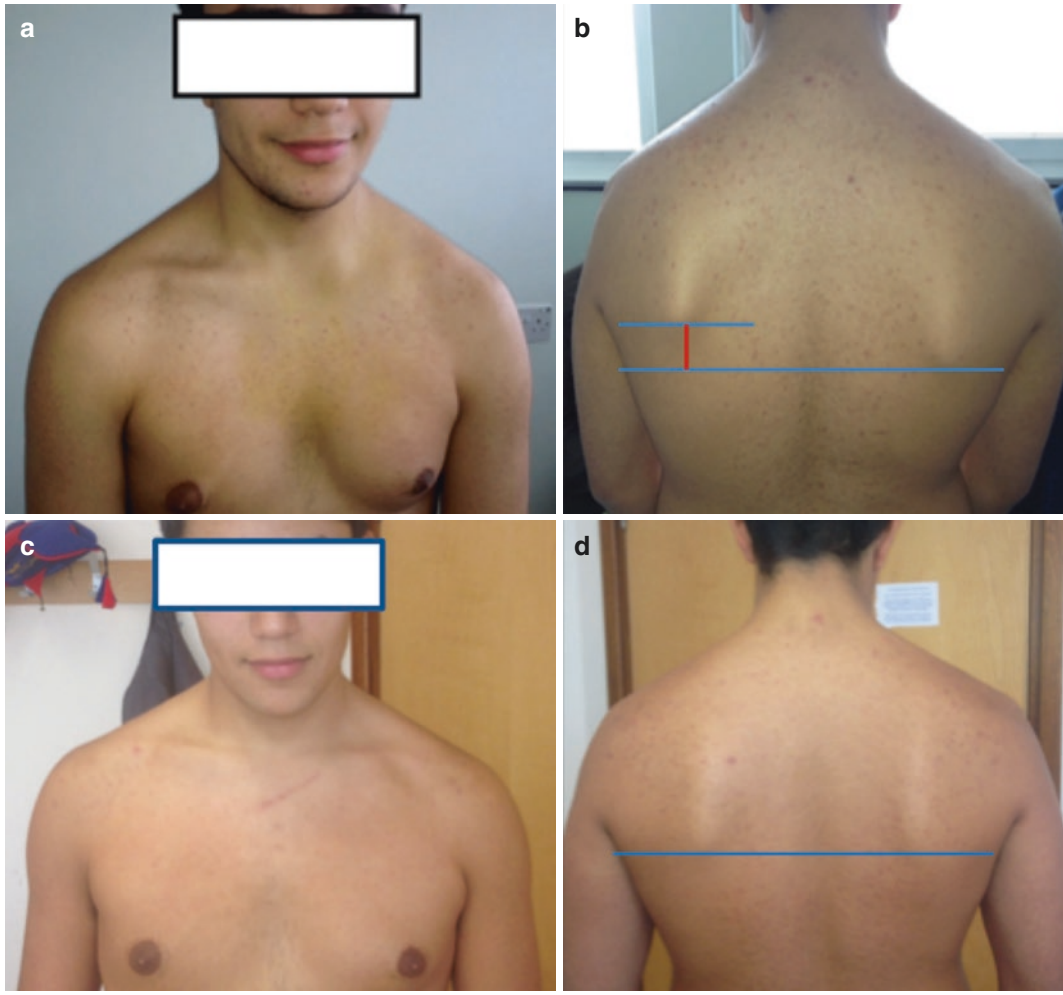

Fig. 1.5 Posterior dislocation. A 16 year old boy referred 4 weeks after sustaining a left posterior SCJ dislocation in a tobogganing accident. His CT scan confirmed an SCJ dislocation rather than an expected medial clavicular physeal injury. (**a**) Anterior view: note the asymmetry and loss of clavicular contour on the left. (**b**) Posterior view. Note the elevated and winged scapula on the left hand side. 3 months following open reduction and stabiisation using a figure of eight gracilis graft. (**c**) Anterior view: clavicular symmetry has been returned. (**d**) Posterior view: the left scapula has now returned to its normal position

On examination a patient with an anterior SCJ dislocation presents with an obvious forward displacement of the clavicle, while a patient with a posterior dislocation demonstrates asymmetry compared to the contralateral side, with diminution of the entire clavicular contour on the affected side. However, following an acute posterior dislocation, significant soft-tissue swelling often occurs over the first few days making a posterior deformity less obvious. It can also be difficult to clinically distinguish a medial clavicular physis fracture-dislocation from a true SCJ dislocation. A high clinical suspicion for medial clavicle physeal injury should remain for anyone under the age of 25 years.

Traditionally initial investigations following an SCJ injury include plain radiography using a Serendipity view. However, these are often difficult to interpret. A plain chest x-ray may be considered following an acute injury to check for an associated pneumothorax secondary to rib fractures. Currently the investigation of choice is a CT scan or, in the case of a posterior dislocation, a CT angiogram, this should be undertaken as a matter of urgency in the acute situation should there be any concern with regards to mediastinal compromise [16]. A CT scan can accurately assess the position of the medial end of the clavicle with regards to the sternum and the contralateral SCJ. It can also differentiate between a dislocation and a medial physeal injury. A CT angiogram additionally shows the arch of the aorta and great vessels in relation to the medial clavicle (Fig. 1.6). An MRI scan has poorer bony resolution than a CT scan but is able to more effectively demonstrate the ligamentous structures following subluxation and recurrent dislocation. It is also able to assess the intra-articular disc for injury and the condition of adjacent neurovascular anatomy.

Management of Type 1 SCJ instability depends on the severity of the injury, the direction of instability and the time from injury. Anterior and posterior undisplaced ligamentous sprains and subluxations of the SCJ (Grades 1 and 2) and minimally displaced medial physeal fractures can usually be treated with conservative measures. Initial reassurance, oral analgesia, and ice coupled with a short period of immobilisation

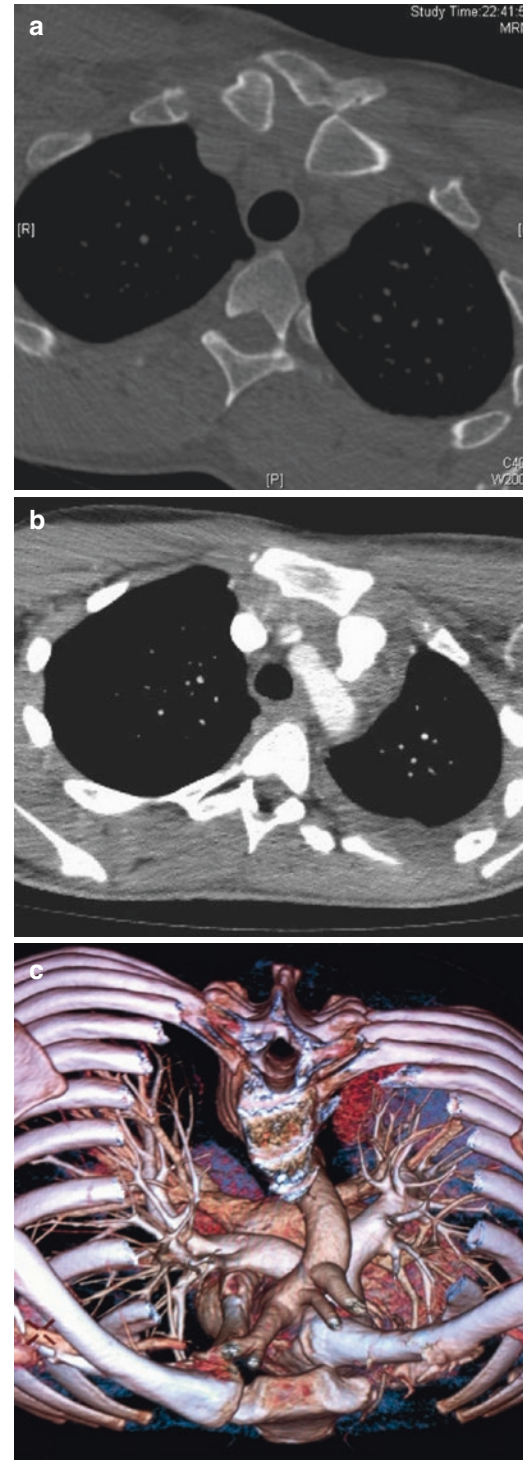

Fig. 1.6 CT scan (plain, angiogram and 3D reconstruction) of an acute posterior dislocation of the left SCJ. (**a**) Plain CT: axial view. (**b**) CT angiogram: axial view. The dislocated medial end of the left clavicle is abutting the arch of the aorta. (**c**) CT angiogram 3D reconstruction: the medial end of the clavicle is sitting on the arch of the aorta

in a sling is usually sufficient. The patient should be advised to avoid re-injury for 3 months and should avoid contact sports or other high-risk activities until there is a resolution of clinical symptoms [17]. There is no brace or support that will provide any extra protection to the SCJ on return to contact sports.

The management of SCJ dislocations (Grade 3 injuries) is dependent on the direction and the time after injury (<48 h or later). For anterior dislocations that are less than 48 h post injury, a closed reduction under sedation or general anaesthetic can be attempted. With a bolster placed under the patient between their scapulaethe clavicle is pushed in a posterior direction. The SCJ usually reduces easily but sometimes traction to the arm is necessary to pull the clavicle laterally. The arm should then be kept in a sling for 4 weeks in internal rotation [11]. Unfortunately, in over 50% of cases the SCJ re-dislocates.

The majority of surgeons adopt a wait and see policy following an anterior dislocation. Over a period of 3 to 6 months many patients' symptoms settle with conservative management, including a combination of physiotherapy and time [14]. A recent study has described a surgical repair technique for the treatment of first time traumatic anterior dislocations of the SCJ in younger patients involved in contact sports. They undertook a repair and plication of the anterior capsule augmented with internal bracing in 6 patients following a first time anterior dislocation. At a median follow-up of 28.2 months (range 24–35 months) none of the patients had sustained a further dislocation and they had all returned to their pre-injury level of sport [18].

If a patient continues to experience significant symptoms, despite an adequate period of conservative management, or if they sustain further recurrent dislocations then surgical stabilisation may be considered. This would usually require reconstruction using an autograft, allograft or synthetic ligament [19].

For posterior SCJ dislocations there is a greater need to reduce and maintain reduction of the joint. In the acute situation, in the face of mediastinal compromise, this is particularly the case. A chronic posterior dislocation may affect shoulder girdle function due to protraction of the scapula and there are concerns of potentially developing erosion to the subclavian artery or thoracic duct injury and trachea-oesophageal fistula. Although these complications are rare their probability will increase over time and so operative reduction and stabilisation may perhaps be of more consideration the younger the patient. Closed reduction is only generally considered if the injury is less than 48 h old. Closed reduction manoeuvers after 48 h are discouraged, as they may result in tearing of posterior structures, owing to the formation of adhesions. Closed reduction is undertaken using a general anaesthetic and a radio-translucent table allowing access for fluoroscopy. A bolster is placed posteriorly between the scapulae with the patient supine. Abduction, traction and extension are applied to the affected arm and a towel clip is used to grasp the medial clavicle and to pull it anteriorly [20].

Closed reduction of an acute posterior dislocation is difficult, with a reported success rate of approximately 50% in those cases attempted within 48 h and of 31% between the second and fifth day [15]. In a multicentre series of 30 acute posterior dislocations, of the 16 cases that were treated within 48 h, 7 required an open reduction and 2 of the 7 cases that could be reduced re-dislocated within 7 days and required a subsequent open stabilisation [21]. If a closed reduction is successful, due to soft-tissue swelling and difficulties in interpreting fluoroscopy images around the SCJ, a repeat CT scan to confirm the reduction has been maintained should be undertaken the next day.

Considering the high potential failure rate for a closed reduction it is important to consider, pre-operatively, the potential need to proceed to an open reduction and stabilisation. This may mean that a patient requires transfer to an appropriate facility where cardiothoracic cover is available.

Open reduction in the acute phase is usually technically easier due to the lack of adhesions, and the consequent diminished risk to the posterior mediastinal structures. In the chronic situation preoperative planning with a CT arteriogram with discussion and collaboration with a cardio-

thoracic surgeon are essential. Any likely adhesions to the posterior mediastinal vascular structures, with the brachiocephalic veins in particular, can then be anticipated. A transverse incision is made over the SCJ and, after freeing any adhesions, the clavicle is reduced by anterior and laterally directed traction applied through a towel clip or bone holding forceps. The normal capsular and ligamentous stabilisers are usually only partially repairable and are not biomechanically sufficient to maintain the reduction and, as a result, an open reduction will usually require some form of additional reconstruction [22].

Various types of wires and pins have been used to stabilise the joint, however, due to reported lethal complications, these techniques have, in the most part, been abandoned [23]. Reconstruction using sutures alone through osseous drill holes or suture anchors have been reported but with only marginal biomechanical results. The most recent trend has been towards reconstruction techniques using autograft (palmaris longus, semitendinosis, gracilis or sternocleidomastoid) or allograft. Several techniques have been described and although satisfactory outcomes have been reported for most techniques, a figure-of-eight reconstruction appears to be biomechanically superior and may lead to better longer term outcomes [22]. In this technique the graft is shuttled through 3.2 mm drill holes in the strenum and medial end of the clavicle. Synthetic ultra-strong synthetic braided sutures, such as Orthocord (DePuy Mitek, Raynham, Massachussetts) and Fibrewire (Arthrex, Naples, Florida) may be useful in augmenting the graft. The ends of the graft are then tensioned and sutured together, any surrounding remnants of the capsule may be incorporated into the repair (Fig. 1.7).

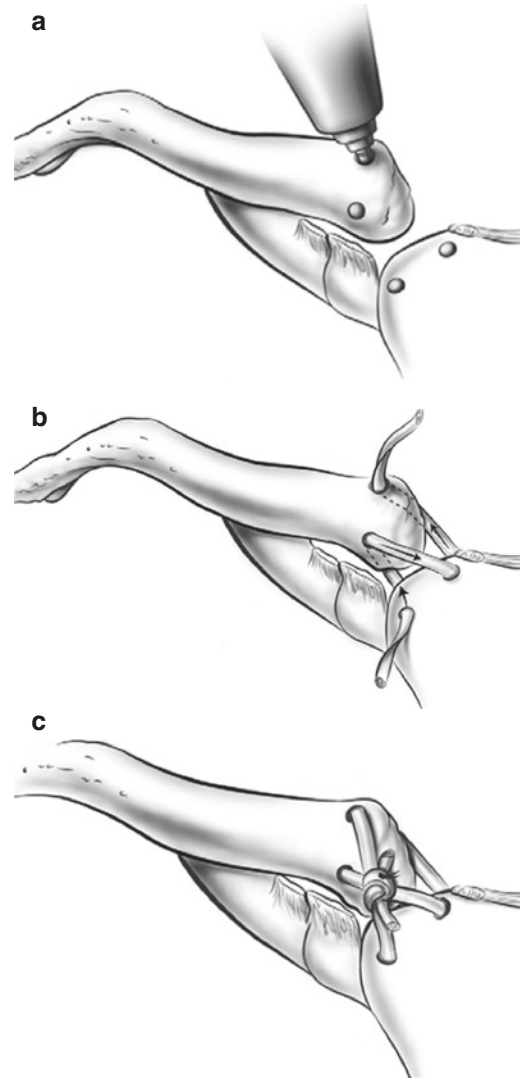

Fig. 1.7 SCJ reconstruction using a figure-of-eight hamstring tendon graft. (**a**) 3.2 mm drill holes are made in the medial end of the clavicle and the sternum. (**b**) Tendon graft is passed through the holes in a figure of eight. (**c**) The tendon ends are tensioned and sutured/tied together

Medial Physeal Clavicle Fractures

The medial clavicular epiphysis does not ossify until between 18 and 25 years of age. As a result, injury to the SCJ in patients younger than twenty five may actually lead to a displaced medial physeal fracture rather than a straightforward dislocation. A CT scan is the investigation of choice (Fig. 1.8). Fortunately, most physeal injuries are either un- or minimally displaced and rarely extend into the SCJ [24]. These injuries can be treated non-operatively with immobilisation in a sling.

More than 50% of patients with significantly displaced fractures that are treated non-operatively end up with persistent discomfort [14]. Some authors recommend an attempt at closed reduction for posteriorly displaced fractures within 7 days of injury. Open reduction should be

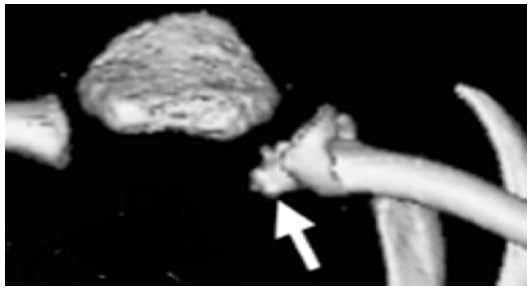

Fig. 1.8 CT 3D reconstruction of a right clavicular medial physeal fracture in a 19 year old man

reserved for injuries associated with mediastinal compressive symptoms [14]. Medial clavicle physeal injuries are stable once reduced and usually do not require fixation [25]. Anterior physeal injuries and posterior injuries presenting after 7 days may be treated symptomatically, with a degree of remodelling possible depending on the age of the patient.

Miscellaneous Causes of Type I Instability

Clavicular malunion resulting in relative anterior angulation of the medial end of the clavicle can give the appearance and sensation of anterior subluxation. This is particularly accentuated during retraction of the scapula and over time can lead to type II instability due to stretching out the anterior SCJ capsule. Other conditions which place the scapula in persistently abnormal positions, such as occurs with scoliosis, also predispose to atraumatic SCJ instability [11]. If the clavicular malunion induced SCJ symptoms are significant a corrective clavicular corrective osteotomy with a simultaneous SCJ stabilisation procedure may be necessary.

Type II Atraumatic Structural

Type II SCJ instability occurs as the result of either increased laxity or stretching out of the joint stabilising ligaments. It can be caused by a variety of pathologies including conditions that lead to ligamentous laxity (Marfan's, Ehlers Danlos) or those that can weaken or stretch the ligaments such as degenerative and inflammatory arthritis, infection and clavicular shortening, secondary to fracture malunion. Correct diagnosis therefore requires an accurate history and careful local and systemic examination.

In cases of capsular laxity clinical evidence of a generalised ligamentous laxity secondary to conditions such as Ehlers-Danlos and Marfan's may be present. Typically patients present in their teens with no specific history of trauma, with a prominence and subluxation of the medial clavicle and associated pain with overhead activities. The majority of patients can be managed successfully with physiotherapy and corticosteroid injections. In the largest reported series twenty nine of thirty seven patients (78%) returned to full activity when treated non operatively [26]. Eight of the patients (21%) had ongoing discomfort with evidence of persistent subluxation remaining in nearly all cases. The authors cautioned against surgical treatment of these cases as all of the patients that were managed surgically reported unsatisfactory results.

Owing to the much stronger posterior capsular restraints posterior atraumatic type II instability secondary to ligamentous laxity is much rarer than anterior [22, 27]. However, in a similar way to the traumatic posterior dislocations, if at any point a patient's symptoms should become suggestive of retrosternal compression an open operative reduction is indicated.

Type III Muscle Patterning

Type III instability is characterised by poorly coordinated afferent and efferent neuromuscular biofeedback loops in the presence of otherwise normal musculature and a structurally normal joint. The pectoralis major is the most commonly affected muscle and can be confirmed with EMG studies. Management focuses on re-learning the correct patterns of muscle contraction with proprioceptive feedback playing an important role [28]. Occasionally Botulinum toxin is can be used to suppress hypertonicity in pectoralis

major, if slow progress is being made with physiotherapy treatment.

Muscle patterning can also arise secondary to type I or II instabilities, making the diagnosis lie on the I/III or II/III axis. In this situation, it is important that the biofeedback loops are addressed prior to any stabilisation surgery. Botulinum toxin should be considered routinely pre-operatively in order to protect the ligamentous stabilisation in the first 3 months post operatively.

Clinical Pearl
Acute dislocation of the SCJ is usually the result of a high-energy injury and should be treated expectantly. Plain radiographs are insufficient and a CT or MRI should be undertaken. Mediastinal symptoms occur in 30% of patients with a posterior dislocation and discussion and referral on to a specialist unit should be considered.

Sternoclavicular Joint Ostoearthritis

Osteoarthritis of the SCJ is relatively common in patients over the age of 50 and particularly in women. Evidence of osteoarthritic changes at the sternoclavicular joint (SCJ) have been shown to be present on computed tomography scans in over 90% of patients over the age of 60 years [29]. However, it is usually asymptomatic and may present as a painless lump secondary to effusion and osteophytes. When symptomatic patients complain of pain, crepitus and clicking. This is particularly on cross body adduction and related to overhead sports such as tennis and golf.

Non-operative treatment including physiotherapy, NSAID medications and ultrasound guided intra-articular steroid injection are adequate in the majority of cases. Occasionally, in patients with unremitting symptoms, resection of the degenerate disc and the medial end of the clavicle are indicated. When undertaken as an open procedure the patient requires a period of immobilisation to protect the repaired anterior SCJ ligament [30]. It is now possible to do this arthroscopically as a day case without immobilisation [31] (Fig. 1.9). The results of an excision arthroplasty of the medial end of the clavicle for SCJ osteoarthritis, whether undertaken as an open or arthroscopic procedure, are good, with over 80% of patients scoring their SCJ as good or excellent after a minimum follow-up of 2 years [30, 31].

Arthritic involvement of the SCJ has been reported in over 30% of patients with rheumatoid arthritis and in 90% of patients with severe psoriatic arthritis. The management of these conditions usually involves systemic pharmacological suppression and local intra-articular steroid injections. However, in severely affected cases debridement of the SCJ and stabilisation maybe considered.

Clinical Pearl
Excision arthroplasty of the medial end of the clavicle is usually a very successful treatment for patients with symptomatic SCJ osteoarthritis that have failed non-operative treatment.

Sternoclavicular Joint Disc Injuries

The SCJ is divided into medial and lateral halves by a complete fibrocartilaginous disc which resembles a discoid meniscus in the lateral compartment of the knee. Although rare, damage to the disc can cause symptoms of pain and clicking of the joint on movement. Sometimes this clicking can be mistaken for minor anterior subluxation. In younger patients a shearing injury results in a complex tear in the middle part of an otherwise normal disc. This can occur when the joint is both loaded and twisting, such as in serving in tennis. In older patients there is usually pre-existing degenerative change present and the disc usually has torn from the superior periphery

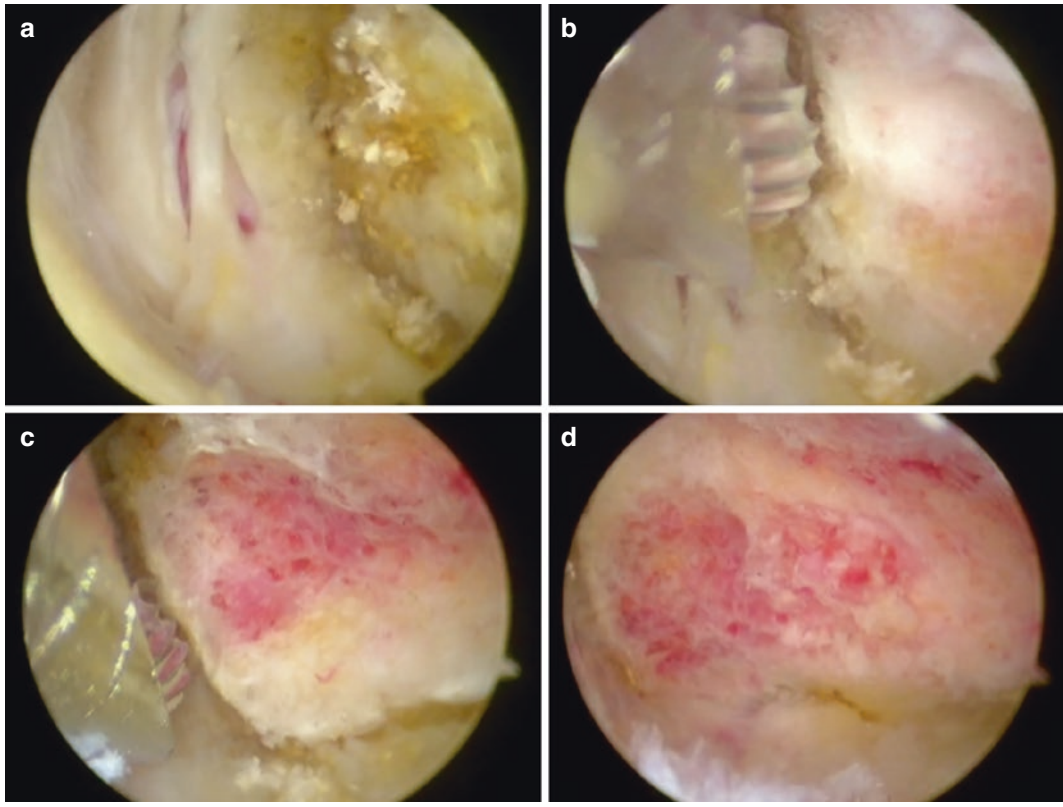

Fig. 1.9 Intra-operative arthroscopic pictures of a left SCJ arthroscopic excision. (**a**) The residual articular cartilage and soft-tissue has been resected off of the medial end of the clavicle (C). The intact posterior joint capsule (P) can be seen with the relatively well preserved sternal articular surface on the left (S). (**b**) A 4 mm acromioniser burr has been introduced through the superior portal and is beginning to resect the superior part of the medial end of the clavicle. (**c**) Boney resection has progressed inferiorly and medially to the inferior recess of the joint with the tip of the inferior osteophyte about to be resected. (**d**) Resection has been completed with the intact inferior capsule clearly visible

of the joint. There are often associated degenerative articular changes present within the joint.

An MRI scan can usually demonstrate a disc tear which has a characteristic wavy appearance when compared to the normal ipsilateral side (Fig. 1.10). A CT scan is not able to demonstrate the disc.

An ultrasound guided cortisone injection can be tried as the first line of treatment. If this is unsuccessful resection of the torn disc is indicated. This has previously been done as an open procedure but can now be undertaken arthroscopically [32, 33]. At surgery the whole of the disc is resected back to a stable rim. In the presence of a degenerative tear, resection of the medial end of the clavicle may also be undertaken if there are significant associated osteoarthritic symptoms.

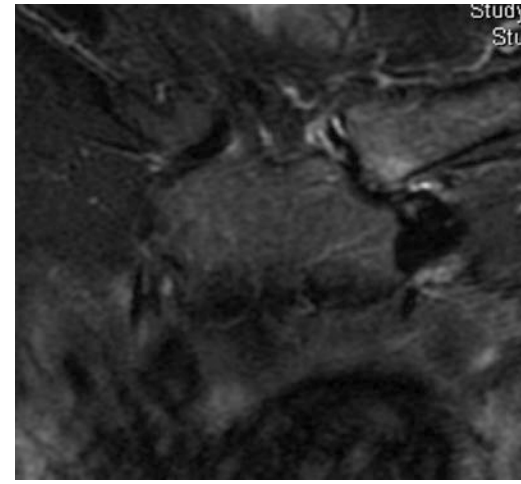

Fig. 1.10 MRI scan (T2) demonstrating a wavy appearance of the superior disc with a small joint effusion. This represent a tear/detatchment of the superior part of the discleft from the capsule. SCJ disc

Miscellaneous Sternoclavicular Pathologies

The SCJ can be the focus of a disparate group of other pathologies including inflammatory arthropathies, crystal-deposition arthropathies (gout and pseudogout), SAPHO syndrome (synovitis, acne, pustulosis hyperostosis and osteitis) and CRMO (chronic relapsing multifocal osteomyelitis). These conditions are all rare but the surgeon should be mindful of them as a potential differential diagnosis for a painful swollen SCJ. Initial investigations would be screening inflammatory markers (CRP, ESR) and either an MRI or CT scan.

Conclusion

Injury around the Sternoclavicular joint is relatively unusual. Injuries are usually high energy and result in instability and/or fracture of the medial end of the clavicle. An understanding of the complex arrangement of the ligaments, tendons and muscles that stabilise the joint and an appreciation of the posterior mediastinal structures is an essential requirement to treat these injuries successfully.

Osteoarthritis of the sternoclavicular joint is very common with increasing age and usually asymptomatic. Symptomatic osteoarthritis can usually be adequately treated with non-operative measures. In the unusual situation where symptoms persist, excision arthroplasty of the medial end of the clavicle, either as an open or arthroscopic procedure, is usually successful.

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Clavicle Fracture

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Introduction

'Clavicle' is derived from the early seventeenth century Latin word clavicula that means 'small key'. It is named so, because of its shape and the fact that it rotates 'like a key' on shoulder abduction. Clavicle is the only long bone that lies horizontally connecting the scapula to the sternum and is entirely subcutaneous thus easily accessible to inspection and palpation.

Codman (1934) mentions in his book the functional importance of clavicle in development of humans- "We are proud that our brains are more developed than the animals: we might also boast of our clavicles. It seems to me that the clavicle is one of man's greatest skeletal inheritances, for he depends to a greater extent than most animals, except the apes and monkeys, on the use of his hands and arms" [1].

As far back as 400BC Hippocrates is said to have noted the displacement pattern of the fractured clavicle; the distal fragment sagging with the arm and the proximal fragment point upwards. He stated that the fractures were difficult to reduce and maintain reduction but usually unites with a prominent callus and deformity [2].

The traditionally held belief that these fractures could generally be treated non-operatively has been brought into question in recent years, and the controversy over the optimal treatment has continued. Recent studies have shown a high prevalence of symptomatic malunion and non-union after non-operative treatment of displaced midshaft clavicular fractures while some studies have shown that the shortening in a malunion may be well tolerated.

Embryology

The clavicle is the first bone to ossify in the developing embryo and the only long bone to ossify by intramembranous ossification. It is formed by two membranous primary ossification centres appearing by 5–6 weeks and fusing approximately 1 week later. Cartilage at both ends of the clavicle then develops. In time, the medial cartilaginous mass contributes more (80%) to the growth in length of the clavicle than the lateral cartilaginous mass [3, 4].

The sternal ossification centre appears between 12 and 19 years and fuses relatively late in life, by 22 to 25 years of age [5, 6].

McGraw et al. (2009) [7] have shown at 18 years of age the mean clavicle length +/-SD

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