Case Study – Ultrasound Guided AC Joint Injection
Barry O'Flanagan

Introduction

The acromioclavicular (AC) joint is a diarthrodial joint with a limited range of motion, connecting the distal clavicle to the acromion of the scapula (Menge et al, 2014). The incongruent joint is lined by a fibro-cartilagionous disk and synovial membrane, which acts to absorb force transmitted through the joint in a similar fashion to the meniscus in the knee. Horizontal stability is provided by the acromioclavicular ligament, while the trapezoid and coronoid ligaments (coracoclavicular ligaments) provide vertical stability. (Chang et al, 2017). Dynamic stability is provided by anterior fibres of the deltoid muscle, trapezius and serratus anterior. These muscles provide support to the shoulder girdle, which in turns allows the upper limb to manage significant loads which are transmitted through the joint. (Corteen & Teitge, 2005).

While there is an overall paucity of epidemiology regarding AC joint pain, one Dutch study reported the incidence to be roughly 0.5 per 1000 per year in primary care (Van der Windt et al, 1995). Pain in the AC joint can be caused by direct or indirect contact. Direct contact by blunt force to the superior or lateral aspect of the shoulder can create a partial or complete tear of the ligamentous structures within the joint, and frequently occurs in contact sports such as rugby, American football and ice hockey. (Saccomanno et al, 2014).

Case History

JH, a 37 year old retired ex-professional rugby union player currently playing in an amateur men's rugby team in an over 35's league, was seen in a general practice sports clinic following referral by the team physiotherapist. His primary complaint was an acute right shoulder pain, an injury sustained in a training session, on a background chronic right shoulder pain. He reported symptoms of localized swelling and tenderness over the AC joint, difficulty when sleeping on the affected shoulder at night time and pain when performing cross body movement with the affected arm. JH also reported a history of recurrent shoulder dislocation and underwent corrective arthroscopic surgery to treat shoulder instability in a local orthopedic center 8 years prior.

Past injury history also includes left sided ACL surgical repair at the age of 21, with comorbid low grade medial ligament injury from which he made a full recovery. Exercise history is significant for repetitive overhead weight lifting throughout his long rugby career. In terms of past medical history, JH takes omeprazole 20mg once daily for treatment of gastro-esophageal reflux disease. He has no relevant family history and no known drug allergies.

He was assessed by the team physiotherapist at the time of onset by the team physiotherapist and his injury was considered to be a grade 2 AC joint injury. Initial management involved a conservative approach, according to best practice guidelines (Reid et al, 2012). This involved immobilization in a sling for the first two weeks until pain had eased somewhat. He was given regular paracetamol and NSAIDs, iced regularly and upper limb activity was limited to exercises to restore glenohumeral range of motion: internal and

external rotation, flexion to tolerance, towel slides and pendular exercises. Despite these conservative measures pain persisted and limited his participation in progressing his rehabilitation to return to play.

History, Examination and Differentials

On discussion with JH, he reported several instances through his playing career where blunt trauma from collision had resulted in shoulder pain on his right side. In most cases he had played through the pain and discomfort and rarely reported to medical staff. Typically, he would get strapping before each game with padding applied underneath, and also wore shoulder pads to protect his shoulders. He reported a generalized right shoulder pain that was focused around the AC joint but occasionally would radiate to the deltoid.

On initial assessment of the shoulder, there was an obvious step deformity present on the right AC joint with clavicle sitting approximately 1cm above the acromion on both sides, suggestive of AC joint pathology (Chronopoulos et al, 2004). The right shoulder appeared to be set slightly lower on the right side when compared to the left. Additionally, there was an asymmetrical distribution of muscle bulk of the pectoral muscles anteriorly and also posteriorly in the posterior fibers of the trapezius muscle and to a lesser extent the supraspinatus and infraspinatus.

On palpation there was clear tenderness over the AC joint on the right side, however this can be considered as a non-specific sign of AC joint pathology (Hegedus et al, 2008). There was no tenderness on the sternoclavicular joint on either side, nor tenderness along the anterior shoulder in the bicipital groove, the acromion and along all other bony surfaces. There was no tenderness on palpation of the cervical vertebrae.

Assessment of cervical spine flexion, extension, rotation and side flexion were all unremarkable with JH achieving full range of movement without pain or exacerbation of symptoms. Glenohumeral range of flexion, extension, abduction, adduction, internal and external rotation were all within normal limits on the affected shoulder, although pain was noted on active abduction and also end range of flexion. Power was preserved throughout all planes on resistance, except for 4/5 power on abduction.

Cross body adduction with 90° flexion and elbow fully extended (scarf test) was positive, resulting in clear pain. Resisted forward flexion resulted in pain, which can be indicative of ACJ pathology also (Chronopoulos et al, 2004). Other special tests for shoulder pathology including Hawkins-kennedy, with internal rotation at 90° flexion, was positive indicating likely sub acromial impingement of rotator cuff muscles (Park et al, 2005). Of note, neurological tension tests for radial, ulnar and median nerve were negative. Sperling test for nerve root compression was performed and did not elicit pain.

O'Brien active compression test, which comprises of resisted forward flexion with 10° of adduction was also positive with both internal and external arm rotation. This is suggestive of both AC joint abnormality, but also indicative of a super labrum anterior-posterior (SLAP) lesion, which may have resulted from previous shoulder dislocation. Despite having undergone arthroscopy for shoulder stabilization, JH was examined for instability however apprehension test was negative. Crank test, where arm is flexed and adducted to 90° in the

seated position. Axial load was applied toward the joint with one hand while another hand performed gentle humeral rotation to 10° internal and externally. This test was positive for pain, most likely indicating a concomitant labral pathology. This test was found to have 91% sensitivity and 93% specificity according to Lue et al (Leu et al, 1996). JH filled out a visual analogue scale for pain at this time which scored an 8/10.

Differential Diagnosis

In the context of multiple positive provocative shoulder stress tests, it is most likely that there is a concomitant acute grade 2 AC joint injury on a background of chronic AC joint osteoarthritis, and also potential labral pathology. Other differential diagnosis considered include AC joint instability, rotator cuff tear, os acromiale, brachial plexus injury, osteolysis of distal clavicle, complex pain syndrome, thoracic outlet syndrome and clavicle fracture.

Investigations and Diagnosis

In terms of accurately evaluating AC joint injury, X-Ray represents a cheap, accessible and effective initial investigation for AC joint injury. The joint can be studied with normal AP views of the shoulder, even though the best option according to the literature is the Zanca view (a cephalad tilt of 10–15° with 50% exposure reduction compared to the standard AP view of the shoulder). Radiological signs of AC joint osteoarthritis include joint space narrowing, subchondral cysts, osteophytes and subchondral sclerosis (Mazzocca et al, 2007)

Computed tomography can be used to evaluate for concomitant bony injuries. CT allows for superior osseous visualization, while magnetic resonance imaging (MRI) provides superior visualization of soft tissue lesions, such as capsuloligamentous structures, bone edema, and abnormalities in surrounding soft tissues such as bursal effusion or tendon pathology (de Abreu et al, 2005).

Ultrasound also offers an easily accessible point of care assessment of the AC joint, specifically can determine for presence of superficial bone irregularities and osteophytes, capsular hypertrophy, joint space narrowing and joint effusion or synovial hypertrophy (Precerutti et al, 2020). In the case of JH, we elected to use ultrasound evaluation as an adjunct to clinical examination to help evaluate and manage the shoulder injury. The key findings on ultrasound evaluation his acromioclavicular joint included some evidence of joint space narrowing, superficial osteophytes, and capsular hypertrophy indicating joint degeneration consistent with OA.

In summary, history, exam and ultrasound findings indicate an AC joint pathology, however there is potentially a significant potential for overlap of rotator cuff and labral pathology, and is therefore important to determine the source of pain for this patient. According to Precerutti et al, when assessing shoulder pain, it is important to distinguish between AC joint osteoarthritis and other causes such as rotator cuff pathology which is more common. When there is overlap, an injection of local anesthetic in the AC joint may be helpful in formulating a diagnosis (Precerutti et al, 2020).

An interesting study identified in the literature which may assist in determining diagnosis; a study performed by Cadogan et al that identified a number of features which identify candidates most likely to benefit from AC joint injection. Firstly, they evaluated the diagnostic accuracy of traditional tests for AC joint pain, including cross body adduction, O'Briens test, Hawkins-Kennedy test and localized AC joint tenderness. Perhaps unsurprisingly, they determined that candidates who are most likely to have a positive response to local anesthetic are observed when all 4 tests were positive (PPV 0.50; 95% CI, Table 1) (Cadogan et al, 2013).

Clinical tests	Cell counts				Diagnostic accuracy						
	TP	FN	FP	TN	Sensitivity (95% CI)	Specificity (95% CI)	PPV (95% CI)	NPV (95% CI)	LR+ (95% CI)	LR- (95% CI)	OR (95% CI)
Individual tests											
Cross-body adduction	14	8	93	33	0.64 (0.43, 0.80)	0.26 (0.19, 0.35)	0.13 (0.08, 0.21)	0.81 (0.66, 0.90)	0.86 (0.58, 1.12)	1.39 (0.71, 2.43)	0.62 (0.24, 1.61)
Active Compression/ O'Brien's test	3	19	10	*117*	0.14 (0.05, 0.33)	0.92 (0.86, 0.96)	0.23 (0.08, 0.50)	0.86 (0.79, 0.91)	1.73 (0.53, 5.15)	0.94 (0.72, 1.06)	1.85 (0.47. 7.33)
Hawkins-Kennedy test	14	6	81	45	0.70 (0.48, 0.86)	0.36 (0.28, 0.44)	0.15 (0.09, 0.23)	0.88 (0.77, 0.95)	1.09 (0.74, 1.41)	0.84 (0.39, 1.55)	1.30 (0.47, 3.61)
Localised ACJ tenderness	8	14	34	94	0.36 (0.20, 0.57)	0.73 (0.65, 0.80)	0.19 (0.10, 0.33)	0.87 (0.79, 0.92)	1.37 (0.70, 2.39)	0.87 (0.58, 1.13)	1.58 (0.61, 4.10)
Combinations of tests											
At least 1 of 4	21	1	120	9	0.96 (0.78, 0.99)	0.07 (0.04, 0.13)	0.15 (0.10, 0.22)	0.90 (0.60, 0.98)	1.03 (0.84, 1.11)	0.65 (0.11, 3.54)	1.58 (0.19, 13.09)
At least 2 of 4	11	9	77	43	0.55 (0.34, 0.74)	0.36 (0.28, 0.45)	0.13 (0.07, 0.21)	0.83 (0.70, 0.91)	0.86 (0.53, 1.20)	1.26 (0.69, 2.01)	0.68 (0.26, 1.78)
At least 3 of 4	6	14	22	93	0.30 (0.15, 0.52)	0.81 (0.73, 0.87)	0.21 (0.10, 0.40)	0.87 (0.79, 0.92)	1.57 (0.70, 3.13)	0.87 (0.59, 1.09)	1.81 (0.63, 5.25)
4 of 4	1	19	1	113	0.05 (0.01, 0.24)	0.99 (0.95, 1.00)	0.50 (0.10, 0.91)	0.86 (0.79, 0.91)	5.70 (0.60, 52.63)	0.96 (0.77, 1.01)	5.95 (0.36, 99.19)

Abbreviations. TP, true positives; FN, false negatives; FP, false positives; TN, true negatives; CI, confidence interval; PPV, positive predictive value; NPV, negative predictive value; LR+, positive likelihood ratio; LR-, negative likelihood ratio; OR, odds ratio.
Note: Cell counts do not total 153 in some cases due to missing data.
All *P*-values for the OR were >0.05 (not significant).

Table 1. Diagnostic accuracy of traditional tests for acromioclavicular joint pain (from Cadogan et al, 2013).

Cadogan et al went further, and identified five clinical variables from history and physical examination that were associated with an 80% positive anesthetic response following ACJ diagnostic injection (P≤0.05). These variables are listed below.

(1) repetitive mechanism of pain onset.
(2) the absence of referred pain below the elbow.
(3) visual observation of a thickened Ac joint on ultrasound.
(4) typical symptoms were not reproduced glenohumeral joint abduction.
(5) typical symptoms were not reproduced by passive glenohumeral external rotation at 90° abduction.

These variables, when all present, were associated with an 80% positive anesthetic response following AC joint injection (P≤0.05) (Cadogan et al, 2013). Examination of JH revealed that indeed all of these criteria were present, which suggested optimal outcomes and decision was made to progress with AC joint injection.

Role of intra-articular injection in acromioclavicular osteoarthritis

There are many options available and worth considering for arthritic joint injection. These include hyaluronic acid, platelet rich plasma, corticosteroids and local anesthetic.

Corticosteroids

A prospective study was established to assess the effect of an intra-articular injection of a combination of corticosteroid and local anesthetic into the acromioclavicular (AC) joint.

Fifty-eight patients with isolated AC joint symptoms were included. Clinical tests were repeated immediately following the injection, as well as at 1-month follow-up. The diagnostic value of the injection of a local anesthetic in the AC joint is immediate. Only 28% have a clear pain at 1 month. Longer term, 19% of patients reported no AC joint related pain after an average follow-up of 42 months (van Riet et al, 2012).

Larger studies have demonstrated that at low dose intra-articular steroids can have beneficial effects arthritic joints. A systematic review performed by Wernicke et al in 2015 included 40 high quality studies assessing impact of steroid injection on articular cartilage. They determined the best outcomes were associated with lowest effective steroid dose (Wernicke et al, 2015). Another study evaluated safety and efficacy of long term intra-articular triamcinolone steroid for knee osteoarthritis determined that the steroid was not only safe at low doses, but also long-term treatment of knee OA with repeated steroid injections appears to be clinically effective in halting the progression of the course of OA in the knee (Raynauld et al, 2003). Complications of this procedure are not common but include post infection flare (2%), septic arthritis (0.03%), hypopigmentation (0.8%), fat atrophy (2.4%) and facial flushing (1%).

Hyaluronic Acid

Hyaluronic acid is a natural constituent of synovial fluid, and is noted to be decreased in patients with advanced degenerative joint disease. For this reason, hyaluronic acid is often administered to degenerative joints. Hyaluronic acid has also been found to prevent escaping proteoglycans from cartilage in the joint space, and can therefore be used as a barrier against inflammatory cells (Gupta et al, 2019). Other animal studies have demonstrated anti-inflammatory, anti-oxidative, immune modulating and analgesic effects of hyaluronic acid (Takahashi et al, 2001; Chernos et al, 2017; Balazs 1985; Gotoh et al, 1993).

Platelet Rich Plasma

Platelet rich plasma (PRP) is an autologous blood product that when injected into tissue is thought to have anti-inflammatory effects and create conditions favorable to repair and regeneration (Andia & Maffulli, 2013). A systematic review and meta-analysis in 2020 demonstrated level 2 evidence to demonstrate PRP to be more effective than hyaluronic acid in treating pain in knee osteoarthritis (Hohmann et al, 2020). However, there is a paucity of research in the area of PRP therapy in AC joint therapy, but evidence to date is ambiguous and for this reason the use of PRP was not considered for this case.

Local Anesthetic

Local anesthetic has long been used to inject into joints when there is diagnostic uncertainty when trying to determine the source of pain surrounding the AC joint (Shaffer, 1999). 1ml of 1% Lidocaine is typically used due to rapid onset of analgesic effect. In larger doses lidocaine can be chondrotoxic, affecting osteoarthritic joints at a higher rate than non-osteoarthritic joints (Breu 2013). Other safety concerns regarding local anesthetic include cardiotoxicity in higher doses that can affect heart rhythm leading to atrioventricular heart block, ventricular tachycardia and fatally ventricular fibrillation. For these reasons the lowest effective dose is used and not exceeding 4.5mg/kg.

Resolution of pain after intra-articular injection of local anesthetic is considered an extremely valuable diagnostic tool for patients with AC joint pain (Bigliani et al, 1993). It is a valuable prognostic tool when considering surgical interventions such as distal clavicle resection. Difficulties arise in the event of false positive outcomes, where a misplaced injection relieves pain. On the other hand, false negative results that may arise when the joint is missed, may deny the patient a relatively safe and effective intervention (Tallia et al, 2003).

Role of ultrasound in diagnosing and treating AC joint arthritis

Despite the relatively superficial location of the AC joint, clinical accuracy of landmark guided injections remains relatively low. One small study involving 30 participants, assessed landmark guided AC joint injection which was subsequently radiographically evaluated to determine accuracy, found only 13 of the 30 injections (43%) were successfully accurately sited (Wasserman et al, 2013).

Ultrasound can provide good visualization of the affected joint, which typically in symptomatic AC joints can be complicated by the presence of osteophytes and narrowed joint spaces, making successful delivery of the local anesthetic and steroid to the site technically challenging. Another small study assessed ultrasound guide injection on 40 cadaveric AC joints found successful intra-articular injection in 36 out of the 40 injections (Borbas et al, 2012).

Other Considerations in Treatment of AC Joint Pain

In the event of failure to respond to basic analgesia or intra-articular joint injection, suprascapular nerve block represents a useful tool for pain management and can allow for the patient to engage with physiotherapy until clinical recovery or can be used as a last resort for those considered unsuitable for surgical intervention (Sinha et al, 2020). The suprascapular nerve provides innervation to the supraspinatus and infraspinatus muscles and is located in the suprascapular notch. It is a safe procedure and may be repeated at regular intervals if required.

Ultrasound Guided Injection Technique

Risks of the procedure were carefully explained. JH understood and took time to communicate the risks back to me. He then communicated verbally and in writing his understanding of the benefits and risks of the procedure, and his intentions to progress with the procedure, therefore demonstrating capacity. JH's wife was brought in from the waiting room to witness the consenting process. A time out was then taken to ensure correct patient identifiers, the correct injection site, confirm known allergy status, and to confirm emergency anaphylactic medications were on site and in date.

A GE LOGIQ e R8 Ultrasound Machine was used for the procedure with a linear L4-12t-RS probe set to 5-14Mhz with the machine preset to 'MSK'. An initial view of the AC joint was performed to evaluate the joint. A narrowed joint space with evidence of osteophytes were noted. Following this, a sterile field was set-up. A 2ml syringe was selected with a 25G

needle and filled with 20mg of depomedrone. 1ml of 1% lidocaine was added into the syringe containing the steroid.

Chlorhexidine was used to sterilize the area, starting at the center of the injection site and cleaned in concentric circles outwards away from the anatomical landmark of the AC joint. The patient was positioned in the seated position facing the ultrasound machine with the arm resting on the lap. The transducer was placed in the coronal plane over the joint. There was some evidence of osteophytes and reduced joint space, so the decision was made to take an out-of-plane approach in order to navigate the steep angle. Doppler view revealed no blood vessels in close proximity, and this was confirmed when no flashback was observed. Once the needle was satisfactorily placed within the joint, the plunger was pushed in a bolus, flowing freely with minimal resistance.

Aftercare

JH was again advised of signs of infection and safety net advice was given in order to seek urgent medical advice if this should develop. A prescription for NSAIDs was given in the unlikely event of a steroid flare over the subsequent 48 hours. Before leaving, JH was asked again examined for AC joint injury stress tests, which revealed an immediate improvement of pain. JH was asked to fill out a visual analogue scale for scored pain as a 2/10. JH was advised to recommence in physiotherapy to strengthen the rotator cuff and rehabilitate the AC joint as outlined above.

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