Pain referral from the sternoclavicular joint: a study in normal volunteers

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Abstract

Objective. The sternoclavicular joint (SCJ) is commonly affected by rheumatological conditions. Case reports suggest that it may refer pain to distant areas, potentially leading to delays in diagnosis and inappropriately targeted investigations. Therefore, we studied the patterns of pain referral from the SCJ of nine healthy volunteers.

Methods. Hypertonic saline was injected into the SCJ of nine normal volunteers and the location of any resulting pain was noted, as was the effect of resisted shoulder abduction and flexion. Composite pain maps were then constructed from individual pain diagrams.

Results. An unpleasant, deep aching pain was produced locally in eight subjects and referred to distant sites in all subjects. Tests of shoulder movement had varied and inconstant effects.

Conclusions. We demonstrated that the SCJ is capable of referring pain to areas distant from the joint. Knowledge of these referral patterns will enable the SCJ to be considered in patients with pain in these areas.

Key words: Sternoclavicular joint, Pain, Hypertonic saline.

Pain is one of the cardinal symptoms leading to presentation of rheumatic diseases. It is axiomatic that a sound knowledge of the significance of pain in any given anatomical area will facilitate appropriate investigation and treatment. In the proximal upper limb and the lower neck this is particularly pertinent as several structures have the potential to refer pain to the region of the shoulder cowl and lower neck. These include the cervical zygapophyseal joints and intervertebral discs, the acromioclavicular joint and the subacromial space, as well as non-musculoskeletal structures such as the heart and cervical nerve roots. Knowledge of the patterns of pain that may originate from these structures may lead the clinician to consider appropriate diagnostic possibilities for a particular presentation. Conversely, unlikely possibilities could be discounted.

The patterns of pain referral from the cervical nerve roots [1] and cervical zygapophyseal joints [2–4] have been studied, as has the pattern from the acromioclavicular joint and subacromial space [5]. However, to-date there have been no similar experimental data on the patterns of pain that may arise from the sternoclavicular joint (SCJ). The SCJ is a diarthrodial joint, divided into medial and lateral compartments by an intra-articular, fibrocartilaginous disc and is the only synovial articulation between the upper limb and the axial skeleton. As a source of referred pain, the SCJ has been implicated in the differential diagnosis of shoulder, subscapular, neck, arm and chest wall pain in case reports and review articles, [6–8]. Interest in the SCJ is not simply academic. It is affected by common rheumatological pathologies including osteoarthritis, rheumatoid arthritis, ankylosing spondylitis, psoriatic arthritis, sternoclavicular hyperostosis, infection, hyperparathyroidism, traumatic dislocations and metastases. The SCJ is not seen well on conventional radiographs and is not always included in the rheumatological examination. Therefore, SCJ pathology may be missed or not considered if it has distant, but unrecognized, patterns of referral.

We therefore performed a study to determine whether irritation of the SCJ in normal volunteers produced characteristic patterns of pain and to map these patterns. The results demonstrated a surprisingly diverse set of referral patterns, with important clinical implications in the assessment of patients with pain in the neck, arm and shoulder.

Methods

Nine healthy volunteers with an average age of 29 yr (range 27–43 yr) were recruited for this study. Six males and three females participated, with no current symptoms in the upper arm, neck, shoulder or chest regions, and no known pathology of the SCJ. All were medical practitioners who had administered intra-articular injections themselves and who were fully cognizant of the potential adverse effects of such injections. Informed consent was obtained from all participants, and the local institutional ethics committee approved the study.

All procedures were performed in a radiology angiography suite equipped with a ‘C’ arm image
intensifier. The same operator, who has extensive experience of intra-articular injection and image intensifier-guided techniques, performed all but one injection (LB). The other author (GH) performed the remaining injection on this operator. The subjects lay supine and the upper chest and lower neck were exposed and disinfected. The SCJ of the subject’s non-dominant side was identified by palpation of the groove just medial to the proximal end of the clavicle. A 25 g, 2.54 cm needle was placed over this site and briefly imaged using the image intensifier to confirm the correct position. The needle was then guided into the SCJ with intra-articular placement suggested by a loss of resistance after the capsule was pierced. A small aliquot (approximately 0.2 ml) of contrast medium (Ultravist) was then injected to confirm intra-articular placement. This was usually indicated by the contrast outlining the medial end of the clavicle (Fig. 1). The joint was then slowly injected with 0.5 ml of 6%, hypertonic saline. This agent is known to irritate synovial structures and has been used in previous, similar studies [5, 9–11]. The subject was then asked to report and mentally note any sensation of pain as well as its location and quality. Once the pain had plateaued, two movements of the ipsilateral shoulder were performed in order to determine their effect on the pattern and intensity of the pain. First, the shoulder was abducted to 60° and then an examiner resisted further abduction. The shoulder was then anteroflexed to 90° and further flexion was resisted. These movements were tested on the basis that they have been suggested as clinically relevant in the diagnosis of SCJ pain [8]. Following these manoeuvres, the joint was injected with approximately 0.5 ml of 0.5% bupivacaine to relieve the pain. This relieved pain promptly in all but one volunteer, in whom the needle had become dislodged from the SCJ during the resisted shoulder movements. Rather than repuncture the joint, the periarticular tissues were infiltrated with bupivacaine. We performed a total of nine injections into the non-dominant SCJ of the volunteers, seven into the left and two into the right SCJ.

Following the removal of the needle, each subject completed a pain drawing on a diagram of the upper torso and head with posterior, anterior and lateral views (Fig. 2). Free comments as to the quality and site of pain were also sought, as well as the effect of the shoulder manoeuvres. Composite diagrams of the sites of pain were then created by overlaying the individual diagrams. The subjects were not permitted to communicate with other subjects until they had completed these diagrams and descriptions. This was to prevent any contamination or expectation biasing the results. The subjects were encouraged to contact the investigators if there was any adverse effect after the injections.

Results

All subjects had pain produced by the injections. The pain was relieved by bupivacaine in all subjects except the one noted above, who continued to experience pain that interfered with sleep the night following the injection. All other subjects had only mild residual discomfort for about 24 h. No long-term adverse effects occurred following any of the injections.

The quality of pain was described as deep and unpleasant by the majority of subjects, and was usually maximal immediately over the SCJ. The pain would commence over the SCJ within 5–20 s and then spread outwards to the referred sites with maximal duration and intensity reached within minutes. Only one subject did not experience pain over the SCJ, rather having pain referred to the ipsilateral jaw. Several patterns of pain referral were obtained. The most distal referral was to the ipsilateral elbow, seen in one subject only. The majority of subjects experienced pain in the anterior neck with some noting referral along the clavicle to the ipsilateral shoulder. A composite map of the sites of referral of pain is shown in Fig. 2.

The stress manoeuvres of the shoulder had inconstant effects on the pain. Of the nine trials, resisted shoulder abduction aggravated the pain in five, whereas in three it had no effect and relieved pain to some extent in one. Resisted flexion aggravated the pain in five cases, but had no effect in four. The effect of these manoeuvres was determined by qualitative comparison with the maximum pain reached after the injection.

Discussion

The composite maps derived from our data demonstrate that irritation of the SCJ provokes somatic pain locally over the joint as well as referred pain to various ipsilateral anatomical locations. These include the anterior

![Fig. 1. Representative anteroposterior X-ray of a left SCJ arthrogram with contrast medium outlining the medial end of the clavicle.](image-url)
trapezial fold, along the lateral clavicle to the anterior shoulder, the neck and jaw. In one volunteer, pain radiated across the clavicle from the SCJ to the tip of the shoulder and then down the ipsilateral arm to the elbow as well as deep in the throat. Such a pattern could mimic the pain of myocardial ischaemia, an observation noted elsewhere [8–12]. Notably, none of our volunteers experienced chest wall pain, which had previously been thought to be a site of pain referral from the SCJ [8]. Whilst the number of subjects in our study is relatively small and thus other patterns of pain referral cannot be excluded, this study raises the question as to whether or not SCJ pathology should remain on the differential diagnosis list for anterior chest wall pain. On the other hand, we only used intrasynovial chemical irritation as our method of pain induction, which may not have produced the full repertoire of SCJ referral patterns. For instance, some pathological processes such as septic arthritis may cause distension of the joint as well as irritation of the synovium. This may cause pain from extrasynovial structures that could be referred to the chest wall.

Pain was not referred to the posterior neck, occiput or interscapular region as may be seen with pain from the cervical zygapophyseal joints. Resisted abduction and flexion of the ipsilateral shoulder did not alter the pattern of pain in any of our volunteers, and had variable effects on the intensity of pain experienced. The quality of the pain varied, but was reported as an unpleasant deep gnawing pain in the majority of the volunteers.

The explicit purpose of this paper was to describe the patterns of pain referral from normal SCJ. We did not seek to account for these referral patterns, but the distant pattern of referred pain from this joint is analogous to experimental visceral pain [13]. A similar

Fig. 2. Composite illustration of the distribution of pain observed after irritation of the SCJ. The density of the shading reflects the number of subjects reporting pain in that area. In one subject, pain was referred to the arm, which is not depicted in this figure. (A) anterolateral view, (B) anterior view, (C) lateral view.
distant referral pattern was seen by Gerber et al. [5] with hypertonic saline injection of the acromioclavicular joint. However, in contrast to experimental visceral referred pain from a defined anatomical site, which has marked variation between subjects, injection of the acromioclavicular and SCJ produced overlapping patterns of pain between subjects [13]. This is similar to that seen in experimental referred pain from muscles [5]. In our study, to minimize subject discomfort, confirmation of secondary hyperalgesia in the distribution of the referred pain was not assessed. Therefore, we are unable to comment on the changes in descending pain modulation (central sensitization) as a mechanism for the distant referral. However, we noted that the referred pain onset was delayed compared with the onset of local pain over the SCJ. A similar observation was made by Hockaday and Whitty [14] who suggested that this delay reflected the involvement of central rather than peripheral mechanisms.

The nerve supply to the SCJ is from branches of C3, C4, the medial supraclavicular nerves and the nerve to the subclavius muscle, which originates from C5, C6 [15]. Our observations are consistent with the sclerotomes of these nerve roots [1] and the multilevel innervation is reflected in the wide range of pain referral patterns.

Concerns may be raised that variations in the injections may somehow produce different pain referral patterns. In particular, as the joint is divided into two compartments by an intra-articular disc, injections may have affected one or other or both compartments. This may have led to variations in pain referral. Also, the injection may not have maximally distended the capsule for all subjects, potentially resulting in incomplete and differing patterns of pain. However, there is no a priori reason to believe that pathological processes uniformly affect the SCJ. Therefore, the patterns of pain referral noted in this study, which may have arisen by virtue of irritation of different compartments of the joint, are likely to reflect accurately the range of SCJ sclerotomes.

The pain patterns obtained in this study overlap those of the acromioclavicular joint, subacromial space and cervical nerves. Hence, SCJ pain would need to be considered in the differential diagnosis of pain from these structures and their referred anatomical sites. This should prompt evaluation of the SCJ with clinical examination for the presence of swelling, erythema and tenderness, as well as appropriate laboratory and radiological investigation.

References