Management of shoulder injuries using dry needling in elite volleyball players

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These case reports describe the short-term benefits of dry needling in shoulder injuries in four international female volleyball athletes during a month-long intense competitive phase, using both replicable subjective and objective measures. Dry needling of scapulohumeral muscles was carried out. Range of movement, strength and pain were assessed before and after treatment, with a functional assessment of pain immediately after playing and overhead activity, using the short form McGill Pain Questionnaire. All scores were improved post-treatment and athletes were able to continue overhead activities. Previous studies have suggested that myofascial trigger points may cause significant functional weakness and reduced range of motion, with referred pain. Trigger point dry needling has been successful in treating athletes with myofascial pain and impingement symptoms but with only subjective improvement and not during a competitive phase. These cases support the use of dry needling in elite athletes during a competitive phase with short-term pain relief and improved function in shoulder injuries. It may help maintain rotator cuff balance and strength, reducing further pain and injury.

These case reports describe four female athletes from the Great Britain National Women's Volleyball Squad who complained of recent onset anterior/anterolateral shoulder pain. Subjects (mean age 25±2) were right-arm dominant for hitting and serve. They were involved in an intensive 26 day overseas competitive summer tour at the time of assessment. Twenty-five matches were played in addition to training, averaging 5 h a day. A brief history was taken, combined with assessment of range of movement (ROM), strength and pain. The results are displayed in table 1. Pure abduction (figure 1) and internal rotation at 90° abduction (figure 2), using a goniometer, were used as objective measurements of function as dysfunction of these motions may be associated with overhead shoulder complaints. Power was manually tested in lateral rotation at 90° abduction (figure 3) and the 'empty can test' (resistance against 90° elevation in the scapular plane with full internal rotation, figure 4) was used as a special test to identify supraspinatous problems.[1] No investigations had been undertaken following these new onset complaints.

Myofascial trigger points (MTrPs) were identified manually as tender points eliciting the athlete's complaint. Taut bands were found mainly in infraspinatous and teres minor, with referred pain to the anterior shoulder, leading to functional problems in abduction and internal rotation at 90° abduction and impaired scapulohumeral rhythm to varying degrees. Western medical acupuncture (dry needling) was then carried out with the aim of releasing these bands, supported by the literature in the review.[2–6] Five to 12 needles (Dongbang Acupuncture needles, 0.25 mm×0.40 mm) were inserted into the muscles, perpendicular to the fibres, with a deep insertion of between half and two thirds of the whole length of the needle's shaft. Each needle was twisted until a local tenderness was felt and a referred sensation to the anterior aspect of the shoulder and left for 10 min. Muscle tone was assessed by palpation and in all subjects there was a return to the perceived 'normal'. Other forms of therapy included were limited to soft tissue therapy around the shoulder, post-training icing strategies, exercises and stretching. The treating therapist is approved by the Acupuncture Association of Chartered Physiotherapists with 3 years experience in delivering dry needling sessions. He has 10 years experience with elite sports with the recent 2 years focused on volleyball.

To assess pain, the short form McGill Pain Questionnaire (SF-MPQ)[7] was used, consisting of three parts: (1) a pain rating index (PRI), 15 descriptors; (2) a present pain intensity (PPI) on a scale of 0–5; and (3) a visual analogue scale (VAS). It has been used previously in studies of pain including dry needling experiments[8] and sports injuries[9] as a quick qualitative assessment tool. It was used directly after a volleyball session/match to indicate pain levels during activity. Verbal pain scores were taken immediately before and after treatment, combined with measures of active ROM. Measures of ROM were only taken on the day of treatment, while functional pain scores were assessed on day 1 (day of treatment), 2, 3 and 7. Both verbal and written consent was obtained.

Outcome

ROM (previously restricted by pain) was markedly improved, for both abduction (improvement 100–120°) and internal rotation at 90° abduction (50–90°) along with notably lower movement pain scores after dry needling, compared to before (table 1). Before treatment, testing of muscle power with lateral rotation against resistance was painful and weak in all subjects, most apparent in subject 1 and 2. Medial rotation power was normal. All four subjects showed a positive 'empty can test'. Post-treatment, both the 'empty can test' and muscle power, assessed using manual resistance were subjectively improved.

Three of the subjects had one session of dry needling. Subject 2 underwent dry needling on two consecutive days as after match play on day 2, ROM scores had not improved enough to allow sufficient function. While the level of pain experienced during dry needling was higher on this second day, functional assessment on day 3 revealed full recovery of active ROM.

The results of the functional pain scores (post-training or match) are represented in figures 5–7. The PRI for the four athletes ranged between 19 and 4 before dry needling to between 6 and 1 during day 2's session (figure 5). The VAS ranged from 7.1 to 3.1 before treatment to between 3.1 and 2.4 on day 2 (figure 6). The PPI was 2 or 3 for all four athletes on day 1, reduced by day 2 and further reduced by day 7 (figure 7). These results indicate a trend of reduction in functional pain over the days following treatment. Subject 1 had the best results with an improvement on day 1–2 of 19 to 6 on the PRI, 7 to 2.5 on the VAS and 3 to 1 on the PPI. Subject 2 showed no change between day 1 and 2 after the first dry needling, but then reduced scores after day 2's treatment. Despite continued training and competition, none of the pain scores increased to near pretreatment levels in any of the four athletes.

LITERATURE REVIEW

This case report series describes the short-term benefits of dry needling on shoulder problems in elite volleyball athletes, with replicable measures of functional pain scores on court and objective measurements of active ROM. Volleyball is a sport requiring high technical and athletic demand with repetitive movements, predisposing to a variety of injuries such as shoulder problems,[10] ankle sprains and patellar tendinopathies.[11] Shoulder problems have been described as the second most common overuse injury with an incidence of up to 20%,[12] and with an average loss of 6.5 weeks training and/or competition in this

Table 1 Results

Subject	1	2 (day 1)	2 (day 2)	3	4
Position	Hitter	Setter	–	Hitter	Hitter
Shoulder history	Intermittent 'discomfort' over last 2/12. Conservative Rx only (Theraband/stretching)	Partial non-repaired SLAP lesion (6 years prior) but with no functional impact. Acute onset pain for 7/7	–	Right arthroscopic capsular tightening before 18 months. Intermittent pain over last 6/12 with increased symptoms over training camp	Intermittent pain in right shoulder for 6/12 previously. Management – conservative with exercises/ stretching. Now struggling due to volume of match play
Painful movements	'Miss-hit' (overhead movement requiring unexpected change in muscle load eg, ball not where expected)	Movements outside body line and serve (eg, in greater abduction, where power is generated more from shoulder than core muscles)	–	Backswing and overhead serve (lateral rotation/extension)	Overhead serve, blocking, abduction, hitting outside body line
Positive TrP muscles (bellies)	Infraspinatous, teres minor, anterior deltoid	Infraspinatous, teres minor	–	Infraspinatous, teres minor, anterior deltoid	Infraspinatous, teres minor
Verbal pain score prior to Rx (/10)	6	5	5	8	4
Verbal Pain score during Rx when TrP activated (/10)	6	5	9	8	5
Verbal Pain score after Rx (/10)	4	3	3	3	2
ROM					
Abduction: before Rx	Pain at 70–80° to 140°	Pain from 80° to 140°	Pain at 80°	Pain at 50–80° and 150°	Pain at 50° and 150°
Abduction: after Rx	Full ROM	Full ROM	Full ROM but tender	Full ROM	Pain at 170°
Internal rotation at 90° Abduction: before Rx	Pain from 0° internal Rotation	Pain from 0°	Pain at 0–80°	Pain from 0° to 80°	Pain from 40° to 50°
Internal rotation at 90° abduction: after Rx	Pain at 70° (end range)	Pain at 75° (end range)	Full ROM	Full ROM	Pain at 75–80° end range

ROM, range of movement; Rx, treatment; SLAP, superior labrum tear from anterior to posterior; TrP, trigger point.

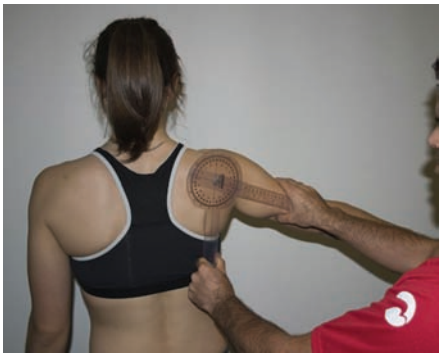

Figure 1 Abduction using goniometer.

Figure 2 Internal rotation at 90° abduction.

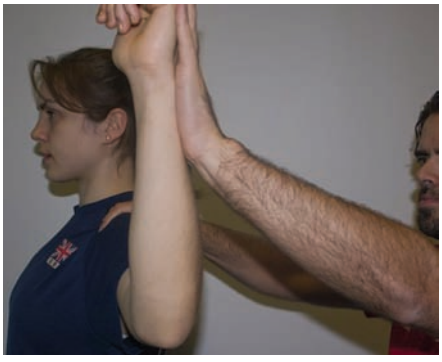

Figure 3 Lateral rotation at 90° abduction.

Figure 4 The 'empty can test'.

sport.[13] This is most probably related to the high volume of hitting activities during a season,[10 13] combined with the mechanics of the arm swing.

MTrPs, first introduced by Travell and Simmons,[14] are hyperirritable taut bands of skeletal muscle, which are exquisitely tender and exhibit fairly consistent muscle-specific patterns of referred pain. They may develop due to muscle injury or repetitive overload in any part of the body during sport.[15] Trigger points (TrPs) can be active (with spontaneous pain), or latent (no pain), causing shortening, stiffness or weakness of muscle, reduced ROM and postural changes.[16] They can be identified by palpating a rope-like induration that is locally tender with the characteristic referred pain associated with that muscle.[14]

Pathophysiology of MTrPs

Dysfunctional motor endplates are thought to play a role in MTrPs.[17] Damaged fibres of injured or overloaded muscles are thought to release excessive amounts of acetylcholine at the neuromuscular junction, shortening muscle fibres into taut bands.[17] Tissue hypoxia follows (oxygen saturations having been observed to be less than 5% of normal[15]), stimulating the release of nociceptive chemicals such as bradykinin,

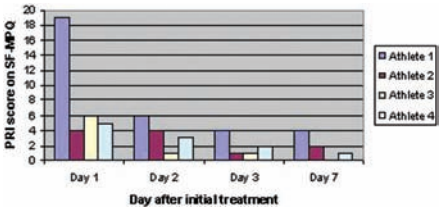

Figure 5 Pain rating index (PRI) results from short form McGill Pain Questionnaire (SF-MPQ).

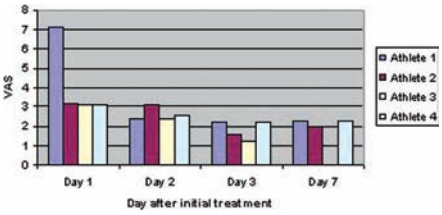

Figure 6 Visual analogue scale (VAS) results from short form McGill Pain Questionnaire.

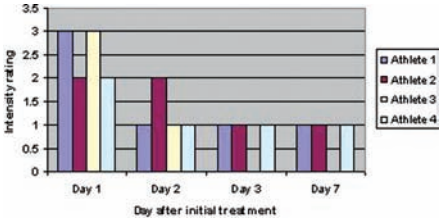

Figure 7 Present pain intensity results from short form McGill Pain Questionnaire.

calcitonin gene-related peptide and substance P,[15] which activate C-fibres, producing pain. In addition, bradykinin sensitises the nociceptors both directly and indirectly, via prostaglandins and also contributes to a vasodilation-mediated oedema. This sensitisation and inflammatory response cause allodynia at the MTrP site and explain why they are so tender to touch.[18]

Mechanism of dry needling

Dry needling involves the direct insertion of a needle into the MTrP. William Osler, Regius Professor of Medicine at Oxford stated that "for lumbago, acupuncture is in acute cases the most effective treatment. Needles of from 3-4 inches in length are thrust into lumbar muscles at the seat of pain and withdrawn after 5-10 mins…".[19]

In 1979, Lewit was the first to suggest that needle insertion itself, rather than injected anaesthetic, was sufficient for analgesia.[20] There are a number of proposed mechanisms that are not mutually exclusive:

1. Mechanical stretch by the needle stimulates a spinal reflex, causing a brisk transient contraction of the fibres,[18] called a local twitch response (LTR). The local stretch disentangles myosin from actin and allows it to resume its resting length.[15] Winding the needle may be beneficial as it provides greater stretch.
2. The stretch is sensed by Aβ mechanoceptors in the fibre, which act via 'gating' afferent neurons to inhibit the intradorsal horn passage of C-fibre action potentials, thus alleviating pain.[18]
3. Needle insertion activates cutaneous Aβ fibres, stimulating enkephalinergic inhibitory interneurons in the dorsal horn to release opioid-like peptides that also inhibit C-fibre transmission.[18]
4. Chemical changes at MTrPs may be corrected after an LTR,[15] which may reduce nociceptive stimulation.
5. Improved haemodynamics and muscle recovery have been correlated to reduced pain levels the day after needling.[21]

Various imaging studies have identified parts of the descending inhibitory pain pathway that are activated during acupuncture,[22 23] which may be involved in dry needling. While investigating the effects of anaesthetic injection versus dry needling, Hong showed that for more immediate needling results, a series of LTRs had to be evoked by rapidly inserting the needle into separate loci within the MTrP,[24] suggesting that LTRs are key to obtaining the desired response. However, within 8 h of needling, soreness that was different to the patient's original myofascial pain was noted in all patients who had LTRs.

Dry needling in elite athletes and the shoulder

While dry needling has been shown to have positive analgesic effects, the significance of these results has varied.[2 3] Huguenin *et al* were the first to conduct a randomised controlled trial on treatment of TrPs in athletes.[4] Gluteal MTrP dry needling in Australian Rules football players improved hamstring and gluteal tightness and reduced hamstring pain. Changes were greater after running than at rest. However, there was no significant improvement in straight leg raise range, suggesting only a subjective alleviation of pain, without an objective measure, which does not rule out the placebo effect. In athletes, the placebo role in cortical top-down inhibition of pain is arguably important clinically. However, if TrPs are causing reduced ROM or weakness, then this effect alone would be insufficient for resuming full function.

MTrPs can be associated with unilateral shoulder pain.[5] Dry needling case studies have been described in three overhead sport athletes with shoulder impingement (tennis/racquetball players), who had not responded to a conservative approach.[6] Dry needling and stretching varied among athletes but all returned to full pain-free function within 2 years. This was based on reports of 'no pain', although without evidence of replicable assessments.

Lucas *et al* later used electromyography to measure muscle activation patterns of the scapular rotator muscle group.[25] A group with latent TrPs was randomly assigned to receive placebo treatment of dry needling and stretching, which was then compared to a control group. When TrPs were present in these muscles, a significantly different temporal sequence of muscle activation was measured, compared to pre-intervention, which may predispose individuals to impingement of shoulder structures. This altered timing was shown to be normalised by dry needling and stretching.

DISCUSSION

Studies have suggested a successful role of dry needling in treating acute myofascial pain[2 3] and a subjective improvement in pain when used in athletes, including those with overhead actions.[4 6] To our knowledge, these are the first case studies described in athletes during intense competition that combine short-term replicable assessments of sport-specific pain scores with an objective measure of ROM directly following treatment.

Targeting sport specific muscle TrPs

Dry needling was successful in treating acute shoulder pain by targeting specific muscles acting at the glenohumeral joint. Hitting and serve movements that were causing these symptoms predominantly involve concentric internal rotation and eccentric external rotation of the joint.[26] Teres minor and infraspinatous were the primary muscles treated. They are external rotators that are particularly active eccentrically in combination with supraspinatous and anterior deltoid during the deceleration phase of hitting or serving in volleyball.[27] This phase occurs straight after ball contact and was described by these subjects as the most painful, particularly when there was a 'miss-hit' (requiring compensatory forces). It is therefore logical to assume that the location of ball contact relative to the shoulder and thus the ratio of rotator cuff muscle activation, can affect the load on the joint.

Wang *et al* showed that the mean strength ratio of external rotation to internal rotation of the shoulder differed between dominant and non-dominant arms for concentric contraction in male volleyball players,[26] of whom six out of 10 reported a diffuse pain located laterally on the dominant shoulder,

similar to the pain described in this case report series. A strength imbalance may cause instability or overload the glenohumeral joint, and may predispose volleyball players to tissue damage and TrPs in weaker external rotator muscles.[27] This highlights the importance of maintaining optimal eccentric external rotator cuff biomechanics, such as by TrP dry needling.

Mechanism of dry needling

The main effect of needling occurred immediately after dry needling or within the first 24 h, with minimal further pain reduction in the following days, but no relapses to pretreatment levels. This may be explained by various mechanisms including the mechanoreceptive gating of nociceptive input,[18] the opioid system or reduction in chemical stimuli.[15] In theory, gradually improving muscle haemodynamics may also contribute to the response over days 1–3.[21] The immediate improvement in ROM could be explained by the needle stretching of muscle fibres, allowing them to resume normal length, on top of reduced pain inhibition of movement. Passive ROM was unaffected.

The effects on pain lasted up to 7 days after the initial session, although a longer effect was not assessed. It may have been beneficial to treat again on day 3, to further reduce symptoms. Various studies have used weekly dry needling sessions and it has been suggested that a week is necessary between treatments to allow the muscle to recover.[28] However, these studies were not in elite athletes, where the cause of injury, for example, overhead activity must be repeated regularly.

As subject 2 showed, the treatment process itself may be painful,[23] possibly due to elicitation of LTRs.[23] The second more painful session actually produced a better ROM and a delayed further reduction in pain the following day. Pain caused by the LTR-producing needling may also mask the extent of initial pain reduction, causing an apparent further improvement when this separate pain wears off. The second session may have elicited more painful LTRs, but as Hong suggested, obtaining LTRs appears to be associated with a more immediate reduction in pain.[24] The extent of sarcomere contraction in the initial MTrP may affect which athletes experience this undesired pain from needling.

As in any sport environment, athletes were required to maintain fitness on a daily basis, often needing combined treatment regimes. It was therefore felt that restricting treatment to dry needling in a competitive scenario would be impractical and unethical and that other forms of treatment, such as soft tissue therapy, may be required to maximise the effects. These subjects were sustained in a performing role over a high intensity period. This is very appropriate clinically as rest post-injury is not always possible during competition. Combining the sport-specific pain scores with ROM enabled a better appreciation for the practical effects and reduced the impact of placebo. While further investigations are required to identify the effects specific to dry needling (without other treatment or placebo), this may be difficult in athletes. This has particular relevance for in-season athletes.

SUMMARY

This case report series supports the use of TrP dry needling in elite female athletes with short-term pain relief and improved active ROM in the management of acute shoulder injuries, during an intense competitive period. This agrees with previous studies that have shown it is a successful modality in the treatment of anterior shoulder pain with a known source of rotator cuff pathology. It is a quick, safe and effective technique. No increased sensitivity or adverse reactions were observed, suggesting that it may be used on the day of competition with positive results. The long-term role or impact cannot be assessed. Further studies investigating the use of dry needling in elite competitors are therefore recommended.

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Notes