Calcific tendinopathy of the rotator cuff. Conservative management with 434 Mhz local microwave diathermy (hyperthermia): A case study

ANNALISA DI CESARE¹, ARRIGO GIOMBINI², STEFANO DRAGONI², LUCIANO AGNELLO¹, MAURIZIO RIPANI³, VINCENZO MARIA SARACENI¹ & NICOLA MAFFULLI⁴

¹Department of Physical Medicine and Rehabilitation, University of Rome “La Sapienza”, Rome, Italy, ²Institute of Sport Medicine and Science, Rome, Italy, ³Department of Health Sciences, University of Motor Sciences, Rome, Italy, and ⁴Department of Trauma and Orthopaedic Surgery, Keele University School of Medicine, Stoke on Trent, UK

Abstract

Purpose. To report the effects of local microwave diathermy (hyperthermia) at 434 Mhz on calcific tendinopathy of the shoulder in two middle aged patients.

Methods. Two middle-aged women with calcific tendinopathy of the shoulder were treated with local microwave diathermy (hyperthermia) at 434 Mhz three times a week for four weeks. Plain radiographs and ultrasonography demonstrated calcific deposits in the area of infraspinatus or supraspinatus. Shoulder Pain and Disability Index (SPADI) and passive Range of Motion (ROM) were used to assess the response to treatment.

Results. At the end of the treatment period, the improvement as measured by the SPADI score was respectively 30% for the first patient and 40% for the second patient with an improvement of the shoulder passive ROM for both patients. The calcific deposits seen on the initial radiographs and ultrasonography were no longer visible. At 1 year follow-up, both patients continued to be symptom free.

Conclusions. Hyperthermia is a safe option in the management of calcific tendinopathy of the shoulder. Prospective randomized controlled studies with long term assessment are needed to further document its therapeutic efficacy.

Keywords: Calcification, hyperthermia, microwave, diathermy, shoulder, tendinopathy

Introduction

Calcific tendinopathy of the shoulder is characterized by the presence of macroscopic deposits of hydroxyapatite (a crystalline calcium phosphate) in any tendon of the rotator cuff [1,2]. It may be an incidental finding in an asymptomatic shoulder or it may be the cause of shoulder pain and disability, thus interfering with daily living activities [3]. This condition, seen most frequently in women, affects mainly 30- to 60-year-old individuals and is bilateral in 25% to 30% of patients [1]. The management of calcific tendinopathy remains controversial, and includes the use of non steroidal anti-inflammatory agents, roentegen therapy, physical modalities to control the pain and prevent loss of joint mobility, local steroid injection, and open or arthroscopic surgery [4–6].

In the last decade, local microwave diathermy machines producing hyperthermia have been introduced in physical medicine and rehabilitation [7,8]; they combine a superficial cooling system and a deep heating source with a microwave power generator at 434 MHz [9]. The clinical value of hyperthermia in the management of acute and chronic musculoskeletal injuries has been shown in randomized controlled trials [10–12].

We describe the use of local microwave diathermy (hyperthermia) in two middle-aged women with calcific tendinopathy of the rotator cuff.
Case reports

Patient 1

A 62-year-old woman reported a six month history of severe pain and disability in her right shoulder. The pain had markedly worsened two months prior to presentation. The patient reported that the pain was over a diffuse area on the posterolateral region of the right shoulder, and she described it as a constant, deep, dull and nagging ache, also present at night. The patient did not report any traumatic event, but she had been physically more active in the past several months prior to the onset of pain, and reported no referred pain or other neurological symptoms. The patient did not undergo any physical treatment in the three months prior to presentation to our clinic, and did not experience any improvement of the symptoms despite the prolonged use of oral NSAIDS and local NSAIDS ointments.

Physical examination revealed no swelling of the shoulder, and a limited range of motion due to pain. Palpation over the infraspinatus insertion on the greater tuberosity elicited marked tenderness. At plain radiography, the internal rotation view showed a calcific deposit of the infraspinatus tendon, amorphous with a poorly defined contour (Figure 1). The diagnosis was confirmed at high resolution ultrasonography, using a 10 – 13 MHz linear array transducer Philips Envisor CHD, Philips Medical Systems, Nederland BV (Figure 2).

We proposed to the patient the possibility of undergoing conservative management with hyperthermia, the analgesic effect of which has recently been reported [11,12]. Before initiating hyperthermia, specific contraindication to this management modality (conditions known to be sensitive to increase cell proliferation rates or skin treated in the past 6 months with radiotherapy, ischaemia, local thrombosis or defective arterial circulation, impaired cutaneous thermal sensitivity, metal implants, local infections, indwelling electronic equipment, e.g., pumps or cardiac pacemakers) were excluded. The patient gave her consent to receive hyperthermia. We used the Shoulder Pain and Disability Index (SPADI) as an outcome measure to assess the response to treatment. This self administered questionnaire uses 13 questions, 5 of which deal with the severity of pain on various arm movements, the pain being assessed by using a visual analog scale (VAS). The other 8 questions deal with functional impairment of the shoulder, assessed with a VAS ranging from 0 (no difficulty) to 10 (so difficult that I need help). An overall score was calculated for the 13 questions as a whole [13]. The SPADI questionnaire was filled out by the patient before the hyperthermia management regimen was started, at its end, and at one-year follow up. The range of passive forward elevation, abduction, internal and external rotation of the shoulder was assessed by using a manual goniometer. Both patients were evaluated by the same investigator (AD) with the patient supine on an examination couch. External and internal rotation movements were conversely assessed with shoulder prepositioned at 70° of abduction or less (maximal abduction according to tolerance). At baseline, patient 1 had shoulder abduction of 100°, forward flexion of 135°, internal rotation of 48°, and external rotation of 65°.

Changes from baseline in the calcium deposits on radiography and ultrasonography were assessed at initial, last treatment, and one-year follow-up examinations. The results of imaging were assessed by the same experienced radiologist under standardized conditions. During the course of treatment, the patient was prompted to modify her daily home activities to decrease the stresses on the affected shoulder.
We used an ALBA Hyperthermia System (Restek SRL, Rome, Italy) equipped with a 434 MHz microwave generator with a maximum output power of 100 W; a microstrip antenna applicator, with a curve shape specific for semicylindrical joint volumes of 20–30 cm in diameter, with a total radiating area of 240 cm² and an effective field size (50% SAR (specific absorption rate) on a surface of 96 cm²; and a 50% SAR max depth between 2.3 ± 0.3 cm); a pad of silicone 0.5 cm thick, filled with thermostatic deionized water that allows the greatest energy transfer to be achieved while preventing overheating of superficial tissues near the radiant source. A T-type thermocouple thermometer made of copper and constantan (a paramagnetic material) is the sensor measuring the temperature of the skin in contact with the pad. This gives a real time feedback to the computerized system to optimize the treatment. The accuracy of this thermocouple in the treatment area, with a uniform temperature in the environment is ±0.2°C, with a measured range of temperature between −273°C to +150°C and a signalling velocity of 0.1 sec. We administered hyperthermia at a power of 50 W, a pilot temperature on the skin of 41°C, and a water pad temperature at 38°C, according to the depth of the target area and the thickness of the subcutaneous fat of the patient. The thermocouple was placed on the shoulder approximately 2 cm from the greater tuberosity with the patient lying on the left side, the arm adducted and internally rotated. The thermocouple on the shoulder was perpendicular to the electromagnetic field. The patient underwent 30 minute treatment of hyperthermia three times a week for four consecutive weeks. No medications were used during these four weeks. The SPADI score at the end of the treatment was 17, with an improvement of 30% when compared to the initial score of 56. The range of motion of the affected shoulder after the end of treatment was abduction 160°, forward flexion 155°, internal rotation 65°, external rotation 75° (Table I). At the end of treatment, a second set of radiographs and ultrasonographs was obtained. The calcification clearly seen on the original radiograph and ultrasonography was no longer visible (Figures 3 & 4).

At one-year follow up, the radiographs and ultrasonography showed no recurrence, and the patient continues to be symptom free. At one-year follow up, the SPADI score was 19, essentially unchanged from the value at the end of the treatment.

Patient 2

A 55-year-old woman presented with a three month history of left shoulder pain. The left shoulder pain started gradually with no apparent causative event, and it was described as continuous, and moderately severe. The pain was dull and achy in the resting position, and became sharp and stabbing when moving the arm in some positions, such as when getting dressed, ironing or lying on the left side. The patient did not report any previous ailment to her shoulder.

Table I. Shoulder passive range of motion at initial and final treatment.

<table>
<thead>
<tr>
<th></th>
<th>Initial</th>
<th>Final</th>
<th>Initial</th>
<th>Final</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abduction</td>
<td>100</td>
<td>160</td>
<td>80</td>
<td>150</td>
</tr>
<tr>
<td>Forward flexion</td>
<td>135</td>
<td>155</td>
<td>140</td>
<td>165</td>
</tr>
<tr>
<td>Internal rotation</td>
<td>48</td>
<td>65</td>
<td>50</td>
<td>66</td>
</tr>
<tr>
<td>External rotation</td>
<td>65</td>
<td>75</td>
<td>60</td>
<td>80</td>
</tr>
</tbody>
</table>

Figure 3. Patient 1. Antero-posterior radiograph of the right shoulder at the end of the course of 12 sessions of hyperthermia treatment showing disappearance of the calcific deposit.

Figure 4. Patient 1. Disappearance of calcification after treatment.
Clinical examination revealed passive abduction of 80°, forward flexion of 140°, internal rotation of 50°, and external rotation of 60°. Reflexes were normal. Palpation revealed tenderness at the supraspinatus insertion. Plain radiographs demonstrated a calcific deposit within the left supraspinatus tendon (Figure 5). The diagnosis was again confirmed at high resolution real time ultrasonography (Figure 6). The patient was told about hyperthermia. After appropriate consent, she underwent the same conservative management that the first patient had received. The positioning of the patient was different, as she was supine with the left arm adducted to the trunk and externally rotated, and the thermocouple was centered two cm below the acromion.

At the end of the four-week treatment period, follow up radiographs and ultrasonography revealed no remaining calcific deposits in the right supraspinatus tendon (Figures 7 & 8). At the end of treatment, the shoulder showed abduction of 150°, forward flexion of 165°, internal rotation of 66°, external rotation of 80°.

The SPADI score at the end of the treatment was 24, an improvement of 40% when compared with the initial score of 60. At one year follow up, the SPADI score remained 24 (Table II). At one-year follow up, plain radiographs and ultrasonography showed no calcification.

**Discussion**

Calcific tendinopathy is a common painful condition of the shoulder. The calcifications can be an incidental radiographic finding, and are usually asymptomatic, with an incidence between 3% and 20% [1,14]. The highest incidence is especially in
women 30 to 60 years old. Calcific tendinopathy of the shoulder often undergoes spontaneous resolution, and does not necessarily cause pain. Symptomatic patients, however, complain of acute or chronic shoulder pain and reduced range of motion, with impairment of the activities of daily living.

The pathophysiology of intratendinous calcium accumulation is still controversial. Tissue hypoxia could be the primary factor preceding fibrocartilaginous metaplasia, with subsequent necrosis of a portion of the rotator cuff tendons, and a tendency for calcium deposition [1]. Conversely, other authors supported the hypothesis that ‘dystrophic calcification’ of degenerate tendon matrix is a pathological entity distinct from cell-mediated calcific tendinopathy [2]. In this instance, calcification is one possible outcome of chronic tendon injury. The traditional management modalities for calcific tendinopathy are different, from non-steroidal anti-inflammatory drugs, analgesics or steroid injections for pain relief, to percutaneous needle aspiration, shock wave therapy, and surgery [15 – 19] to remove the calcifications. Surgery to remove shoulder calcification has a relatively high rate of success, but carries the risk of possible operative complications [20], including failure [21]. Although percutaneous needle aspiration provides clinical success rates varying from 60 – 74% of patients [22], there is the concern for potential injury to the tendon caused by multiple punctures of the intratendinous calcification with large-bore needles. Shockwave therapy reported partial or complete disintegration of calcium deposits in almost two thirds of patients, while three quarters had clinical improvement [23]. In a recent randomized prospective trial in 80 patients, high-energy shock wave therapy significantly improved symptoms in refractory calcifying tendinopathy of the shoulder after three months of follow up, but the calcific deposit remained unchanged in size in most patients [24]. In another randomized double-blind controlled study, Ebenbichler et al. [25] demonstrated the beneficial effect of ultrasound in patients with symptomatic calcified tendinopathy of the shoulder either for the resolution of calcifications (42%) or for short-term clinical improvement.

To our knowledge, the use of thermotherapy in the management of calcific tendinopathy of the shoulder has not been reported. Microwave hyperthermia has been authorized in the European Union for clinical practice in 1998 [8]. Our hyperthermia apparatus, employing a superficial cooling system and a deep heating source operating with a microwave power generator at 434 MHz, allows the increase in the target tissue to therapeutic temperatures between 41°C and 45°C to a depth of several centimetres from the skin, with no risk of overheating the superficial tissues [9,26]. We have recently reported the short term effectiveness and safety of hyperthermia in controlled clinical trials [10 – 12]. In the present study, both clinically and at imaging the use of local microwave hyperthermia has been beneficial. The SPADI index has demonstrated good internal consistency test and retest reliability and criterion and construct validity [13]. The SPADI is also able to demonstrate changes in patients’ status with time. A SPADI score decline of greater than 10 points is highly specific for improved shoulder function [13].

Hyperthermia helped to reduce symptoms, and probably favoured resorption of calcium deposits. The mechanism whereby hyperthermia could produce the reduction of pain is poorly understood. The analgesic effect might be mediated peripherally and/or centrally by inhibition of noxious evoked discharge of ascending tract neurones [27]. Even a metabolic hypothesis has to be considered, and analgesia in this case would be produced by a washing out the pain mediators from the degenerated area [27]. The effects of hyperthermia on the resorption of calcium deposits are not well known, and only hypotheses can be made. The most important physiological response of the tissue exposed to hyperthermia is the regional increase in blood flow [28]. This increase in blood perfusion [29] may increase metabolic rate [7], and could facilitate the disintegration of calcium deposits. Hyperthermia may also stimulate the accumulation of peripheral blood mononuclear cells by activating endothelial cells [7]. Since activated endothelial cells express and release a variety of chemotactic substances, migrating macrophages might be involved in the phagocytosis of calcified particles. There is also an increase in cytosolic calcium concentration (from extracellular origin), probably from greater permeability of the cell membranes when temperature exceeded 42°C [30,31].

Patients’ tolerance during treatment was good, and we observed only minor side effects. In particular, at the third session for Patient 1 and at the fifth session for Patient 2, there was temporary increase of the pain, which however disappeared three hours after at the end of session.

Although we report clinical improvements with hyperthermia in two patients, the characteristics of patients with calcific tendinopathy who are likely to have a response remain undefined. For example, calcific tendinopathy has different pathological
phases corresponding to the evolution of calcium deposits [32]. The promising preliminary results support the need to establish the efficacy of hyperthermia in the management of calcific tendinopathy of the shoulder [33]. Further prospective randomized well designed controlled trials will help define its proper role.

References
