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Treatment of post-traumatic myositis ossificans of the anterior thigh with extracorporeal shock wave therapy

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Objective: *This case study demonstrates the effectiveness of a novel approach to the treatment of post-traumatic myositis ossificans with extracorporeal shockwave therapy in an elite athlete.*

Clinical Features: *A 20 year-old male semi-professional rugby player presented with progressive pain and loss of range of motion after sustaining a severe, right quadriceps contusion nine weeks earlier. The differential diagnosis of myositis ossificans was suspected and confirmed on radiographic examination.*

Intervention and Outcome: *A two week treatment protocol was undertaken consisting of three sessions of extracorporeal shockwave therapy and an unsupervised exercise program consisting of active and passive range of motion, gradual strengthening and balance exercises. The patient experienced appreciable improvements in pain and range of motion in two weeks and was able to participate in sport specific activity four weeks after presentation.*

Summary: *This case illustrates the successful conservative management of post-traumatic myositis ossificans of the anterior thigh with extracorporeal shockwave therapy and a primarily unsupervised graded exercise program within a condensed treatment time frame of 2 weeks.*
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KEY WORDS: myositis ossificans, high-energy shock waves, muscles, injuries

Objectif : *cette étude de cas démontre l'efficacité d'une nouvelle approche relative au traitement de la myosite ossifiante post-traumatique avec thérapie par onde de choc extracorporelle sur un athlète d'élite.*

Caractéristiques cliniques : *un joueur de rugby semi-professionnel de 20 ans éprouvait des douleurs et une perte d'amplitude des mouvements après avoir subi une grave contusion au quadriceps droit neuf semaines auparavant. Le diagnostic différentiel de myosite ossifiante soupçonné fut confirmé suite à une radiographie.*

Intervention et résultat : *un protocole de traitement de deux semaines fut entrepris. Celui-ci comprenait trois séances de thérapie par onde de choc extracorporelle et un programme d'exercice non supervisé comprenant l'amplitude des mouvements actifs et passifs, le renforcement graduel et des exercices d'équilibre. Le patient a senti une grande amélioration au niveau de la douleur et de l'amplitude des mouvements en l'espace de deux semaines, et fut en mesure de participer à une activité sportive quatre semaines après avoir ressenti des douleurs.*

Sommaire : *ce cas démontre le succès de la gestion conservatrice de la myosite ossifiante post-traumatique de la cuisse antérieure avec thérapie par onde de choc extracorporelle et un programme d'exercice non supervisé dans un délai de 2 semaines.*
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MOTS CLÉS : myosite ossifiante, ondes de choc de haute énergie, muscles, blessures

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Introduction

Posttraumatic myositis ossificans (MO) occurs as a complication in approximately 20% of large haematomas associated with muscle contusions and strains. It is responsible for considerable morbidity, with symptoms of prolonged pain, diminished flexibility, local tenderness and stiffness lasting an average of 1.1 years.[1–3] The majority of contusions and strains are typically responsive to conservative treatment within a few weeks of injury, however, MO becomes clinically suspected when a strain or contusion is unresponsive to conservative care and patients begin to demonstrate increasing pain and progressive loss of range of motion (ROM).[1,4] MO is a non-neoplastic proliferation of bone and cartilage tissue at the site of a previous injury, most commonly after blunt trauma or repeated micro-injuries.[1,5] It is also known as post-traumatic heterotopic ossification, non-hereditary heterotopic ossification and myositis ossificans circumscripta.[3,6] Radiographic imaging is used for a definitive diagnosis with evidence of bone formation being detected 3 to 4 weeks after the initial trauma.[7] It is most commonly found in athletes in contact sports but ectopic bone formation is also a frequent complication in approximately 19% of total hip arthroplasties.[1,3,8–10] MO is typically found in muscles but can also occur in tendons, joint capsules, ligaments and fascia.[5,6,11,12]

The goal of therapy for MO is the restoration of strength and ROM. Therapy has been largely based on the RICE principle of rest, ice, compression and elevation and non-painful, passive stretching and strengthening routine.[3,13] Due to the relative rarity of the condition and variability of the diagnosis in location and severity, evidence for effectiveness of manual therapy has been sparse. A Medline literature search from January 1991 to January 2011 for conservative therapies for myositis ossificans revealed mostly case reports[2,3,14–16] and review articles.[4,5,9,12–14] However, a case-series was published in 2010 demonstrating the effectiveness of extracorporeal shock wave therapy (ESWT) for the treatment of MO in elite or sub-elite athletes in significantly less time than traditional therapeutic approaches reported.[1] After three sessions of ESWT spaced over six weeks and an intense program of supervised exercises and stretching, the athletes all experienced significant short-term improvements with 87% of the patients returning to competitive sport activities after 13 weeks of therapy.[2,3] This was the first study to evaluate the use of ESWT for the treatment of MO.

The following is a case of a young rugby player that sustained a severe contusion to the right quadriceps. Two months after the initial trauma, he presented to the clinic with progressing pain and disability and a significant loss of ROM of the knee. He was diagnosed with posttraumatic myositis ossificans of the right vastus lateralis and a trial of ESWT was initiated.

Patient History

A 20 year-old male semi-professional rugby player presented to a chiropractic clinic with a severe, right quadriceps contusion that he sustained nine weeks before in Scotland where he was attending school. The injury occurred during a game of touch rugby where there was a significant collision with another player who fell into his anterior thigh while running. The injury was quite debilitating and he was forced to bed-rest for one week. The rehabilitation began in Scotland with pool exercises, hot/cold baths and ultrasound. Soft tissue therapy was attempted but not well tolerated. His thigh seemed to get worse with more pain, loss of strength and reduced range of motion (ROM). He saw an orthopaedic surgeon in Edinburgh three weeks after the injury who ordered an MRI (Figure 1) which revealed a significant haematoma in the vastus lateralis. The quadriceps tendon and structures of the knee were intact.

Upon presentation to our clinic nine weeks later, he walked with a significant limp and could not bend his knee more than 45 degrees. He reported difficulty walking, going up or down stairs and difficulty sleeping due to pain. Past medical history revealed that he was otherwise healthy. On physical examination, the contusion was located in the proximal one-third of the vastus lateralis with notable swelling and tenderness along the length of vastus lateralis. Palpation revealed a mass approximately 12 cm × 8 cm that was firm and very tender. Knee extension strength was graded 2/5 on the right (he could not extend against gravity while supine) and 5/5 with knee flexion. Sensation of the lower limb was intact. He could perform a double leg squat comfortably to 45° of right knee flexion. Passive range of motion of the knee revealed 70° of flexion with the hip flexed at 90°. He was diagnosed with a large, severe chronic contusion of the right vastus lateralis. A differential diagnosis of MO was considered due

Figure 1 *The lateral view of the MR images of the right thigh three weeks post-injury demonstrating the lesion in the vastus lateralis.*

Figure 2 *Radiographs taken nine weeks post-trauma demonstrating the appearance of fine, lacy, heterotopic ossification in the right thigh consistent with the diagnosis of MO. Frog-leg (left) and lateral (right) thigh series.*

to the progressive loss of function. He was advised to ice at home and to begin a progression of stretching (active hamstring contraction and gentle passive manoeuvres) and strengthening exercises (isometric contraction, supine straight-leg raises and one-foot balance) on his own. He was instructed that all components of the treatment plan were to be gentle and pain-free. The patient had radiographs taken the following day which verified the diagnosis of MO (Figure 2).

Based on an article by Buselli et al., a trial of shockwave therapy was initiated with the patient five days after the initial assessment (10 weeks post-injury). Before the first ESWT treatment, the patient was fully informed and consent was obtained. On examination, the right knee had regained some strength and the patient could lift his heel off the table 10 cm while supine. Passive flexion was 90° and he reported to continue to have pain at night. There was more delineation of the contours of the mass with exquisite tenderness at the proximal end. The first EWST treatment (Masterpuls MP100, Storz Medical) consisted of 100 impulses at 1.5 bar (1 bar = 0.1 MPa = 0.1 N/mm^2) delivered to each of five locations over the mass: two at the proximal end, one in the middle and two at the distal end. Home instructions remained the same.

Two days later, the patient reported that he had experienced about 12 hours of soreness after the treatment but presently felt great and had no night pain. Objectively, his ROM increased to 115°. He had a second shockwave treatment for 100 impulses at 3.0 bar over every square centimeter of the mass (2500 impulses). He was recommended to have another treatment one week later and was told to continue with his home care.

When the patient returned the following week (11 weeks post-injury), he reported that he was able to walk for over an hour with no pain and had no night pain. The ROM of his knee was not restricted and was equal to the contralateral side (125°). He had a final treatment of 2500 impulses over 25 points and was advised that he could start shallow, body weight squats and lunges to 45° of knee flexion. He was advised to gradually increase his ROM with the lunges and squats before adding resistance.

The patient returned to Scotland the next day so the remaining follow-ups were through written correspondence. The patient remained diligent with the gradual stretching and strengthening. Two weeks after the last ESWT session (13 weeks post-injury), he reported that he was running an average of four km/day and had just played his first 60-minute touch rugby session with no pain. The following week he was running over 5 km in 25 minutes

with speed intervals of up to 85% capacity and playing touch-rugby three times a week. He reported full ROM with only some muscle fatigue that seemed to be similar in both legs, possibly due to deconditioning. At 17 weeks post-injury, he reported he was playing touch rugby at full pace, his timed sprints were back to pre-injury levels, and his squat and deadlifts were back to full strength and ROM. He reported being unrestricted in training with the rest of the team and felt that he had made a full recovery.

Discussion

Post-traumatic myositis ossificans is the proliferation of bone and cartilage within a muscle after the formation of an intramuscular haematoma. It is more common in the sporting community as a complication of muscle contusions and strains by either a major trauma or repeated injury.[1,5,11] Muscle strains and contusions account for over 90% of all injuries sustained in sports and, of these, approximately 9% to 20% are complicated by MO.[3,5,17] The case presented was typical in that it is usually found adjacent to the diaphysis of tubular bones, most commonly in the anterior thigh and is also commonly found in the anterior third of the arm involving the brachialis.[3,7]

Diagnosis can be obtained from the clinical history, physical examination, radiographic imaging, and less commonly by diagnostic ultrasound or magnetic resonance imaging (MRI).[3,18] The symptoms of pain, tenderness, erythema, soft-tissue swelling and periarticular stiffness overlap between muscle strains/contusions and MO. However, MO becomes clinically suspected after the injury is unresponsive to 10–14 days of rest.[12] As in the case presented, MO causes intensified pain with progressive loss of ROM and a painful, palpable mass in the weeks following trauma.[1,12] Sporting activities as well as activities of daily living are impaired by the reduced ROM and soft-tissue contractures.[1,4,12] Radiographic signs of ectopic bone usually develop approximately 3–5 weeks after the injury.[5,13,18] The radiographic signs of MO during the early stages demonstrate a fine, lacy radiopacity that later appears cloudy within a well-defined mass (Figure 2).[6,17] MRIs will demonstrate well-defined margins and a lack of soft-tissue invasion which helps to differentiate it from sarcomatous lesions (Figure1).[6,17,19,20]

The pathogenesis and primary etiological factors of bone formation remains unclear.[1,12] After a muscle is crushed or torn, the tissues at the center of the traumatized area usually liquefy or form sheets of non-specific cells. It has been hypothesized that the ectopic bone and cartilage are from the differentiation of osteoblasts from these rapidly proliferating mesenchymal cells under anoxic conditions.[7,14,21] Inflammation caused by the damage, with heat, swelling and tenderness, recruits an influx of inflammatory cells and macrophages into the necrotic tissue that release osteogenic bone mediators which encourage the formation of heterotopic bone.[1,3,7,21]

During the first 2 to 4 weeks, osteoid formation is minimal and a biopsy can lead to an erroneous diagnosis of neoplasia if the history of trauma is not disclosed.[7,12] The tissue in the periphery is the most prompt to repair, organize and mineralize into mature tissue with the lesion becoming progressively less differentiated towards the center. Differentiation of the tissues continues through the second and third months, leading to the characteristic zoning of MO.[6,7] The zoning helps to distinguish MO from osteosarcomas with the latter being the least differentiated at the periphery and most differentiated at the center.[6,7,11] MO tends to shrink as it matures over a six month period.[12] Surgery is reserved until approximately 12–14 months post-injury, when the lesion becomes stable and the periosteum has formed. Surgery is contraindicated for immature lesions due to the high recurrence rates.[5] Muscle function typically does not recover with or without surgery, however, muscle contours typically return to normal.

The literature for the effectiveness of typical therapeutic approaches to MO, such as stretching, strengthening and proprioceptive retraining, is sparse.[3] Acute care of a severely injured muscle during the initial two weeks aims to reduce local inflammation which is hypothesized to reduce the chance of developing MO. This typically includes immobilization of the muscles in slight tension with compression, along with ice and elevation in order to limit the intramuscular bleeding.[1,5,22] During the first 15 days after trauma, the lesions are vulnerable to further trauma and, therefore, excessive activity, forceful stretching and massage should be avoided to limit bleeding.[5,11] Non-steroidal anti-inflammatories are also incorporated and have been shown to reduce the onset of MO after hip arthroplasty, but have not been studied in post-traumatic contusions.[12] If MO develops despite the best efforts of prevention, the graded restoration of flexibility and strength with minimal pain becomes the goal of rehabilitation.[3]

Extracorporeal shock-wave therapy (ESWT) is a sequence of high intensity sonic pulses with a short duration (10 ms).[23,24] ESWT was originally used for fragmentation of urinary stones and other types of body calculi and has since been extended in its use and shown to be effective for calcification of tendons and pseudo arthroses.[3,5,25,26] ESWT, when applied to a tissue, produces a mechanical action through a cavitation effect that can induce biological action through microdisruption of avascular tissues. This leads to suppressive effects on local nociceptors as well as stimulation and reactivation of tissue repair through neovascular angiogenesis, release of local growth factors and anti-inflammatory mediators, such as nitrous oxide, and recruitment of local stem cells for the repair process.[23,26–30] It is thought that the analgesic ability of ESWT may be due to a form of hyperstimulation analgesia[8,31,32] which occurs when a moderate to intense sensory input is applied to the site of greatest discomfort in a chronic pain patient. The relief can last for days, weeks, months or sometimes permanently.[31–33]

Consideration for the use of ESWT for the treatment of MO for this particular patient came from a case-series by Buselli, et al., which demonstrated successful treatment of 21 of 24 MO athletes treated with EWST.[1] A significant portion of the patients in that study were similar to the patient presented here. Twelve of the 24 patients with MO in Buselli's study were the result of contusions to the quadriceps, were relatively young athletes (average age of 25 years), and were also treated within twelve weeks of the initial trauma.

In Buselli's study, ESWT was administered every other week for a total of three treatments. The application of ESWT was in accordance of the International Society of Medical Shock Waves Therapy in which 100 impulses were applied at medium power (1.3 to 2.3 bar), within the patient's tolerance, to every square centimeter of the ossification.[24] In the case presented here, due to the novelty of the treatment, the first session of ESWT was limited to 500 impulses at a low-medium intensity (1.5 bar) to gauge the patient's level of tolerance. Of note, even at the reduced intensity, the patient reported a notable analgesic effect 24 hours post-treatment and an improvement in ROM of the knee. Physical examination also confirmed a reduction in swelling and tenderness of the vastus lateralis muscle. It is possible that the gentle stretching and strengthening exercises also contributed to the improvement of his symptoms. However, the ESWT was suspected to have contributed to the majority of the analgesia due to the dramatic reduction in pain and improvement of ROM within 48 hours of the first ESWT application. The patient had a more intense ESWT treatment (2500 hits, 3.0 bar) two days after the first and the last one seven days later. After the last treatment, there was full restoration of knee flexion and significant reduction in swelling and tenderness over the lesion and no pain at rest.

The patients in Buselli's study also underwent a much more intense regimen of physical therapy (6 times per week for six weeks, 80 minutes per session) consisting of stretching, proprioceptive exercises, manual and mechanical active and passive mobilizations. After six weeks of treatment, over 90% of those patients were able to return to competitive sporting activities after an average of 11 weeks (24 max., 8 min.) and complete return to activities after an average of 14 weeks (28 max., 10 min.). In the case presented here, the two week timeline and predominantly unsupervised, home-based rehabilitation program contrasted with the daily physiotherapy sessions that was proposed in Buselli's study. Our therapy consisted of unsupervised active and passive stretching and a graded exercise program of basic movements, from non-weight bearing to weight bearing, with the instructions that it was to all be completed pain free. The patient was permitted to return to sport-specific training after he was able to demonstrate equal ROM of the injured and uninjured knees, as well as pain-free use of the injured muscle during functional testing.[5] In this case, the patient was able to return to sport-training thirteen weeks post-injury (two weeks after the final ESWT application).

No serious side-effects from the use of ESWT on MO have been reported. However, the procedure can be painful and cause pain over the treatment area afterwards for 24 to 48 hours. Other known side-effects include minor skin bruising, reddening and short-term swelling.[1,25,34] In this case, the first treatment was quite sensitive even at the lower pressure settings. Subsequent treatments were only moderately painful. The patient reported twelve hours of soreness after the first treatment with only mild, short-term discomfort after the last two applications.

The MO patients in Buselli's study did not demonstrate a reduction in the size of the ossification despite the improvement in ROM and strength after treatment with ESWT.[1] This may be because the ossification in MO

tends to be well organized which is consistent with the finding that ESWT does not cause fractures in cortical bone.[35] No follow-up radiographs were available for the patient presented in this study, however, a firm mass was still palpable in his lateral thigh at the last visit. Therefore, a reduction in the size of the ossification area may not be necessary for patients to regain their functional ROM, strength and to experience a reduction in pain.

It should be noted that the evidence for the effectiveness of ESWT on MO is limited to descriptive case reports and has not been validated in controlled trials. A controlled trial can help to delineate the relative contribution of ESWT on pain relief and disability versus the traditional exercise protocols commonly used. Of note, all of the patients in these case reports were male, elite or sub-elite athletes and between 18 and 54 years of age (mean age of 25 years) which restricts the generalizability to other patient populations prone to MO, such as those receiving hip arthroplasty. More research is also needed to establish timelines for the onset of treatment, the number of treatments that are necessary, and to confirm the safety of the modality.

Conclusion

MO is a chronic, debilitating condition and is not an uncommon diagnosis in contact sports due to the high incidence of traumatic contusions. Non-invasive treatment options for MO have remained consistent for over 20 years with stiffness and tenderness lasting 1.1 years on average[1–3]; however, a recent study has demonstrated that ESWT may be a promising treatment modality for the management of pain and loss of ROM that result from MO.[1] Although the results have not yet been confirmed in a controlled trial, the appreciable improvement in pain scores and ROM in elite and sub-elite athletes after only 3 treatments of ESWT in a relatively short period of time is encouraging. In the case presented here, a two week program of ESWT and an unsupervised, progressive strengthening program were effective modalities in the treatment of a post-traumatic MO in the quadriceps of a 20 year old, male, semi-professional rugby player. Despite relatively high disability for 10 weeks before treatment with ESWT, he regained much of the function of his right quadriceps and was back to sport specific training four weeks after initiating treatment. The current literature on ESWT indicates that it can have a substantial analgesic effect on the lesion although the mechanism remains elusive.[36,37] ESWT is an attractive modality for the treatment of MO given that it is non-invasive, affordable and with few side effects.

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