

Myositis ossificans traumatica of the deltoid ligament in a 34 year old recreational ice hockey player with a 15 year post-trauma follow-up: a case report and review of the literature

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Myositis ossificans traumatica is a relatively common injury associated with sports especially those involving contact. It continues to frustrate both athlete and health practitioner alike due to its continued lack of treatment options and a lengthy natural history. This case study chronicles the observation of a 34 year old recreational ice hockey player who presented 7 years post-trauma, was diagnosed with myositis ossificans traumatica and was followed up on 8 years later (15 years post-trauma). This case report is suspected to be the first published case study of its kind. The literature review outlines the various types of myositis ossificans, its incidence, pathogenesis, differential diagnoses including osteosarcoma, and the various methods/modalities reported in its treatment.

(JCCA 2010; 54(4):229-242)

KEY WORDS: myositis ossificans traumatica, heterotopic ossification, post-traumatic myositis ossificans, ice hockey, deltoid ligament

La myosite ossifiante traumatique est une blessure relativement courante liée à la pratique des sports, particulièrement les sports de contact. Elle continue de frustrer les athlètes et les professionnels de la santé en raison de l'absence d'options de traitement et du fait qu'elle existe depuis longtemps. Cette étude de cas raconte l'observation d'un joueur de hockey sur glace de ligue récréative de 34 ans qui reçut un diagnostic de myosite ossifiante traumatique après 7 ans, et qu'on examina ensuite 8 ans plus tard (15 ans après le traumatisme). Cette étude de cas est probablement la première en son genre. Une analyse de la documentation à ce sujet souligne les divers types de myosite ossifiante, sa fréquence, sa pathogénie, les différents diagnostics, notamment l'ostéosarcome, et les diverses méthodes/modalités signalées dans son traitement.

(JCCA 2010; 54(4):229-242)

MOTS CLÉS : myosite ossifiante traumatique, ossification hétéropique, myosite ossifiante post-traumatique, hockey sur glace, ligament deltoïde

Introduction

Myositis ossificans traumatica (MOT) is often defined as heterotopic, non-neoplastic proliferation of bone in an area previously exposed to trauma and hematoma.^{1,2}

The most common areas that are affected by MOT are the quadriceps femoris, brachialis anticus, and the adductor muscles of the thigh³ although it may occur anywhere. It can happen at any age, but occurs most frequently in adolescents and young athletes, with over half of the cases occurring in the third decade.^{1,3} MOT is con-

sidered rare in children under 10 years of age¹ and males are more often affected than females.³

The incidence of MOT following quadriceps contusions is reported at varying percentages depending on the severity of the injury. Mild contusions have shown an incidence of MOT of 0-9%, moderate to severe 17-72% and recurrent contusion 100%.^{4,5} Contusions of the thigh are generally graded according to the subsequent loss of range of motion at the knee joint. Contusions are graded as mild (active ROM greater than 90°), moderate (45-90°)

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Figure 1 Photograph of patient's bilateral ankles. The arrow indicates the area of myositis ossificans traumatica of the left medial ankle.



Figure 2 Photograph of the patient's left medial ankle. The arrow indicates the area of myositis ossificans traumatica.

and severe (less than 45°).⁵ Arrington⁶ grades thigh contusions as: mild – near normal ROM, local tenderness, no gait abnormality; moderate – swollen tender muscle, 75% ROM, antalgic gait; and severe – marked tenderness/swelling, 50% ROM with a severe limp. Muscle contusion injuries are second only to strain injuries as a major cause of morbidity in the modern athlete.²

This paper presents a case study of a 34 year old recreational ice hockey player who was diagnosed with MOT of the deltoid ligament of the ankle 7 years post-trauma and followed up on 8 years later (15 years post-trauma).

Case Report

History

A 34 year old recreational hockey player presented with an unusual bony lump just anterior and inferior to his left medial malleolus (see Figure 1 and 2). He reported that the lump had started following blocking a shot in a hockey game 7 years previously. He was able to finish the game and had partial weightbearing following the game. The foot became increasingly swollen and was treated with rest and ice. No radiographs were taken at the time of the initial injury. He reported that the lump had increased in size slowly over the next few years. Two

years after the injury, he had returned to play competitive hockey and didn't recall any limitation although the lump had not resolved. Four years post injury, he began to notice the lump was larger and was becoming increasingly irritated from the direct pressure of tightening his skate laces. He was also getting sharp pain in his foot with pivoting while skating and noticed decreased range of motion especially in dorsiflexion. Seven years post-injury, he began to notice increased pain when turning around pylons while demonstrating drills as a hockey coach. Stopping, and backward skating had also become painful and pivoting was still difficult due to pain. He also noted increasing difficulty going up stairs and felt he had to lift his leg higher to get his foot flat on the next stair. At this point, he presented to the clinic for examination and possible imaging.

There was no history of recent infection, sudden unexplained weight loss or night pain. Systems review revealed a history of seasonal bronchitis but was otherwise unremarkable. Previous medical history revealed a previous right shoulder surgery for recurrent subluxation but no other major traumas or motor vehicle accidents. He did not report any previous injury to the left foot or ankle. Family history did not reveal anything relevant. He is an otherwise healthy individual who exercises regularly and



Figure 3 Medial sagittal CT image of the left ankle 7 years post injury showing an irregular ossific density anteroinferior to the medial malleolus indicating myositis ossificans traumatica of the deltoid ligament. The white arrow indicates the area of ossification.

does not smoke. This patient is a factory worker and a part-time hockey coach.

He did not report any numbness or tingling in his foot or ankle.

Physical examination

Upon examination, the patient was able to ambulate normally. A visible prominence was noted anterior and inferior to the medial malleolus of his left foot. Active and passive range of motion revealed a decrease of 40% in dorsiflexion, inversion and eversion due to restriction not pain. Plantar flexion was decreased 10–20% due to soft tissue restrictions. (The patient felt he could go further but was tight and no bony end feel was noted.) Joint play of the midtarsal joints was within normal limits. Other ranges of motion were full and pain free. Strength was slightly decreased compared to the right side in all ranges but there was no pain. Palpation of the bony mass revealed some point tenderness but the foot and ankle were otherwise pain free. Radiographs and a CT were ordered for this patient at this point in the examination (see Figure 3–6).

Diagnosis

The patient was subsequently diagnosed with myositis ossificans traumatica of the left deltoid ligament of the ankle.

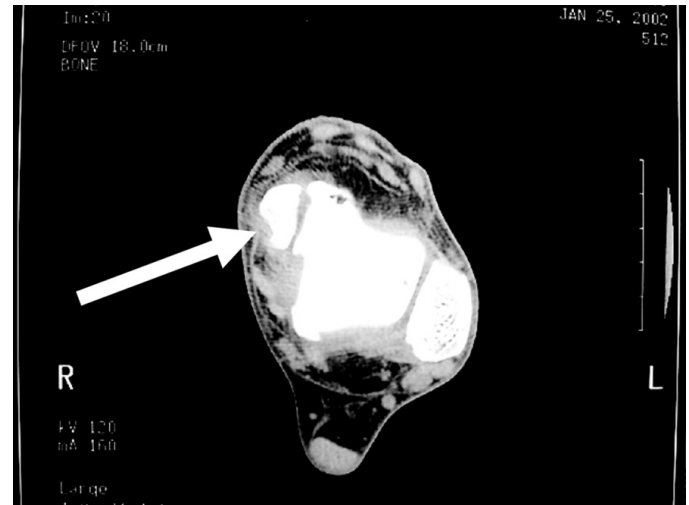


Figure 4 Axial CT image of the left ankle 7 years post injury showing an irregular ossific density medial to the medial malleolus. The white arrow indicates the area of ossification.

Plan of management

The initial plan of management for this patient was to rule out any insidious diagnosis, including osteosarcoma, with the imaging. The diagnosis of osteosarcoma was unlikely due to the slow, progressive nature of the injury and its lack of pain but it was felt imaging was prudent in this case. Following the diagnosis, the patient was informed of the natural history of MOT and that there were few proven treatment options available at that time. Due to the relatively minor irritation experienced during hockey and activities of daily living the patient was not interested in surgery and decided to treat the area symptomatically with ice and rest as needed. A “wait and see” approach was taken with instructions that if the lump was increasing in size and/or pain that the patient was to return for further examination.

15 Year Follow-up

The patient, now 42 years old, was contacted to follow-up on his status. The patient reported that he felt there was little change in the size of the lesion on his left ankle. He still had similar restrictions with regard to his on-ice activities including quick pivoting and demonstrating drills and his activities of daily living including going up stairs. He felt these activities were difficult due to his decreased



Figure 5 Coronal CT image of the left ankle 7 years post injury showing an irregular ossific density anteroinferior to the medial malleolus. The white arrow indicates the area of ossification.

ability to dorsiflex his ankle. The patient reported that he had learned to avoid certain aggravating activities because of the length of time of his injury. No follow-up physical exam was performed. Radiographic images were obtained at follow-up. The follow-up radiographs show that little change has occurred in the size of the MOT as visualized (see Figure 7 and 8).

Discussion

Types of Myositis Ossificans

Heterotopic bone formation in soft tissue has historically been classified as myositis ossificans. Many authors now consider the term myositis ossificans to be a misnomer arguing that there is no inflammatory process and the condition may or may not involve bone or muscle tissue.^{7,8} Myositis ossificans consists of three main types – congenital, idiopathic, and traumatic (see chart 1). Myositis ossificans traumatica (MOT) is also known in the literature by specific names given to MOT in specific areas of the body (see chart 2).^{3,7,9,10} Arrington⁶ classifies MOT into three types as does Mestan and Bassano (see chart 3).¹⁰

The pathogenesis of this injury remains unclear at this time. Some of the common theories include:¹⁰



Figure 6 Radiograph left ankle AP view 7 years post injury showing an irregular ossific density inferior to the medial malleolus. The white arrow indicates the area of ossification.

1. transformation of muscle hematoma to bone;
2. hematoma calcification;
3. intramuscular bone formation from detached periosteal flaps;
4. osteoblast proliferation from periosteal rupture;
5. metaplasia of intramuscular connective tissue cells;
6. individual predisposition.

It is believed that blunt trauma to the extremity creates a compression wave travelling through soft-tissue crushing the deepest muscle against the bone. The force is transmitted through the fluid compartment of all of the layers of muscles but the damage usually occurs in the layer that is next to the bone.⁵



Figure 7 Radiograph left ankle Oblique view 15 years post injury showing an irregular ossific density inferior to the medial malleolus. The black arrow indicates the area of ossification.

Wang⁷ suggests that there are several steps following the injury to the tissue that leads to the development of MOT. There is cellular damage causing necrotic debris that is subsequently removed through the invasion of histiocytes. Fibroblasts from the endomysium then assail the



Figure 8 Radiograph left ankle AP view 15 years post injury showing an irregular ossific density inferior to the medial malleolus. The white arrow indicates the area of ossification.

injured cells and mesenchymal cells begin to proliferate. The fibroblasts and mesenchymal cells produce osteoid and chondroid tissue that lays down the groundwork for the formation of bone within the damaged tissue. This can occur as early as 4 to 5 days after the injury has occurred.

A particularly important aspect of MOT occurs at this

Chart 1 Types of Myositis Ossificans

<p>1. Congenital²⁴</p> <ul style="list-style-type: none"> • three inherited diseases that are characterized by heterotopic bone formation²⁴ • these are: fibrous dysplasia ossificans progressive (FOP), progressive osseous heteroplasia (POH), and Albright's hereditary osteodystrophy (AHO) • although rare, they should be included in children presenting with myositis ossificans of an idiopathic nature. 		
<p>Fibrous dysplasia ossificans progressiva (FOP):</p> <ul style="list-style-type: none"> • also called "stone man disease" and myositis ossificans progressive • first described in the late 17th century • characterized by the formation of bone in tendons and muscles. • manifests itself in childhood and is slowly progressive resulting in the formation of a "second skeleton" in patients. • very uncommon occurring in approximately 1 in 2 million. 	<p>Progressive osseous heteroplasia (POH):</p> <ul style="list-style-type: none"> • first described by Kaplan in 1994 • originally thought to be atypical FOP • in contrast to FOP, ossification begins in the dermis and spreads to the subcutaneous tissue and fascia with no skeletal abnormalities. • POH is very rare and begins in childhood, similar to FOP. 	<p>Albright's hereditary osteodystrophy (AHO):</p> <ul style="list-style-type: none"> • manifests with a certain phenotypical presentation along with subcutaneous calcifications about the limb joints • phenotypical features includes: short stature, a round facies, hypertelorism, and shortness of the 4th and 5th digits. • mental retardation is also common in these patients.
<p>2. Idiopathic</p> <ul style="list-style-type: none"> • controversy regarding the idiopathic nature of myositis ossificans and its naming. • some authors use the term myositis ossificans circumscripta (MOC) to describe the heterotopic ossification of soft tissue of an idiopathic nature²⁵ • other authors use MOC as synonymous with myositis ossificans traumatica^{8, 16} • has been reported following burns, tetanus, and polio and neurogenic injuries including spinal cord injuries, closed head injuries, central nervous system infections, and stroke^{1,9} 		
<p>3. Traumatic</p> <ul style="list-style-type: none"> • difficult to adequately research MOT due to its many synonyms. • these include post-traumatic myositis ossificans, myositis ossificans circumscripta, pseudomalignant heterotopic ossification, pseudomalignant myositis ossificans, pseudomalignant osseous tumor of soft tissue, extraosseous localized non-neoplastic bone or cartilage formation³ • some radiologists consider the traumatic ossification of ligaments specifically to be called dystrophic calcification. • dystrophic calcification is defined as "calcium salt deposits in the presence of normal calcium/phosphorus metabolism involving tissues that do not physiologically calcify"²⁶ which may not adequately describe our case 		

Chart 2 *Specific Areas of MOT with Specific Names*^{3,7,10,27,28}

<p>“Rider’s Bone”, Prussian’s Disease or “Saddle Tumor”</p>	<ul style="list-style-type: none"> found in the hip adductors in horseback riders and jockeys from the pressure of the saddle against upper/inner thigh. described by Geschickter and Maseritz in 1938²⁷ as ossification in the thighs of cavalry men. <p>Author’s Note: the terms Prussian’s Disease and saddle tumor were attributed to Ackerman¹¹ by Danchik et al.³ but no mention of these terms were found when examining the Ackerman paper. A subsequent literature search of these terms did not reveal any articles on PubMed.</p>
<p>Pelligrini-Stieda Disease</p>	<ul style="list-style-type: none"> found in the medial collateral ligament of the knee. first described by Pellegrini in 1905. Kohler reported a similar case in 1905 as well. Stieda, unaware of the previous works of Pellegrini or Kohler reported a similar case in 1907.²⁸ most commonly found in football players.
<p>“Rider’s Bone”</p>	<ul style="list-style-type: none"> found near the attachment of the hamstrings at the ischial tuberosity. Danchik et al.³ suggests it is secondary to hypervascularity following an avulsion of the hamstrings has also been called “Rider’s Bone” due to the proclivity of this injury in horseback riders³ Common in sprinters, hurdlers and cheerleaders <p>Author’s Note: in checking Danchik’s reference of Ackerman¹¹ no mention of “Rider’s Bone” was found suggesting that the “Rider’s Bone” mentioned may be similar to the aforementioned with “Prussian’s Disease” and the ischial tuberosity injury as described is misnamed.</p>
<p>“Rifle Shoulder”</p>	<ul style="list-style-type: none"> found in the pectoralis major or anterior deltoid muscle due to the repeated kickback of a rifle or due to carrying the rifle on the shoulder. most common in soldiers particularly the infantry. described by Geschickter and Maseritz in 1938²⁷ as the “rifle shoulders” of infantry men.
<p>“Fencer’s Bone”</p>	<ul style="list-style-type: none"> found in the brachialis anticus due to the overextension of the forearm⁷ most common in fencers and baseball pitchers.
<p>“Dancer’s Bone”</p>	<ul style="list-style-type: none"> found in the soleus muscle⁷ <p>Author’s Note: a subsequent literature search of the terms “Fencer’s Bone” and “Dancer’s Bone” did not reveal any articles on PubMed.</p>

Chart 3 Classification of MOT

Arrington Classification ⁶		Mestan and Bassano Classification ¹⁰	
1. stalk	there is a stalk attachment to the underlying bone	1. parosteal	the ossification is found near or against bone
2. periosteal	there is total continuity between the underlying bone and the heterotopic bone	2. periosteal	the periosteum is torn away from the underlying cortex due to the trauma. The resulting injury may have a sunburst appearance. Note: 60% of MOT's have a periosteal reaction secondary to the trauma. ¹²
3. broad-based	is a large base of attachment to the underlying muscle	3. extraosseus	the heterotopic bone is found in the substance of the involved muscle

stage and is critical to the differentiation of MOT and osteosarcoma. The previously mentioned steps begin in the least damaged area moving toward the area of most damage. As a result, lamellar new bone is laid down in a centripetal pattern that is referred to as “the zonal phenomenon” (see Figure 9).^{7,11}

Zonal phenomenon seems to be first mentioned by Ackerman in 1958.¹¹ He states, “I have been impressed by what I have designated as zone phenomena (inner, middle and outer zones).” He further states, “... they are well documented in examples of classic myositis ossificans, but no one has mentioned it, probably because the process is often recognized by typical histories and locations.”¹¹

Beginning in the second week to second month, bone is formed surrounding the area and then moves inward toward the site of injury giving layers of varying tissue activity. Moving inward, the outside layer is bone, the middle layer is an area of extensive osteoblastic and fibroblastic activity, and the central layer is an area of highly cellular tissue with a lot of cell differentiation and necrotic cells.^{7,8} Osteosarcoma does not show this zonal phenomenon. The calcification seen with osteosarcoma begins in the central areas of the tumour. Unfortunately, if a biopsy

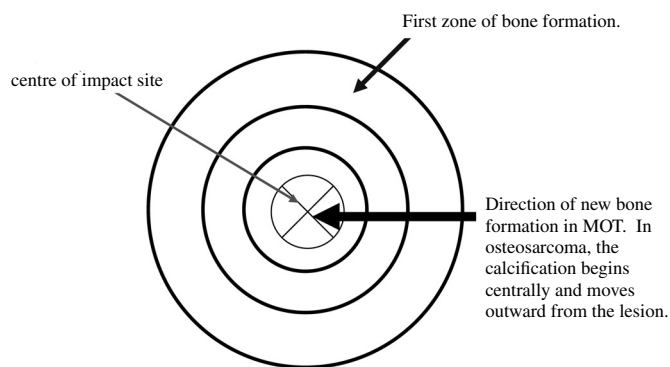


Figure 9 The “Zonal Phenomenon” of MOT.

of the area is done and the majority of the cells come from the middle and central layers, an incorrect diagnosis of osteosarcoma can be made and improper treatment has followed, including amputation.^{3,12}

Typical Patient Presentation

A typical patient presentation includes a history of trauma to the affected area with increased difficulty in moving

Chart 4 *Myositis Ossificans Traumatica and Osteosarcoma*
 A comparison of the two conditions includes the following:²³

Myositis Ossificans Traumatica	Osteosarcoma
<ul style="list-style-type: none"> • history of trauma • found in the diaphysis • cortex usually intact even with a periosteal reaction • pain and mass decrease with time • activity-related pain • alkaline phosphatase levels often normal but can be elevated² 	<ul style="list-style-type: none"> • no history of trauma (although trauma can occur in up to 40% of cases)¹⁷ • found in the metaphysis • cortex often violated • pain and mass increase with time • night pain alkaline phosphatase levels elevated

and using the affected limb. In football, an opposing player’s helmet to the thigh and in hockey and soccer, an opposing players knee to the thigh are common mechanisms of injury.¹² Trauma (direct and repetitive) is reported in 60–70% of the cases.³ As previously mentioned the onset seems to be related to the severity of the injury.

In our case, the athlete reported a severe, yet common cause of trauma (blocking a shot). However, he did not feel it was severe enough to get a radiograph or seek treatment at the time of the injury.

A clinician should initially suspect the early stages of MOT if the pain, swelling and tenderness of the affected area has not responded to conservative management within the first 4–5 days.¹² This suspicion should increase further if the athlete reports that the symptoms have not improved significantly or have worsened within 10–14 days of the injury.¹²

A physical examination of an athlete suspected of having MOT begins with observation. If the injury is to the lower limb, particularly the thigh, an antalgic gait with limited weight bearing of the affected limb will often be noted as the athlete enters the treating room. The athlete will often have difficulty getting into the seated position due to an inability to flex the adjacent joints. A significant superficial hematoma is often noted with palpable tensesness of the affected area. However, a deep intramuscular hematoma may not produce visual signs of injury but should be suspected in cases of a severe blow to the limb.

Active, passive and resisted range of motion will be notably decreased in the affected limb with more severe

injuries. In our case, the athlete’s ankle range of motion was restricted but he was still able to function in his activities of daily living. While playing hockey, he reported that he was still able to play but certain movements while skating were difficult. Booth reports that muscle atrophy may be noted with persistent local tenderness and loss of range of motion.¹² There was no muscle atrophy noted in our case.

Beauchesne reported a case of MOT of the piriformis in a patient that fell down the stairs.¹³ The patient presented with radicular symptoms of the lower limb including paresthesias and decreased sensation on the lateral border of the left foot as well as weakness in the left ankle. Our patient did not present with any lack or change in sensation.

Hyder reported a case of MOT of the tibialis anterior in a 31 year old man 14 years post injury.¹⁴ The man presented with extreme limitation of ankle movements with some pain in the leg, especially with walking.

In another case report by Mestan and Bassano, a 54 year old man presented with acute pain localized to the middle aspect of his left lower leg after a log rolled onto it.¹⁰ The patient was subsequently diagnosed with a fracture of a previous heterotopic bone formation secondary to a karate injury 32 years previously.

Booth identifies three important criteria to consider when diagnosing MOT.¹² These include:

1. a history of significant local injury;
2. clinical and radiological evidence of ossification within 2 months of the initial injury;

3. the location of the lesion in proximal limb areas more commonly associated with MOT including the brachialis anticus and quadriceps femoris.

Other reasonable differential diagnoses include:⁸ extraosseous osteosarcoma, synovial osteosarcoma, osteochondroma, posttraumatic periostitis, osteomyelitis, and tumoral calcinosis. There have been cases of osteosarcoma that have developed from traumatic myositis ossificans but it is very rare.¹ Aboulafia reported a case of osteosarcoma arising from heterotopic ossification that occurred as a result of an electrical burn 10 years previous.¹⁵ (Chart 3 provides a differential diagnoses between MOT and osteosarcoma).

There are several risk factors that have been identified in those athletes that have developed MOT. These are described in Table 1.

Treatment

Natural History

MOT is generally considered to be a self-limiting condition and can have spontaneous resolution.^{1,3,16} Hamida reports that without treatment the radiological and clinical findings will have stabilized and/or resolved within 1.5 to 3 years following the onset of symptoms.¹⁶ Danchik notes that within 4 to 6 months, the lesion has stabilized.³ Full reabsorption can take place especially in lesions occurring within the muscle belly.³ Lesions located near an origin or insertion of a muscle are less likely to reabsorb and may result in functional impairment.³ Parikh reports that full reabsorption is more likely to occur in smaller upper extremity lesions compared to a larger lesion located in the lower extremity.¹ Le Roux noted that smaller upper extremity lesions were more likely to reabsorb except for those lesions occurring at the elbow.⁸ There are several medical management options that are used for MOT. These are listed in Table 2.

Prevention

There is little to be done once the process of MOT has been initiated.^{10,12} However, as a sport medicine clinician that may be responsible for the diagnosis and treatment of MOT in athletes, there are several areas in which the proper management of the risk factors may decrease the possibility of its onset. These include:

1. early consideration of MOT as a differential diagnosis and the proper management of the hematoma (see Post Injury Protocol);
2. protection of the athlete from recurrent injury to the area by restriction of return to play and the addition of extra padding when the athlete does return. Some authors recommend extra protection 3 to 6 months post injury;¹⁷
3. education of the athletes on the causes and consequences of MOT and the importance of early treatment in its possible prevention. This should occur after an injury and also prior to the season before serious contusions are likely to occur.

Fracture of the myositis ossificans is rare but has been reported.¹⁰ Care should be taken to protect existing cases of MOT from fracture in those athletes that have returned to play and are at an increased risk of significant injury to the area.

Post Injury Protocol

Ryan investigated post injury protocols and the incidence of myositis in 117 contusions at West Point.⁵ In a previous study done by Jackson and Feagin at West Point in 1973, early knee extension was emphasized.⁴ In the 1991 study, early return of knee flexion was emphasized in an effort to reduce the disability and incidence of myositis ossificans.

Of the 117 contusions, 71 were mild, 38 were moderate and 8 were classified as severe. Their protocol consisted of 3 phases: Phase I – the limitation of hemorrhage with RICE. Weightbearing was to tolerance with crutches if necessary. The hip and knee were immobilized in flexion to pain tolerance as opposed to extension. The patient was advanced to the next phase when they were pain-free at rest and their thigh girth had stabilized; Phase II – the restoration of motion with emphasis on knee flexion and continued RICE as necessary. The patient was advanced to the next phase when their pain-free active knee range of motion was greater than 120° and their thigh girth was equal bilaterally; Phase III – functional rehabilitation emphasizing the return of strength and endurance with always pain free cycling, swimming, walking and jogging. The patient was advanced to full activities if they had full active range of motion, full squat, and all other activities were pain free. They were to wear extra thigh protection for 3 to 6 months for all contact sports. It is interesting to note that mild and

Table 1 Risk Factors for developing MOT^{3,4,5}

1. Severity of the injury. Although MOT has occurred following relatively minor trauma or even repetitive microtrauma, the more severe the initial injury, the greater the likelihood of developing MOT.
2. Localized tenderness and swelling.
3. Knee flexion <120°. In a study at West Point ⁵ no athlete with a contusion in which knee range of motion in flexion was greater than 120° developed MOT.
4. Re-injury during the recovery phase. Although having a small sample size, Jackson and Feagin ⁴ reported those athletes with recurrent contusions to the same area during recovery developed MOT in 100% of cases.
5. Delay in treatment >72 hours.
6. Improper management of the muscle contusion. ³ These include: i) massage, heat, ultrasound, whirlpool or specific analgesic liniments used in the initial stages of the injury recovery is applied to the area of hematoma; ii) soft tissue manipulation, passive exercises and active stretching of the contused area is performed too soon in the rehabilitation of the injury; iii) the athlete returns to competition too soon; iv) increased bleeding in the tissue secondary to hemophilia or anti-coagulant therapy.
Author's Note: Danchik did not provide references for this list of improper management strategies and is therefore thought to be evidence based on the expert opinion of the authors. ³

moderate quadriceps contusions were treated daily and severe contusions were treated twice daily.⁵

The results of this study showed that average disability time was reduced for moderate (19 versus 56 days) and severe (21 versus 72 days) contusions but increased for mild contusions (13 versus 7 days). The incidence of MOT occurring was 11 of 117 (9%) following contusions overall (mild contusion 3 of 71 (4%), moderate 7 of 38 (18%) and severe 1 of 8 (13%)). Compared to the 1973 study, there was a reduction in overall incidence from 20% to 9% and in severe contusions 72% to 13%.^{4,5}

Extracorporeal Shock Wave

In a prospective study done by Buseli et al in 2010, three sessions of extracorporeal shock wave therapy was performed over a 6 week period occurring once every 2 weeks.¹⁸ The shockwave was administered at 100 impulses per cm² of ossification at a medium power setting of 0.13 to 0.23 mJ/mm² in an effort to keep pain at a tolerable level. The shockwave treatments were started an average of 4 +/- 2.09 months after the trauma and treatment effectiveness evaluations were made at 1,2,3,6 and 12 months after the last treatment.

Table 2 Medical Management of MOT

<p>Aspiration</p> <p>Booth¹² reported on a study done by Molloy and McGuirk in 1976.</p>	<ul style="list-style-type: none"> • early aspiration of the hematoma with subsequent injection of steroids, lysosomal enzymes, and xylocaine. • able to return the majority of patients to full activity • intervention did not prevent the onset of MOT or the reabsorption of mature lesions. • efficacy in reducing the incidence of MOT is questionable.
<p>Alendronate (Fosamax)</p> <p>Case report.¹⁶ A 22 year old police officer and judoist presented following a period of intense training.</p>	<ul style="list-style-type: none"> • started on Alendronate six months post presentation • six months later the symptoms had resolved although a smaller ossified mass was still present in the affected tissue. • larger trial necessary to rule out the effects of natural history of MOT
<p>NSAIDs^{17,23}</p>	<ul style="list-style-type: none"> • Indomethacin (25 mg, 3 X/day for 6 weeks) suggested for prevention of heterotopic ossification post surgery. • Indomethacin and naproxen sodium are effective if used for 2 to 6 weeks but not effective with shorter-term usage. • NSAID therapy is especially endorsed following hip replacement surgery. • common side effects include the spectrum of gastrointestinal distress to bleeding ulcers and death, make their usage a less viable option.
<p>Acetic acid iontophoresis</p> <p>Case report.²⁹</p> <p>16 year old male that developed MOT following a diving accident.</p>	<ul style="list-style-type: none"> • 2% acetic acid solution was used with iontophoresis in an attempt to decrease the size and progression of the calcium formation. • treatment initiated 4 weeks post injury • consisted of iontophoresis, ultrasound and passive pain free ROM 3X/wk for 3 weeks. • after 3 week period, a follow-up radiograph showed a 98.9% decrease in the size of the mass • athlete regained full ROM and full, pain free ADL's. • a randomized control trial needed to rule out natural history. <p>Author's Note: Iontophoresis involves the movement of an electrically charged substance (in this case acetic acid) through the skin using low electrical current. This is not to be confused with phonophoresis that involves the use of ultrasound.</p>
<p>Surgery^{2,17}</p>	<ul style="list-style-type: none"> • surgery may be necessary if the lesion has not resorbed and functional disability exists. • universally accepted that if surgery is performed, it is only after the lesion has reached osseous maturity as indicated on bone scan or radiograph. This usually occurs 6 to 12 months post-injury. • lesion is likely to reoccur if excised prior to osseous maturity and even in up to 67% of cases after maturity.

There was a complete clinical and functional resolution in 21 of the 24 athletes. Return to previous sport activity in these athletes occurred within the 12 months of follow-up. Interestingly, there were statistically significant improvements in range of motion and pain (visual analogue and Fischer algometer) but no significant difference in the size of the lesion with radiographic follow-up.

In our case, the athlete did not seek any assessment of the injury until 7 years post-trauma. Prior to that, he did not feel that his activities were restricted enough to seek assessment and/or treatment but now felt assessment was warranted.

Conclusions

The reporting of myositis ossificans traumatica (MOT) in the medical literature is, in general, a series of case reports that most commonly involve athletes but can range from injuries as a result of college fraternity hazing¹⁹ to repetitive physical assault and battery found at autopsy²⁰ to subcutaneous injections²¹ to falling down the stairs on the buttocks.¹³ Previous MOT of the ankle in athletes has been reported as heterotopic ossification involving the interosseous membrane following a syndesmotic sprain in football players.²² To our knowledge, the present case study is the first report of MOT involving the deltoid ligament of the ankle following blunt trauma from a hockey puck in a recreational ice hockey player.

MOT must be carefully examined and must be properly diagnosed due to its similarity in presentation to osteosarcoma.^{10,17,23} An inappropriate diagnosis can lead to devastating results for the patient.

Until recently, there have been very few new approaches to the treatment of MOT other than prevention^{10,12} and a proper post injury protocol⁵. Buselli et al have shown extracorporeal shock wave to have some real potential as a viable treatment option for athletes suffering from MOT.¹⁸ More studies are needed in an effort to determine the most effective dose/response ratio for the use of shock wave in its treatment of MOT.

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