Pure bone marrow aspirate injection for chronic greater trochanteric pain syndrome: a case report

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Practice points

- Greater trochanteric pain syndrome (GTPS) is a common cause of lateral hip pain and weakness, associated with gluteus medius and minimus tendon pathology and rarely seen as an isolated trochanteric bursitis.
- Conservative treatments for GTPS, such as medications, physical therapy and corticosteroid injections are often successful, but limited options exist for those with refractory symptoms.
- Orthobiologic interventions, such as platelet-rich plasma and bone marrow aspirate injections, may stimulate tendon healing and improve pain and function in patients who fail conservative treatment with the current standard of care.
- Given growing concerns with regards to the current bone marrow aspirate concentrate procedure technique, a new technique for aspirating the bone marrow has been introduced.
- In this case, a patient with a debilitating GTPS was treated with a pure autologous bone marrow aspirate injection into the tendon, and reported near complete resolution of symptoms at the 1-year follow-up.
- Further research is needed to assess the long-term outcomes with conservative, surgical and orthobiologic treatments for GTPS.

There are limited treatment options for patients with a chronic refractory greater trochanteric pain syndrome. Orthobiologic interventions may stimulate tendon healing and improve pain and function in patients who fail the standard conservative treatment. Since the US FDA’s new position statement regarding the centrifugation of bone marrow aspirate products as a potentially ‘more than minimally manipulated’ product, there is a growing concern about the most common bone marrow aspirate concentrate technique. In this case, a 57 year old female with a debilitating chronic greater trochanteric pain syndrome was treated with a pure autologous bone marrow aspirate injection using a novel aspiration technique. The patient showed significant improvements in pain and function without recurrence at 1-year follow-up. This is the first case report to illustrate this novel technique for aspirating pure bone marrow that should comply with the new FDA regulations.

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Greater trochanteric pain syndrome is a common cause of lateral hip pain and weakness. This condition frequently affects middle-aged females, nearly four times more often than males [1]. Recent literature shows that symptoms are commonly due to gluteus medius and minimus tendon pathology and rarely due to an isolated trochanteric bursitis [1]. A retrospective study of 185 individuals over 50 years old with lateral hip pain showed a correlation between advancing age, insertional gluteus medius and minimus tendon pathology and gluteus medius muscle atrophy [2].

While many patients improve with conservative treatment, there are limited options for refractory cases. Surgical options, such as endoscopic gluteus medius tendon repair, typically yield satisfactory outcomes at a 2-year follow-up, though more prospective trials with long-term follow-up are needed [3,4]. In addition, gluteus medius muscle
atrophy is associated with poorer functional outcomes [5]. Some patients are poor surgical candidates or are not interested in surgery despite failure of nonoperative treatment.

Orthobiologic interventions, such as platelet-rich plasma (PRP) or bone marrow aspirate injections, provide a minimally invasive option that could stimulate tendon healing and improve pain and function in patients who fail the standard conservative treatment [6]. Since the US FDA's new position statement regarding the centrifugation of bone marrow aspirate products as a potentially 'more than minimally manipulated' product, there is a growing concern about the common bone marrow aspirate concentrate (BMAC) technique [7].

A novel aspiration technique that provides a pure autologous bone marrow aspirate has been introduced that maximizes the amount of aspirated mesenchymal stem cells (MSCs) and complies with the current FDA regulations [8–10]. To date, there is limited data on pure bone marrow aspirate injection for the treatment of gluteus medius tendinopathy. The following case report demonstrates a patient who showed significant improvement in pain and function using this new technique to treat chronic refractory greater trochanteric pain syndrome.

**Case presentation**

A 57-year-old female with a history of chronic greater trochanteric pain syndrome presented with chronic left hip pain and weakness for the past 5 years. Two years prior, she had a surgical bursectomy and gluteus medius tendon debridement but failed to get relief. Before and after surgery, she had also failed multiple rounds of physical therapy, non-steroidal anti-inflammatory drugs (NSAIDs) and trochanteric bursa corticosteroid injections. Her pain was described as a moderate aching pain in the lateral hip, worse with going from sitting to standing and with walking up stairs and better with rest. The patient’s left hip examination revealed significant tenderness in the gluteus medius tendon. Manual muscle testing revealed 3/5 strength in hip abduction and 4/5 strength in hip flexion and extension. She had a Trendelenburg gait. Lumbar spine exam was benign. A recent, postsurgical noncontrast MRI of the pelvis showed a partial tear of the left gluteus medius tendon, gluteus minimus tendinosis and gluteus medius muscle atrophy (Figure 1). The patient was diagnosed with lateral hip pain due to a chronic partial tear of the gluteus medius tendon, gluteus minimus tendinosis and gluteus medius muscle atrophy.

The patient was initially treated with physical therapy and prescription NSAIDs. She returned in one month without improvement at which point she decided to pursue a prolotherapy injection to the affected muscles and tendons. At follow-up three months later, she continued to have debilitating hip pain. Since the patient's symptoms were recalcitrant to medications, physical therapy, multiple injections and surgery, the risks and benefits of further treatment options were discussed. These options included repeating non-surgical management, referring to a surgeon for tendon repair, or proceeding with an orthobiologic treatment. The orthobiologic interventions that were offered included an injection of PRP or a pure autologous bone marrow aspirate injection. These would be directed into the gluteus medius partial tear, the gluteus minimus tendinosis and the gluteus medius muscle belly atrophy. The patient opted for a bone marrow aspirate injection with a thorough understanding of the lack of consensus and limited scientific data. The patient expressed understanding and agreed with the treatment plan.
The procedure was performed at an ambulatory surgery center under conscious sedation and local anesthesia in sterile conditions. After sterile skin preparation, 5 milliliters (ml) of lidocaine 2% with epinephrine and 5 ml bupivacaine 0.5% were injected for local anesthesia over the posterior iliac crest and over the posterior superior iliac spine. An 11 blade was used to puncture the skin. Then, a bone marrow aspiration needle (Marrow Cellution kit, Ranfac Corp., MA, USA) was advanced to the cortex of the posterior iliac crest. The needle was inserted through the cortex using a mallet in a lateral and caudal direction. Once the needle passed through the cortex, the sharp stylet was exchanged for a blunt stylet. The needle was then manually advanced 4 cm into the medullary canal. The blunt stylet was replaced with a fenestrated aspiration cannula. The bone marrow was then aspirated following the manufacturer's recommended technique, retracting and aspirating 2 ml of bone marrow from five levels for a total of 10 ml of pure bone marrow aspirate.

The patient was then placed in the right lateral decubitus position on the asymptomatic side. After sterilizing skin and applying sterile gel, an ultrasound machine with a linear probe (Sonosite HFL-50, 15–6 MHZ, FUJIFILM Sonosite Inc., WA, USA) was used to visualize the gluteus medius and minimus tendons. The skin and soft tissue was anesthetized with 5 ml lidocaine 2%. An 18 gauge, 3.5 inch spinal needle was advanced towards the gluteus medius tendon partial tear and 5 ml of pure bone marrow aspirate was injected under ultrasound-guidance into five sites on the gluteus medius tendon. Then, the needle was redirected into the gluteus medius muscle belly atrophy site and 3 ml of pure bone marrow aspirate were injected followed by 2 ml into the gluteus minimus tendinosis (Figure 2).

Postinjection rehabilitation protocol was advised in accordance with the three phases of tendon healing (inflammation, proliferation and maturation) [11]. During the first phase, the patient performed range of motion and weight-bearing as tolerated for 2 weeks. During the second phase, the patient began physical therapy with gentle strength training of adjacent regions and progression to isometric strengthening of the hip abductors. In the third phase, at 6 weeks, the patient began eccentric exercises and return to activity [11].

Results
Prior to the procedure, the patient reported an 8/10 pain on the Visual Analog Scale (VAS) and a phase 7 (out of seven) in the modified Nirschl Pain Phase Scale (mNPPS). 2 weeks after the bone marrow aspirate injection, she reported 25% improvement (6/10 VAS) but remained significantly weak with phase 7 mNPPS. 6 weeks after the injection, she reported 50% improvement (4/10 VAS) and significant improvement in function to a phase 5 mNPPS. 12 weeks after the injection, she reported 90% improvement in symptoms (3/10 VAS), phase 4 mNPPS, her Trendelenburg gait had resolved and had 4+/5 strength in hip abductors. At this point, she resumed exercise for the first time in years. 6 months after treatment, the patient reported 98% symptom relief (0/10 VAS) and phase 1 mNPPS, with no pain at rest or with activities of daily living, and only brief minimal residual discomfort (2/10 VAS) after strenuous exercise. 1-year after her treatment, she continued to report the same successful outcome. There were no complications. The patient gave written consent to use her medical information anonymously in this case report.
Discussion
Orthobiologic treatments for refractory tendinopathies show promise in multiple case series. There are more clinical trials published on PRP injections compared with BMAC injections for chronic tendinopathies. One prospective case series of 21 patients treated with PRP injection and tenotomy for gluteus medius tendinopathy showed statistically significant improvement in pain and function [12]. Another multicenter study of 16 patients treated with PRP for gluteus medius tendinopathy documented 81% of patients having at least moderate improvement of symptoms [13]. A recent randomized controlled trial of 80 patients with chronic gluteal tendinopathy, who were treated with either a blinded PRP or corticosteroid injection under ultrasound-guidance, showed greater clinical improvement at 12 weeks after the PRP injection [14]. The results demonstrated a modified Harris hip score (mHHS) ≥74 in 64.1% and a minimal clinically important difference in 82% of the PRP group, compared with modified Harris hip score ≥74 in 45.9% and minimal clinically important difference in 56.7% of the corticosteroid group [14]. In hopes of finding a treatment option that would have a higher success rate, researchers are studying bone marrow aspirate products that contain MSCs.

Autologous bone marrow-derived MSCs have the potential to differentiate the native tissue as well as signal trophic factors to enhance healing, though further research is needed to ensure safe and effective clinical application [6]. An in vivo study on 57 rats with Achilles tendon tears showed that MSCs differentiated into functioning tenogenic cells and improved tendon healing [15]. Two case series on augmented surgical rotator cuff repair with autologous products containing bone marrow-derived stem cells found improved tendon healing on imaging and decreased ten year retear rates [16]. A case series of 12 patients with lateral epicondylitis, who were treated with allogeneic stem cells mixed with a fibrin scaffold, demonstrated improvement in pain and function as well as smaller tendon defects at a 52-week follow-up [16]. Finally, a case series of eight patients with chronic patellar tendinopathy who were treated with bone marrow-derived MSCs concentrate reported statistically significant improvement at a 5-year follow-up [16].

However, there is concern that the technique commonly used for obtaining bone marrow derived MSCs is diluted with peripheral blood, since most of the stem cells are obtained in the initial 1–2 ml of bone marrow aspirate and after the initial 2 ml aspiration, a void is created which is replaced with whole blood [17]. The average bone marrow aspiration volume obtained with commonly used BMAC kits is 50 ml and the needle is seldom redirected to other parts of the medullary canal, which could imply that physicians are aspirating only at an initial 2 ml of stem cell rich bone marrow and up to 48 ml of whole blood from the void that is created.

In addition, the FDA recently released a position statement with regards to orthobiologic treatments that implies that centrifugation of a bone marrow aspirate may be considered more than ‘minimally manipulating’ the product in the future [7]. In this case, the BMAC product may need to be registered as a drug. The clinical or medical facility in which the procedure is performed will need to comply with all the quality control measures and registrations accordingly. Otherwise, the BMAC product would not be acceptable according to FDA regulations.

A novel technique of aspirating the bone marrow has been introduced that maximizes the amount of bone-marrow derived mesenchymal stems cells and this method complies with the current FDA regulations [8–10]. This technique addresses the concern of aspirating whole blood from the void created by allowing the physician to aspire 1–2 ml of bone marrow from multiple depths in the medullary canal through a single puncture site [10]. In addition, it produces an unfiltered bone marrow aspirate which may serve as a scaffold to retain the stem cells in the partial tendon defect. Studies have shown that this technique yields higher concentrations of fibroblast-like colony forming units and MSCs than previous BMAC techniques [8,9].

This case report illustrated a patient with greater trochanter pain syndrome who failed surgery and over two years of extensive conservative care, who then had near complete resolution of symptoms after a single pure autologous bone marrow aspirate injection. There are no clinical outcome studies published on this technique until now. This data will hopefully serve as a stepping stone for other future studies to further investigate the risks and benefits of this novel technique and its applications for treating musculoskeletal injuries.

Conclusion
There are limited treatment options for patients with chronic recalcitrant gluteus medius tendinopathy and greater trochanteric pain syndrome. Orthobiologic medicine techniques may help improve pain and function in patients who remain symptomatic despite treatment with the current standard of care. This is the first case to illustrate this pure bone marrow aspirate injection technique for a refractory greater trochanteric pain syndrome. There were no
complications and the patient had a successful outcome, with near complete symptom relief. Further case–control studies and randomized control trials are warranted to validate these findings.

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