Case Report

Differential diagnosis and treatment of iliotibial band pain secondary to a hypomobile cuboid in a 24-year-old female tri-athlete

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The purpose of this case report is to relate an episode of movement impairment at the cuboid calcaneal articulation leading to symptoms of iliotibial band (ITB) syndrome. An explanation of the etiology and clinical diagnosis in relation to the differential diagnosis, treatment techniques, and patient outcomes are described. The 24-year-old female tri-athlete reported pain at Gerdy's tubercle and lateral femoral condyle areas occurring within 2 miles of a run. VAS score was 6/10 for the running activity and the lower extremity functional scale (LEFS) score was 93% (74/80). Over the previous 2 years, the ITB symptoms had failed to resolve with extensive conservative treatment at the knee. On weight bearing, the patient demonstrated pain free limitation of active midtarsal pronation more than supination, which correlated with a decrease in passive internal rotation of the cuboid. Symptoms resolved after one cuboid whip manipulation and the patient was able to run pain free. Post-manipulation treatment consisted of two more sessions, which included motor retraining for weight bearing active midtarsal pronation and supination. LEFS was 100% (80/80) and VAS 0/10 with running greater than 10 miles. While causality cannot be inferred from a single case, this report may foster further investigation regarding the differential diagnosis and treatment of a hypomobile cuboid.

Keywords: Iliotibial band, Cuboid, Manipulation, Manual therapy

Background

Cuboid syndrome has been diagnosed under various names including the following: subluxed cuboid, cuboid dysfunction, locked cuboid, dropped cuboid, lateral plantar neuritis, and cuboid fault syndrome.[1–7] Cuboid syndrome has been linked to 6.7% of patients with plantar flexion and inversion ankle sprains per Jennings and Davies.[8] A higher incidence of 17% has been reported in professional ballet dancers.[9] However, this syndrome continues to be a commonly misdiagnosed and mistreated condition. To date, there are no case reports or other literature, to the authors' knowledge, linking cuboid hypomobility to pain along the distal iliotibial band (ITB) track nor at Gerdy's tubercle.

In some cases, foot or knee pain may be the primary presenting symptom when a more proximal or distal structure is actually at fault.[10] Given that cuboid syndrome is common in athletic populations, there should be standardized diagnostic criteria to assist the examiner in the differential diagnosis decision making process.[7] To date, there are no studies which demonstrate the validity and reliability of diagnostic tests and treatment options for cuboid syndrome.[7]

Cuboid syndrome is defined as a minor disruption or subluxation of the structural congruity of the calcaneocuboid portion of the midtarsal joint, which can irritate the joint capsule, ligaments, and peroneus longus tendon.[11] Factors associated with the development of cuboid syndrome include increasing body weight, training on uneven terrain, and inversion ankle sprains.[5,7] In the case of a minor sprain, the abnormal joint play movement stressing the midtarsal joint may not necessarily result in hypermobility or joint effusion, which usually accompanies a more severe capsular sprain.[5] The resultant ligamentous injury from ankle sprains can however, lead to altered joint motion up the kinetic chain and possible laxity.[7] Likewise, in the case of a hypomobility, this too could cause altered mechanics up the kinetic chain.[12]

Diagnostic tests such as a plain film radiograph, magnetic resonance imaging (MRI), or computerized axial tomography (CT) may not be helpful in the diagnosis of cuboid syndrome due to the normal variations that exist between the cuboid and its

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surrounding structures, possible temporary subluxations, minor change in mobility, or lack of signs of disruption such as effusion or edema.[5,9,11,13] Instead, the diagnosis should be based on a thorough patient history and physical examination, since even a minor cuboid dysfunction can result in marked changes in the rearfoot–forefoot relationship.[11] Furthermore, identification of altered motion is largely based on passive motion tests including classical and accessory range of motion.[14] Clinical observations suggest that these techniques are useful in detecting subtle joint changes that result in hyper/hypomobilities seen in patients with musculoskeletal complaints. However, the reliability and validity of these techniques have not been established by controlled studies for the subtalar or tarsalmetatarsal joint.[7,11] Therefore, it is the opinion of the authors that clinical observation of the motions which exacerbate the patient's symptoms should also be closely examined. In the current case presentation, symptoms were exacerbated during specific phases of gait.

During the stance phase and specifically heel strike to initial loading, the subtalar and midtarsal joint should be in pronation while the forefoot is supinating. At this point, the cuboid should be positioned in internal rotation during midtarsal pronation. The heel-off to toe-off phase should then consist of subtalar and midtarsal supination with forefoot pronation, with corresponding cuboid external rotation during midfoot supination. However, if the cuboid is stuck in internal rotation throughout the gait cycle, this would likely cause excessive hindfoot pronation transmitted through the calcaneocuboid joint.[12] Abnormal pronation of the subtalar joint may cause increased internal rotation of the tibia, which increases the tension on the ITB at its insertion point on Gerdy's tubercle during each foot strike.[13,15] Noehren *et al.*[16] have proposed the combination of increased knee internal rotation angle and an associated higher external rotation moment that could place more demands on passive constraints to internal rotation at the knee that control internal rotation. Fairclouth *et al.*[17] have shown through magnetic resonance imaging that, as the knee flexes and internally rotates, the ITB compresses against the femoral epicondyle. Due to the absence of a bursa to protect the ITB from shear forces, those patients exhibiting excessive internal rotation may have an increased risk of irritation to the highly innervated and vascularized fat pad found between the ITB and epicondyle.[16,17] Noehren *et al.*[16] recommended using external orthoses in a subgroup of patients exhibiting excessive rearfoot eversion with increased tibial internal rotation. However, the current authors opted instead to utilize a manual therapy intervention.

Patient Characteristics

A 24-year-old female runner was initially referred to physical therapy by her primary physician three weeks after symptoms began with the diagnosis of right iliotibial band syndrome (ITBS). The primary complaint was an acute onset of localized pain at Gerdy's tubercle and the lateral femoral condyle, exacerbated by walking, running, and prolonged sitting. The patient's subjective history included several probable causative factors for her symptoms including increasing her biking/running mileage and an abnormal landing from a three-tiered step stool the evening before the pain began. The patient denied acute pain in the foot or leg after these events. She first noticed her pain the next morning during the first minutes of a run and was unable to complete the workout. The patient reported pain of 8/10 on the numeric pain rating scale (NPRS) with both walking and running.[18]

The patient had exhausted conservative treatment over the course of three years for ITBS, with minimal improvement, including three rigorous trials of physical therapy by three different practitioners, a local corticosteroid injection to the distal ITB insertion, and two trials of prolotherapy injections. Additionally, diagnostic imaging of the knee including radiographs, ultrasound and MRI were unremarkable.

A fourth attempt of physical therapy by a manually trained physical therapist was carried out and further questioning of past medical history revealed multiple accounts of ankle sprains over the course of 9 years of competitive soccer and intermittent bilateral cuboid subluxations, as diagnosed by a physical therapist 10 years prior to the current evaluation. This information and the patient's extensive history of unsuccessful treatment to the ITB shifted the focus to the kinetic chain's influence from the ground up, with particular attention to the foot and ankle complex. It is the authors' speculation that the tissue specific diagnosis was overlooked because the patient did not show traditional signs and symptoms associated with cuboid syndrome, such as pain and swelling over the cuboid at the time of previous examinations.

Examination

The patient completed a lower extremity functional scale (LEFS) prior to being examined. The LEFS was first introduced by Binkley *et al.*[19] and is used to assess the functional status of patients with a variety of musculoskeletal dysfunctions affecting the lower extremities. It had five possible numeric response categories ranging from 0 to 4 for each of its 20 questions, for a total score ranging from 0 (poor) to 80 (excellent) points.[19] The LEFS was found to have excellent reliability (r=0.94) and can be applied to patients with a variety of lower extremity problems.[19] The construct validity and responsiveness were supported by correlations with the SF-36 and prognostic scores, respectively.[19] The patient's score was 93% (74/80) out of a possible 100% (80/80) ability to perform all activities. The patient reported her pain based on the NPRS, which is an 11-point scale from 0 to 10. The scale describes pain with numbers from 0=no pain to 10=worst possible pain. The NPRS has been documented to be valid, reliable (r=0.94), and appropriate for use in clinical practice.[18] The patient reported 0/10 pain at rest and 3/10 after running 2 miles, which quickly increased to 6/10 over Gerdy's tubercle and the femoral condyle, consistent with the ITB track. The patient was unable to complete runs greater than 2–3 miles without pain. Pain and stiffness were the limiting factors during runs and the pain was exacerbated to 7–8/10 if running on the beach, performing lunges or squats. She reported occasional and minimal swelling with tenderness to palpation around Gerdy's tubercle following her runs. She was able to relieve the pain post-run with ITB stretching, cryotherapy, and rest.

Clinical Impression

Upon structural observation, the patient presented with a lack of significant findings. However, right midfoot active range of motion in weight bearing showed decreased midfoot pronation and supination, or cuboid internal and external rotation, respectively, compared to the left. Right foot passive classical midfoot pronation and supination were pain-free and limited with pronation more limited than supination as compared to the left. Passive accessory testing of the cuboid revealed decreased internal rotation more than external rotation as well on the right compared to the left. Muscle length and manual muscle testing did not reveal significant deficits. The following tests were also unremarkable: ligamentous valgus and varus stress tests (performed at 0 and 30°), Lachman's, the anterior and posterior drawer signs, McMurray's and Apley's tests for meniscal involvement, tests for rotary instability of the knee, and patellofemoral joint tests. Patellofemoral joint testing included provocation tests of the subchondral region, plica irritation tests, patellar instability, and retinacular tests. Bilateral and unilateral heel raises showed decreased midfoot supination on the right compared to the left. The patient's asterisk sign was found to occur with concurrent active hip and knee internal rotation in weight bearing, which are associated with the heel strike to midstance phase of running and lunges. The tissue-specific impairment and physical therapy diagnosis in this case was hypothesized to be a hypomobile cuboid in the direction of internal rotation greater than external rotation.

The clinical management was determined based on an organized treatment approach described by Patla.[14,20] These principles of practice consider the nature of patient dysfunction, stage of tissue healing, level of tissue reactivity, and the patient's functional goal.[14,20] The principle of treatment for this case report was to treat the cause of the knee pain, which was hypothesized to be a hypomobile cuboid, resulting from the patient's fall on the affected foot, which created a restricted midtarsal joint. The stage of condition was determined to be settled or unchanging, considering the cuboid hypomobility was stabilized and without swelling. The tissue reactivity of the midtarsal joint was low, since there was no report of pain at the end range of active or passive mobility testing. The stage of the patient's reactivity was moderate at this time, meaning that she was able to carry out her runs, but that she experienced pain during and after her run. These factors, along with Jennings' and Davies'[8] successful report of immediate return to sport within 24 hours, dictated the plan of care, which was to manipulate the calcaneocuboid joint and allow the patient to return to running if the manipulation was successful. The rationale and priorities for the intervention were specific due to the low tissue reactivity, chronicity without swelling, and patient motivation to return to pain-free functioning.[14,20] The short term goal was to run pain-free for 2 miles, several hours after the manual mobilization. The long term goal was to run pain-free for 3–4 miles, 3–4 days per week and 5–6 miles, 1–2 days per week within 4 weeks. The prognosis and rate of improvement were good for return to running within one treatment since the patient had continued to stay in shape through swimming and weight lifting. The goal of the intervention was to attain full midfoot range of motion equal in comparison to the patient's left foot, which was to be accomplished by performing the cuboid whip technique described by Patla[20] (Fig. 1A and B).

Intervention

The cuboid whip technique was carried out according to Patla[20] in the prone position with the patient's midtarsal joint at the end of the examination table (Fig. 1A). The manipulation is performed by placing the thumb and index pad on opposite sides and diagonal from each other on the cuboid in order to facilitate external rotation (Fig. 2).[20] The knee was then flexed to approximately 70° and the ankle dorsiflexed to approximately 0°, as proposed by Jennings and Davies,[8] for the cuboid whip manipulation. Knee flexion and extension is utilized to gain the necessary low amplitude and high velocity forces for the thrust

Figure 1 (A) Initial stance for the cuboid whip into external rotation per Patla.[20] (B) Final stance for the cuboid whip into external rotaiton with clinician's body rotating into the direction of the mobilization.[20]

technique.[8,20] The thrust was then performed by passively extending the knee and simultaneously plantar flexing the talocural joint. The operator concurrently applied a rotational force through the placement of the fingers and via rotation of the operator's trunk (Fig. 1B).[20] The intervention was successful in restoring normal movement of the calcaneocuboid joint. This technique is considered to be specific to the calcaneocuboid joint which has no direct effect on the knee.

The clinician reevaluated passive accessory mobility of the midtarsal joint after the cuboid manipulation, which was identified to be symmetrical with quantity and quality with the opposite midtarsal joint. In order to maintain the new range of midfoot mobility of pronation and supination, the patient was instructed post-treatment to perform unilateral hind- and midfoot pronation and supination in weight bearing for three sets of 12 repetitions. This may be described as, flattening and exaggerating the arch of the foot, while maintaining first ray and heel contact with the ground. Proper technique insured by the therapist during the patient's initial and follow-up visits. The focus of the exercise was for motor learning and muscular endurance. The number of repetitions was decided based on documentation that performing exercises for greater than 10 repetitions is warranted if strength endurance is the goal.[21] The patient had to be trained to correct her habit of increasing pronation via femoral internal rotation. This was corrected in sitting and, upon demonstration of proper motor control, was transitioned to standing with tactile cuing from the therapist. This was also given as a home exercise program to be performed as often as possible with proper technique. The follow-up treatment also consisted of manual neuromuscular re-education for concurrent concentric and eccentric pronation and supination in supine performed by the clinician for three sets of 12 repetitions (Fig. 3). Concentric manual resistance for midtarsal pronation is given with pressure on the medial plantar aspect of the midtarsal joints and a counter pressure on the dorsal lateral aspect of the

Figure 2 Hand placement for the cuboid whip into external rotation with the thumb and index pad on opposite sides and diagonal from each other.

Figure 3 Neuromuscular re-education for midfoot pronation and supination.

subtalar joint. This is followed by an eccentric manual resistance into midtarsal supination with manual resistance on the dorsal midtarsal surface and a counter force on the plantar medial aspect of the forefoot. The combined concentric and eccentric motion is considered to be one repetition. The patient was also advised to run in her usual running shoes on flat and firm terrain that evening to determine the effectiveness of treatment.

The patient and therapist concluded that the treatment had been successful given that the patient experienced no focal pain on the right distal ITB insertion after a 4-mile run. However, the patient noted minimal swelling and soreness post-run over the right cuboid, which was treated with ice and over the counter anti-inflammatory medication. Both residual symptoms subsided after 2 weeks of running. Patient compliance was expected to be excellent since she had not been able to meet her mileage goal for the past 3 years and was enthused to return to running pain free.

Outcomes

At the time of discharge, the patient had full passive mobility of the midtarsal joint. Additionally, she was independent with her home exercise program for maintenance of cuboid mobility during midfoot pronation and supination in weight bearing. The patient met her short and long term goals within 2 weeks of the initial treatment. The patient received a total of three treatment sessions, including the evaluation with treatment, followed by two sessions for neuromuscular re-education. The LEFS was re-administered at discharge and demonstrated 100% (80/80) ability to perform all activities listed. Ultimately, the cuboid whip technique was speculated to be effective in improving midtarsal joint mobility since the 'hypothesized' associated ITB friction symptoms concurrently ceased after one manual treatment. The patient went on to run a 5-km race later that month and successfully completed her first two half marathons within the next 4 months.

Discussion

This case report details the differential diagnosis and treatment of a hypomobile cuboid that appeared to produce symptoms resulting from ITB friction at Gerdy's tubercle and lateral femoral condyle. This report also supports the principle that, according to Paris,[22] 'pain is secondary to dysfunction.' We propose that the effects of the mobilization technique performed are biomechanical in nature rather than neurophysiological due the lack of pain or tissue reactivity at the midtarsal joint. A complete review of the literature on neurophysiological effects is beyond the intended scope of this case report. However, placebo-related hypoalgesia is considered to be quite specific and localized to the site of treatment and not a remote site, as in the present case.[23–26] The relevance of these factors to the clinical outcomes in this case were not considered, but may be an area for further research. In this case, it appeared that the pain at Gerdy's tubercle was masquerading as the primary dysfunction resultant to a painless hypomobility at the calcaneocuboid articulation. The hypothesis was based on the patient's history, limited active weight bearing midfoot pronation and supination, and limited accessory mobility of cuboid internal and external rotations. We propose that these impairments resulted in a compensatory increase in internal tibial rotation as a result of the consequent positional fault in that direction. Because this was a single case report, we cannot conclude that the patient's improvement in ITB pain and overall function were a result of the interventions provided. However, given the immediate response to treatment, the correlation appears relevant. We propose that a hypomobile cuboid (subluxed cuboid) should be considered as a potential impairment if a patient presents with insertional pain of the ITB. This is of particular clinical relevance since ITBS has been cited as the most common cause of lateral knee pain each year.[27,28]

This case report provides preliminary evidence of the potential influence of an impairment at the calcaneocuboid articulation as a remote cause of lateral knee pain. Limitations of this case report include the lack of objective measurements for active and passive range of motion of the midtarsal joint both pre- and post-manipulation. Further studies would be beneficial to establish a gold standard of measurement for active and passive range of motion testing at the midtarsal joint. Continued studies would be useful to evaluate the link between impairment at the calcaneocuboid joint and ITBS. While it is not the authors' opinion that all patients with ITB pain need this treatment approach, there may be a subgroup of patients for whom this intervention strategy is effective.

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