Atypical knee pain: the biomechanical and neurological relationship between the pelvis, hip and knee—a case report

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Introduction

Runners have a higher reported incidence of hip pain than any other athletes. Furthermore, long-distance runners are prone to an increased lifetime risk of hip pain.1

Athletes presenting with hip and/or knee pain will frequently only receive a regional examination of the symptomatic area. Such an approach can often miss the true aetiology of the problem.2

This case report discusses the relationship between the biomechanical and neurological components of lower extremity and pelvic dysfunction. Moreover, the significance of pain referral patterns is discussed and the possible aetiologies of pain referral are also examined.

Case report

A 31-year-old Caucasian male presented with a 2-week history of right knee pain following a running injury that had occurred as a consequence of a training session along a canal side. The patient had been in preparation for the London marathon.

At the time of presentation (only 5 days prior to the marathon), the patient had routinely been running 20 miles on a twice-weekly basis for 4 weeks. During the case history, he suggested that an injury possibly occurred after slipping on a muddy and uneven path at a canal side. However, the patient was not immediately aware of any pain.

The onset of symptoms included a dull and deep-rooted ache in the right knee that commenced after the running session but went away after a few days rest. However, the symptoms escalated from that point forward and, during every running session, the right knee symptoms included a deep, sharp pain, 7/10 on the Visual Analogue Scale (VAS). This occurred after running for approximately 30 min and, consequently, the severity would force the patient to walk. The patient’s normal pattern of symptomatic recovery included rest and ice to the anterior right knee for 4 days. Initially there would be right hip and knee soreness for 1–2 days and then only right knee soreness for the 2 remaining days (3/10 on VAS). Aggravating factors included...
weight-bearing movement on the right leg, particularly when walking down stairs.

Further case history evaluation revealed that the patient worked as a farm labourer, however, his heavy workload of lifting and carrying remained unaffected. Furthermore, the patient had a history of long-distance running since childhood and on occasions had noticed bilateral aching and uncomfortable knees for many years.

Previous medical history and systems review were unremarkable. Immediate family history included a father with moderate bilateral knee osteoarthritis and a mother with hypertension.

Clinical examination revealed mild postural alterations including: forward head carriage, a depressed right shoulder, mild bilateral forefoot hyperpronation and bilateral pes planus. Full neurological examination was found to be normal. The orthopaedic examination revealed an asymptomatic but restricted right sacroiliac (SI) joint confirmed by motion palpation, prone SI joint challenging, Hibb’s and Yeoman’s tests. Static and motion palpation of the right knee revealed a mild posterior positioning of the proximal tibia on the femur when compared to the left knee, but there was no weakness of the right popliteus muscle on testing. Soft tissue palpation of the surrounding right knee structures identified a non-tender but hypertonic Ilio-Tibial Band (ITB), particularly in the distal third. Active and passive joint Range of Motion (ROM) of the right hip revealed a 15° restriction in internal rotation when compared to the left hip. Orthopaedic examination of the right knee was unremarkable.

The initial working diagnosis was acute tibio-femoral biomechanical dysfunction with concomitant right SI biomechanical dysfunction complicated by right hip dysfunction and ITB spasm, secondary to recently increased training intensity.

An intensive plan of management was commenced, with a view to regaining function in time for the marathon. Consequently, the patient was treated with right SI manipulation (diversified adjustment), supine long-axis hip mobilisation (at 90° with internal rotation) and with a supine posterior proximal tibia manipulation technique. On follow-up the next day, the patient reported having had no discomfort in the right knee but that the ache had moved to the right hip. Furthermore, on presentation the following day, the patient reported that after the second treatment he had complete relief from knee and hip discomfort. This was mirrored by his report that he had completed a 4-mile run in 30 min the previous evening without any pain. A third treatment was repeated 2 days prior to the London marathon. When the patient returned for re-evaluation the next week, he reported that he had successfully completed the event symptom free and had posted a time just below 5 h. The patient followed up 3 weeks later stating that he had experienced no further knee or hip discomfort and had resumed his more leisurely evening runs.

Discussion

The sequential discovery of right hip and SI pathology in isolation from obvious knee findings have previously been considered. This is particularly apparent in patients with knee pain, especially with no definitive structural injury to the knee in question. Thus, the importance of SI and hip joint involvement should not be overlooked in the evaluation of knee symptoms.

When assessing a patient with hip and/or knee pain, there are complex links to investigate when identifying possible connections or interactions between the joints. Therefore, the biomechanical and neurological components of joint involvement within the kinetic chain should be considered.

Biomechanically, the knee is the proximal joint to the hip in the kinetic chain and, therefore, both joints can be described as having a direct biomechanical relationship. An example of this biomechanical relationship can be demonstrated by coxarthrosis. In coxarthrosis, there are certain limitations of ROM. In particular, the movements that are most restricted follow the common capsular pattern of internal rotation, flexion and extension motions. These changes in ROM may, in turn, lead to compensatory biomechanical alterations including increased anterior pelvic tilt and lumbar lordosis; rotation of the pelvis and knee flexion. Consequently, such structural and postural changes could result in increased stress upon the musculature and other structures around the hip and in the joints above or below. The knee, being an adjacent joint in the kinetic chain, may be particularly affected.

The kinetic chain can be expanded upon by describing the involvement of all aspects of the body during the sequencing of tasks. Sequencing malfunctions can be as a consequence of many different factors of which injury is one of the most common. Consequently, a system may not function properly during the completion of a specific task when under load or when altered biomechanics exist. An example of such sequencing is provided by Michaud, who suggests that there are a number of potential injuries related to the postural effects of excessive foot pronation. This hypothesis may help to explain the aetiology of this patient’s problem; specifically, sub-talar pronation causing the talus to adduct and plantar flex, resulting in exces-
sive internal rotation and lowering of the entire lower extremity. Consequently, tensile strain on the iliopsoas and piriformis muscles increases, resulting in a narrowing of the greater sciatic notch (thereby predisposing to entrapment of the sciatic nerve). Furthermore, as the lower extremity drops inferiorly, the ipsilateral innominate lowers in obedience of Freyette’s Law (thus involving the SI joints), causing the body of L5 to rotate toward the functionally shortened leg.

Michaud proceeds to explain that, as a result of this sequence, the lumbar spine attempts to straighten itself by laterally flexing toward the long leg, compressing the lateral aspects of the ipsilateral discs and forcing the facets on the concave side into a hyperextended or close packed position. Conclusively, over a period of years, these actions may lead to a variety of overuse injuries.

Downes describes the pelvis as being the transition area for forces moving superiorly from the lower extremity and inferiorly from the spine, hence both directional forces move towards the pelvis. However, the knee is a more common site of injury in athletes (particularly long-distance runners) and, thus, the forces moving superiorly in the lower extremity are more pertinent to this case.

Further to Downes hypothesis, the SI joints are described as being stress relief regions within the kinetic chain and, therefore, activities such as running would magnify these stresses upon the pelvis. When an athlete sustains an immediate injury or acquires, over a number of years, sufficient reduction in their physiological adaptive range to result in biomechanical breakdown, the proper sequencing of the kinetic chain will be altered. Either could be applicable to this case. Furthermore, it has been reported that athletes with lower extremity overuse injuries or acquired ligamentous laxity may be at risk of the development of non-contact low back pain (LBP) during athletic competition. These clinical observations are, therefore, indirectly describing alterations to the lower extremity in terms of injury and alteration to the normal sequencing of the kinetic chain, consequently manifesting as symptoms of LBP.

This complex link between the knee, hip and SI joints as described elsewhere in this report can also be described in terms of a neurological relationship. When pain referral patterns are observed in clinical practice, the aetiology for such pain referral may not always be straightforward. The neurological interrelationship of the knee, hip and SI regions are considered, inferences can be drawn that help to explain the relationships between arthralgias. The lumbosacral region and the buttock share a segmental nerve supply.

This differs slightly depending on author, however, an unofficial consensus seems to consider L4, L5, S1 and S2 to comprise this supply. The ventral rami of these segmental nerves innervate the deep tissues of the buttock area as they manifest themselves as the superior and inferior gluteal nerves. Therefore, buttock and iliac crest pain, through their common innervation, have a direct link. This is also true for the SI joint and the posterior thigh. The posterior thigh receives cutaneous innervation from the posterior femoral cutaneous nerve, which in turn shares a common origin to the nerves that supply the SI joint. Furthermore, pain referral from the SI joint does not appear to be limited to the lumbar region and buttock. Eighteen patterns of pain referral from the SI joints have been previously reported, with 50% of subjects having described associated lower-extremity pain after SI joint injection.

Suter et al. report on a common clinical link between sacroiliac joint dysfunction and anterior knee pain and consider spinal manipulation to be an effective treatment for the muscle inhibition in the lower limb that they regard as the causative link between the two areas of dysfunction.

The neurological relationship between the hip and knee may be illustrated by again using the example of coxarthrosis. The hip is supplied by branches from the sciatic, femoral and obturator nerves, all of which give branches to the knee joint. In order to understand the process by which coxarthralgia can cause referral to the knee, it is first necessary to understand the mechanism of chronic nociception. The chemical changes that occur within a damaged hip persist long after the precipitating cause. These substances, such as bradykinins, prostaglandins, serotonin, cytokines and growth factors are responsible for the continued reduction in threshold of the already chemosensitive neurones. Furthermore, the combination of aberrant proprioception and altered biomechanics means that minor movements may be aggravational and result in a vicious circle where there is both continued sensitisation and chemical release.

The convergence hypothesis best explains the concept of both interrelated and referred joint pains. This is particularly noted in the hip and knee (although is true of other adjacent joints), but may also explain the referral of pain from joints with multiple innervation, such as the SI, to remote areas. This process occurs within the spinal cord and
the thalamus. When sensory neurones from joints and their surrounding structures are activated, the information converges onto common neurones that in turn relay to higher centres.\textsuperscript{17,18} In the absence of further afferent sensory input, the brain is unable to decipher the actual source of this input to the common neurone.\textsuperscript{17–19} Therefore, the identification of the pain source is difficult or even impossible to locate and is therefore assigned a generalized dermatomal or sclerotomal pattern.\textsuperscript{17,18} The appreciation of the complex interrelationship of both biomechanics and neurophysiology in the lower kinematic chain is of great clinical benefits when considering the symptoms and outcomes experienced in this, and similar cases.

Conclusion

Clearly the relationship between lower extremity symptoms and pelvic dysfunction is complex. This report has discussed the relevant biomechanical and neurological hypotheses that help to explain this complex relationship. Therefore, it is of utmost importance that the clinician, particularly those such as chiropractors who advocate an holistic approach, fully consider all sources of lower extremity problems rather than concentrating only on the symptomatic region. This can only be achieved by having an awareness and understanding of the kinetic chain, relevant anatomy, neuroanatomy and physiology of the regions concerned. Furthermore, this case has demonstrated that, through logical and systematic reasoning, successful outcomes can be achieved quickly and most effectively in athletes who require maximum efficiency for optimal performance.

References