SPORTS CHIROPRACTIC MANAGEMENT OF OSTEOARTHRITIC KNEE PAIN IN A MASTERS LEVEL TRIATHLETE/RUNNER. A CASE REPORT.

Author:
Gary J Smith. BSc, MChiro, ICCSP, Level 1 ASCA, Level 2 Running Coach (AA).
Titled Sports and Exercise Chiropractor (MAICE 2021)

Gary Smith. Private Practice, Hunter Sports Performance, Morpeth. NSW.
Email: runningfree.gs@gmail.com.

Abstract
The purpose of this paper is to present a case study of a female masters' level triathlete/runner with severe medial knee osteoarthritis, a history of multiple lower limb stress fractures and knee pain of 6 months duration who has been treated by a titled sports chiropractor (Australasian Institute of Chiropractic Education; AICE) using current multimodal evidenced-based management protocols. The overall burden of osteoarthritis and its management to the individual and to society is also discussed.

Clinical features: a female master's level triathlete/runner aged 51 years who is highly competitive in her age group category at local, regional and state level events. The athlete presented to a sports and exercise chiropractor with knee pain which had prevented her from running over the previous 6 months. MRI imaging revealed severe medial knee osteoarthritis, subchondral oedema at the medial femoral condyle and full thickness chondral loss, indicating Grade 4 on the Kellgren-Lawrence classification scale.

Intervention and outcome: management consisted of 6 weeks running gait retraining, specific corrective exercise prescription and monitoring and gradual progression of exercises and running load. No manual therapy was provided during this study. At the end of 6 weeks the athlete reported subjective improvements in knee pain and running capacity. Objectively there were improvements in orthopaedic resisted muscle grading testing, joint range of motion and The Knee Injury and Osteoarthritis Outcome Score (KOOS).

Conclusion: diagnosed with severe medial knee osteoarthritic deterioration and pain, the athlete had subjective and objective improvements in function and symptoms following this six-week evidenced based intervention. Further research involving larger sample sizes, longer term follow-up, males, non/binary or transgender subjects and alternative exercise protocols would assist in clarifying the optimum management in a variety of situations.

Key Words
Triathlon, Running, Rehabilitation, Exercise, Gait Retraining, Knee, Osteoarthritis, Pain, Sports Chiropractic.

Introduction

Participation in regular physical activity provides many benefits. Compared to many other physical pastimes, running is easily accessible and is growing in popularity [1,2], with 3 million Australians regularly participating [3]. Running however does have its drawbacks and injuries can frequently occur, resulting in pain, interruption to training and potentially deterioration of health. Musculoskeletal injuries in running are common, with as many as 79% of runners being affected, and it is often the knee that becomes symptomatic to the point of interrupting or stopping the athlete from being able to run [1].

Osteoarthritic deterioration in the knee may present as pain and can be associated with loss of articular cartilage loss of joint space, osteophyte formation, synovitis, bone remodelling and subchondral cysts [4]. Soft tissue changes relating to the knee can include decreases in strength of the quadriceps and sagittal range of motion and increased soft tissue contracture, potentially leading to decline in physical function and progression of disability [4]. Current clinical guidelines emphasize non-pharmacological approaches and, in particular, exercise therapy in the management of knee osteoarthritic pain [5]. This has been exemplified in studies that have shown the benefits of quadricep and hip abductor muscle exercises in reducing pain, improving function and strength and reducing the risk of further tibiofemoral cartilage damage [6].

Immune mechanisms and inflammatory responses are also believed to play a critical role in osteoarthritis [7]. It has been demonstrated that chronic low- grade inflammation, vascular endothelial dysfunction and metabolic disturbances are involved in the process of OA development [8] and it has been hypothesised that physical activity and anti-inflammatory diets can target local and systemic inflammation [9] relieving osteoarthritic symptoms by modulating immune mechanisms and reducing inflammatory responses/factors in the blood [7]. Individuals may run to lose weight, and those diagnosed with OA are sometimes advised to lose weight. The research suggests that what may further assist these people are anti-inflammatory diets high in unrefined and minimally processed foods, fibre, monounsaturated and polyunsaturated fatty acids; fruits, vegetables, herbs, spices, nuts, seeds, fish and olive oil as opposed to pro-inflammatory breads, grains, starchy vegetables and junk food [9].

Running results in cumulative loads in the joints of the lower limbs. Training load errors and diminished lower limb strength and control during running have been associated with the development of injuries or pain and so both strengthening and gait retraining are used by sports clinicians in rehabilitative programs to address knee pain in runners [1].Training errors such as increasing distance, intensity or duration of training too much or too soon, suddenly adding downhill or stairs running can be the cause of over 60% of running related injuries and it is postulated that targeted education regarding training loads should be implemented as a major component of any runner intervention [1].It has been also found that forefoot strikers experience lower running-induced knee loading

compared with rearfoot strikers. Therefore, gait retraining, encouraging the runner to land on the fore or midfoot and not the heel can help in lessening forces through the knee [1].

Considering the above factors and based on the current research an evidenced based rehabilitative program for a runner presenting with knee osteoarthritis and pain could contain the following 3 components [1]:

1. Modified training loads to manage pain and promote tissue adaptation within the scope of current function
2. Prescribed exercises to strengthen the quadriceps, hip abductors, core and other lower limb muscles to increase capacity to sustain loads and improve lower limb control
3. Gait retraining to decrease forces at the knee during running- increase step frequency, running more softly and avoiding a rearfoot strike pattern

Recognising the deleterious impact a pro-inflammatory diet can have, it may also be appropriate for the individual to initiate appropriate dietary changes and seek the opinion of a sports dietitian where indicated.

Patient Information

Patient consent has been granted for this case study.

A 51-year-old female masters level triathlete and distance runner, presenting to a Titled Sports Chiropractor [10] with right knee pain of 6 months duration. An MRI scan on 16/07/2021 revealed severe medial osteoarthritis with subchondral bone oedema at the medial femoral condyle, full thickness chondral loss and mild pes anserine bursitis, indicating Grade 4 on the Kellgren-Lawrence classification scale of knee osteoarthritis. The knee pain was of insidious onset, started 6 months previously and had caused her to stop running completely during that time. She had consulted a Physiotherapist who recommended no running in addition to squat and lunge exercises and “to see how it goes”. No guidance was given as to reps, sets or technique with this exercise suggestion. The patient was able to cycle or swim for one hour daily.

The athlete explained that she started running 7 years previously and over time developed a history of multiple lower limb fractures. Within 9 months she sustained a stress fracture of the right fibula followed by a stress fracture of the right femur. Bone density and bone turnover tests at this time were negative, however as a person new to running she was, within 9 months, running 50 kilometres per week. This tends to suggest that the injuries may have been due to inappropriate increases in running load- too much training too soon. 12 months later she developed right groin pain for which she was given a steroid injection by a local Sports Physician and then 1 year later 2 metatarsal fractures in the right foot and 1 in the left, and 2 years after that experienced bursitis in the right hip whilst performing the Ultra Trails Australia [UTA] 100 km race. Whilst the sustaining of multiple stress fractures raises the suspicion of Female Athlete Triad, her history indicated no disordered eating, menstrual cycle at the time was regular and bone density tests were clear.

The athlete was hit by a car at 22 years of age, fracturing her left hip and sacrum. Radiological examination of this area 2 years ago revealed normal bone density and a deformation of the left Ischium. She has had 3 children since the accident. She is currently on Hormone Replacement Therapy, has not had a period for 14 months, and is not taking any other medication. The subject denied any recent unexplained weight loss, night sweats or nocturnal pain and has not suffered any alteration to bowel or bladder function. The knee issues were preventing her from running. She found the higher intensity of interval running training in particular aggravated her pain and she could not improve her cycling times because of it. Her goals were to: “Be able to run”, stating “I could go through life not cycling, but not running” and “cycle quicker” if possible.

Clinical Findings

The patient walked with a normal gait and was not antalgic. Orthopaedic muscle grading testing revealed weakness of the gluteus medius, iliopsoas and rectus femoris muscles bilaterally and the hip adductors, gluteus maximus and hamstring muscles on the right, graded 3/5. A supine single leg raise was restricted on the right at 75% compared to that achieved on the left, which went to 90 degrees.

Lumbar spine range of motion was not painful, however was restricted near end range of motion in all directions.

Internal rotation of the right hip was restricted and “a bit sore” at approximately 70% of movement compared to the left side. Patrick’s FABER test was tight at end range on the right. Hip scour provocation testing on the right produced some mild pain [4/10]. Previous imaging [MRI, 19/05/20218] of the right hip has shown early degenerative change. Ankle dorsiflexion measured 9 cm[left] and 5 cm [right] and extension of the hallux [weight bearing] was 80 degrees [left]/ 60 deg [right]. Mid- thigh circumference measured 49 cm [left]/ 47 cm [right]. Comparing shoe wear patterns there was noticeable wearing at the left hallux/ toe-off region of the sole and marked and symmetrical wearing on the lateral aspect of both shoes.

Posterior chain testing revealed that the patient could perform 10 repetitions of continuous single leg glute bridges on the left leg and 6 on the right, and 10 repetitions of single leg sit to stand on the left and 0 on the right.

Two dimensional, slow motion video analysis of running gait: slight contralateral hip drop during single leg stance phase bilaterally, heel striking well forward of centre of mass.

The knee injury and osteoarthritic outcome score (KOOS) was completed [11].

KOOS	
Pain	47
Symptoms	46.43
Activities of Daily Living	67.65
Sport and Recreation Function	45
Knee Related Quality of Life	37.5

Clinical impression

Osteoarthritic changes in the knee joint may or may not produce pain even when, as in this case, there may be severe degenerative changes seen on imaging. It is now recognised that imaging is of limited use as a guide for management of osteoarthritis and that other, more subjective measures of pain and disability are of more use in guiding clinical practice [4]. In the examination it is noted that the athlete displays weakness in several muscle groups and reduced range of motion in the right hip, ankle and hallux. There is atrophy of the right thigh compared to the left and the muscles of her right side, and in particular the posterior chain, tested much weaker functionally overall. Whether these findings are contributors to her arthritic condition and pain or have occurred as a result, is speculative.

Her running patterns show signs of lumbopelvic instability (contralateral hip drop) and overstriding, which has been shown to cause more force on the knee in runners and potentially pain [1]. There are therefore a number of clinical findings present, all or some of which may be contributing to the symptoms and therefore justifying the 3 components of treatment protocol highlighted earlier: load modification and gradual progression, exercise prescription and gait retraining. There was no manual therapy utilized in this case study.

Treatment
Based on the history, examination and relevant research recommendations the following regime was prescribed.

Load modification/education
In order for individuals to progress and to develop the desired physical capabilities for performance, rehabilitation, prehabilitation or protection against injury they need to train. However, it is contended that that many training injuries or issues are related to inappropriate training programmes, such as when excessive or rapid increases in training load intensity, frequency or duration are undertaken [12]. Therefore, careful monitoring of training load by the individual, clinician and/or coach becomes a high priority to firstly help establish a baseline training load and then safely overload training over time to facilitate progression.
As the subject had not been running at all she was advised to start walking for 20 minutes duration, 3 times per week. On every 4th minute she would slowly run for 1 minute and avoid known aggravating factors like faster interval training. During her running the subject started to implement the gait retraining principles learnt during a dedicated once a week session. This included running posture, hand, arm and shoulder action, leg action, foot landing, breathing and cadence. Over 4 weeks she was able to progress this to walk 30 seconds, run 1 minute, walk 30 seconds. By week 6 she was able to run for 12 kms using a 1-minute 30 second run/30 second walk repetitive cycle, with no discomfort to the knee being experienced.

Strength and Conditioning exercises (Table 1)
When prescribing exercise in a clinical setting some key guidelines have been identified in order to elicit greater compliance and hopefully success [13]. These include providing a written prescription of the exercises together with a clear demonstration and allowing the client to practice these in front of the practitioner in the clinic or gym. The second phase involves the client performing these at home as prescribed and then again in front of the practitioner in subsequent clinical visits to ensure correct technique and reinforce compliance. Discussion around when, where and how often the exercises are being performed aids compliance.

Exercises prescribed during the first phase of management were:

Table 1. Initial Strength and Conditioning Exercise Program.

STAGE 1 STRENGTH AND CONDITIONING EXERCISE PROGRAM	
EXERCISE PRESCRIPTION	SETS AND REPETITIONS
1. Sitting knee extension, isometric hold. Resistance Band.	3 sets. Hold 40 seconds.
2. Sitting knee flexion, isometric hold. Resistance Band.	3 sets. Hold 40 seconds.
3. Side lying hip abduction.	3 sets. 20 each side.
4. Glute bridges, single leg.	3 sets. 25 each side.
5. Single leg step-ups onto box, 45 cm height.	3 sets. 10 each side.
6. Ankle dorsiflexion; standing, pushing knee over foot.	3 sets. 10 sec hold.

Gait Retraining

This was undertaken once a week over 6 weeks, under the supervision of a qualified run coach [the author]. [Where the clinician is not a running coach, collaboration with such professionals helps to establish clear and open lines of communication, invaluable in helping the athlete to move toward their goals]. Sessions lasted 60 minutes on a 1:1 ratio, and comprised 10 to 15 minute theoretical/education in addition to 45 to 50 minutes practical components. Topics covered included running posture, foot strike/cadence, arm action and hand position, breathing, shoe selection, nutrition and hydration tips, principles of training such as specificity, progression, reversibility, overload, energy systems, training programming/periodization, supercompensation, rest and recovery.

Reassessment

Reassessment was undertaken 6 weeks after commencing the program. At that time, resisted muscle testing revealed weakness in only the left gluteus medius [was previously bilateral]. The iliopsoas, rectus femoris and adductors still tested weak bilaterally [4/5]. The gluteus maximus now tested strongly bilaterally [previously weak on the right] and the right hamstring, although still exhibiting some weakness, was stronger than initially [now 4/5].

Internal rotation of the right hip was now painless and achieved the same degree of movement as the left. Scouring of the right hip still elicited some pain [4/10] and lumbar range of motion was still only slightly restricted at end range. Ankle dorsiflexion measured 12cm on the left [previously 9cm] and 11.5 cm on the right [previously 5cm]. Weight bearing hallux extension was the same bilaterally.

Muscular endurance of the posterior chain muscles was improved (Table 2) as were KOOS scores (Table 3):

Table 2

POSTERIOR CHAIN MUSCLE ENDURANCE TESTING				
	PRE		POST	
	Left	Right	Left	Right
Single leg glute bridge repetitions	10	6	20	20
Single leg sit to stand repetitions	10	10	20	20

Table 3

The knee injury and osteoarthritic outcome score [KOOS, 11].		
	Pre	Post
Pain	47	88.9
Symptoms	46.43	71.43
Activities of daily living	67.65	95.60
Sport and recreation function	45	85
Knee related quality of life	37.5	75
NB: a higher score indicates fewer problems		

The athlete had progressed from not being able to run at all to now running four times a week, comprising;

1. 2 x 5 km, easy runs, where she was running for 2kms, walking for 2 minutes and then running to complete the distance.
2. 1 x 8km. Running for 2 minutes, walking for 1 minute.
3. 1 x 12kms. Running for 1 minute and 30 seconds, walking for 30 seconds.

As part of the reassessment process verbal feedback from the athlete was obtained, to gain her perspectives on the process and how she felt she was progressing toward her goals. The patient reported the approach to be beneficial as she was in less pain and could run. The prescribed exercises were simple to follow, explanations were clear and concise and she appreciated time taken at the beginning to explain and demonstrate them. Meeting once a week was helpful. Revisiting her running technique weekly assisted

when she was out running on her own and helped keep her on track. In summary, she believed the Program so far has provided a solid foundation to build on, the Education/theory component aided her understanding and the small load increments gave confidence to do more and to overcome her kinesiophobia. No outcome measures were used to documents the kinesiophobia however, future reports could utilise the Tampa Scale of Kinesiophobia questionnaire [14].

Overall, the results at reassessment showed that she was progressing toward her goals. Following the reassessment new goals were established and pathways agreed upon:

1. Continue to meet once a week with running coach to further reinforce running technique and to build running fitness.
2. A new strengthening regime was prescribed (Table 4). Adherence, technique and progression monitored by practitioner:

Table 4

Stage 2 Strength and Conditioning Exercise Program.	
1.Sitting knee extension machine, single leg isotonic contraction. 15 kg.	3 sets, 5 reps each side.
2. Sitting leg curl/knee flexion, single leg isotonic contraction. 15 kg.	3 sets, 5 reps each side.
3. Glute Bridge machine, single leg, no added weight.	3 sets, 5 reps each side.
4. Side planks. Static hold.	2 sets, hold 30 seconds each side.
5. Side Planks. Up/down.	2 sets, 5 each side.
6. Dynamic step-ups onto 30 cm box.	3 sets, 5 each side.
7. Single leg squat holding 5 kg kettle bell in one hand.	3 sets, 4 each side.
8. Lateral pull-down machine. 40 kgs.	3 sets, 5 reps.
9. Backstroke flutter kick during swim session.	5 minutes per session.

Discussion

Osteoarthritis is a major health issue in society, being the most common joint disease, and a leading cause of disability and early retirement from work [15]. The overall cost of osteoarthritis to the Australian health system was about $3.75 billion in 2012, with over half this figure coming from joint replacements [15]. Furthermore, it has been estimated that the total cost of arthritis, including lost productivity and loss of wellbeing to be over $23 billion each year [16].

Issues surrounding common osteoarthritis management strategies have been identified [15]:

In addition to the cost of joint replacement or surgery, issues also include the prescription of medications such as paracetamol that display little benefit and can lead to allergic reactions, rash, blood disorders and possibly liver and kidney damage. [17,18].

More recently, the prescription of Opioids has increased and these are potentially addictive and can cause constipation, nausea, vomiting, hyperalgesia, confusion, drowsiness and respiratory depression while non-steroidal anti-inflammatory drugs [NSAIDS] can be associated with gastrointestinal and cardiovascular risks [19,17].
It is clear that many people with osteoarthritis may be relying on such modalities that are either expensive, not helpful or are actually harmful.

The National Osteoarthritic Strategy group in Australia contend that in order to curb the exponential burden of osteoarthritis and its management on individuals and communities, more effective prevention and management is required [15]. Current clinical guidelines emphasize non-surgical treatments and in particular education, advice, exercise, physical activity and weight loss [20].

Just some of the evidenced informed goals of the National Osteoarthritis Strategy include having at least 50% of Australians with osteoarthritis receive a recommendation from a health care practitioner to undertake evidenced based lifestyle and other self-management strategies and enhanced access to, and uptake of, effective non-surgical management for people with severe osteoarthritis [15].

With goals such as these in mind, strategies that advocate care that includes exercise, weight loss, pain management, psychological health and interventions that align with people's needs, goals and preferences are advocated [p10 in 15]. Evidence suggests that the widespread implementation of a more conservative management program for osteoarthritis, whilst leading to better health outcomes will also lead to major cost savings, with estimates of savings of up to $1.9 billion to the economy [p13].

Allied health practitioners and specifically sports chiropractors are well placed play a pivotal role in implementing the conservative management of osteoarthritis. A recent study has shown that this is within their scope of practice, where it is reported that 91% of sports chiropractors utilize a multi-modal approach including manual therapy to care and that 76% provide rehabilitative exercises [21]. In 2018 the Journal of Family Practice outlined evidenced based recommendations for musculoskeletal pain as being exercise, mind-body therapies and complementary modalities such as acupuncture and manipulation, recommending that passive interventions such as manipulation should be combined with active interventions and self-care [22]. The Chiropractic profession, by enacting multi-modal, evidenced- based, best-practice guidelines is positioned take a leadership role in the management of osteoarthritis [23].

This case study therefore highlights the broader role that sports chiropractors can play in the management of a female recreational athlete with severe medial knee osteoarthritis. The pre and post testing portray positive change for this runner both subjectively and objectively and a return to her preferred lifestyle activity.

An obvious limitation of this paper is that it is a case study of just one athlete and one Chiropractor, which raises the questions; can these results be generalisable to a broader population of runners, or other Chiropractors/ sports chiropractors, particularly those not proficient in analysis of running technique? Would results have been altered if manual therapy/ manipulation/adjustments had been used as well? Also, due to the lack of follow up, it remains to be seen whether these results can be sustained over time, and is gender relevant in obtaining these results? Additionally, are these results obtainable for higher level runners who may already do a lot of exercise including weights and other rehab exercises?
Whilst this and other studies display the success due to exercise that can be obtained, questions also remain regarding what may be the definitive, most appropriate exercise regime as there is little data to show one type of exercise is better than another. [15]

Conclusion

The prevalence of osteoarthritis in society is a significant financial, emotional and physical problem. Individuals participate in running for many reasons and the enjoyment can be quickly cut short with the onset of symptomatic osteoarthritis. Increasingly the evidence suggests that surgery and medication are not the best solutions and that lifestyle interventions like specific exercise prescription, in addition to gait retraining and load management are beneficial, cost effective evidenced based management strategies. Sports chiropractors, by virtue of their training and defined scope of practice are well equipped to play a key role in the management of osteoarthritis.

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