Gluteus Medius facilitation using Kinesio Taping in the Treatment of Chronic Iliotibial Band Syndrome

Abstract:

Objective: To determine whether Kinesio Taping (KT) can effectively facilitate Gluteus Medius (GM) and if KT of the GM is effective in the management of a runner with chronic Iliotibial band syndrome (ITBS).

Background: ITBS is one of the leading overuse injuries in runners. Despite its prevalence, few biomechanical studies have been done and little is known about its aetiology. Poor hip biomechanics and specifically GM muscle weakness is thought to contribute to the development of ITBS. KT is a specialized tape developed in Japan and has been claimed to facilitate muscle activation. Despite global use there is conflicting evidence supporting its claims.

Intervention: The Dynamic Step Down Test (DSDT), surface EMG on GM and Tensor Fascia Lata (TFL), and hip abduction/adduction strength ratio (Cybex) were all performed with and without KT facilitation of GM. With KT, DSDT showed a decrease of 17º medial knee collapse and a 58.8% improvement in hip abduction strength was recorded (Cybex). Insignificant change in activity of GM and TFL were recorded (surface EMG).

The patient was instructed to apply KT during running for four months and in conjunction with an existing strengthening program.

Findings: Re-testing without KT showed improvement in GM activity (surface EMG), hip abduction/adduction ratio as well as neuromuscular control during a DSDT.

Outcomes: After four months the patient could run pain free.

Conclusion: This case report suggests that KT is an effective treatment modality in treatment of ITBS with identified weak GM.

Introduction:

Iliotibial band syndrome (ITBS) is one of the leading overuse injuries in runners (Taunton et al, 2002; Ferber et al, 2010). Despite its prevalence, few studies regarding biomechanics have been done and little is known about its aetiology (Noehren et al, 2007).

ITBS has been described as a friction syndrome caused by movement of the fascial tract across the lateral epicondyle during knee flexion/extension that causes lateral knee pain and inflammation in the bursa. The Iliotibial band (ITB) is a thickened band of fascia that originates from the fibres of Tensor Fascia Lata (TFL), Gluteus Maximus and Gluteus Medius (GM). It runs down the lateral thigh over the femoral condyle and attaches to the tubercle of Gerdy at the fibular head (Noehren et al, 2007; Ferber et al,2010). The ITB functions as a hip stabilizer by preventing hip adduction and knee internal rotation (Noehren et al, 2007; Ferber et al, 2010). Traditional management of ITBS includes decrease of activity, myofascial release, non-steroidal anti-inflammatory drugs, ice and stretching and more recently hip strengthening (Fairclough et al, 2007).

Fairclough et al (2007) found that anatomically the ITB is not a separate structure but rather a thickening of fascia connected to linea aspera and the supracondylar region of the femur. They found that there is seldom a bursa present and that inflammation in that area likely comes from the highly vascularised subfascial fat pad between the ITB and the femur. Fairclough et al (2007) suggests that the ITB does not move anterior to posterior but rather, to a small degree, from medial to laterally, causing compression forces. These compression forces can possibly be ascribed to weak hip muscles and thus it should be considered that ITBS could be due to a hip dysfunction. Powers (2010) described that hip abductor weakness can cause a contralateral pelvic drop and a shift in the centre of mass away from the stance leg. This increases the varus angle in the contralateral knee. Shifting the centre of mass over the stance leg to compensate for hip abduction weakness can cause an increase in knee valgus on the affected leg. During limb movment this increase in knee valgus can lead to a medial- lateral compression forces.

Studies are focusing more and more on the biomechanical components, specifically weakness of hip abduction and GM, which could be the cause of chronic ITBS (Noehren et al, 2007; Ferber et al, 2010; Miller et al, 2007; Fredericson et al, 2000).

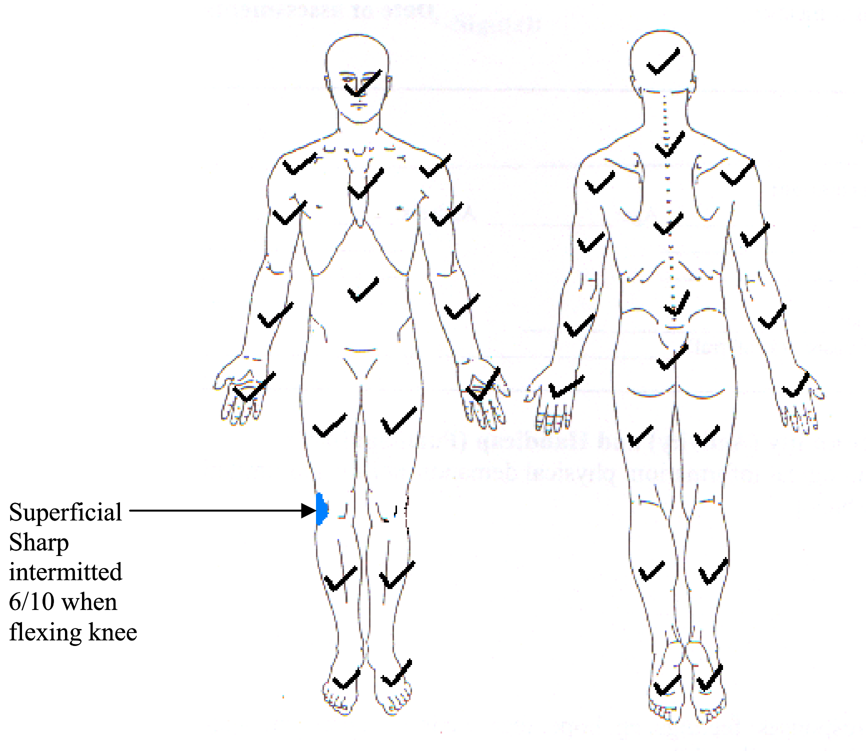
Kinesio taping (KT) is a popular strapping technique used in the treatment of sports injuries. KT was invented by Kenzo Kase in 1996. It is a specialized elastic tape which can be stretched to 120-140% of its original length. The specific techniques of application have claimed to reduce pain, muscular spasm, swelling as well as facilitate and inhibit muscle activity (Halseth et al,2004). Currently the studies available regarding the application of KT are inconsistent with some showing significant and others no significant changes in pain and muscle timing and control (Fu et al, 2008; Thelen et al, 2008; Slupik et al 2007).

In light of the global tendency of addressing biomechanical dysfunction, especially in GM, it was decided to look into the possibility of using KT as an aid to facilitate GM during training. Due to the conflicting evidence in the literature it could not be assumed that the KT would be effective. Three outcome measures were chosen to determine the efficacy of KT.

This patient was selected as he had a history of chronic ITBS and has tried traditional manual therapy and exercise therapy interventions with little success. KT was chosen as a treatment intervention to add to physiotherapy knowledge of treating this difficult condition and to investigate the efficacy of KT as a treatment option for chronic ITB.

This case report describes an alternative approach to addressing a chronic ITBS.
The purpose of this case report was firstly to determine whether KT can significantly facilitate GM and secondly, determine the efficacy of KT of the GM in a male runner presenting with chronic ITBS. It was hypothesized that, if the KT significantly facilitated the GM, this could be used as a tool to correct biomechanical dysfunction causing ITBS.

ASSESSMENT: *(APPENDIX I)*



General demography:

The patient is a 27-year old male recreational runner whose primary complaint was a superficial sharp 6/10 right lateral knee pain that started while training for, and after completing, the Two Oceans Half Marathon. The 24-Hour pain pattern is described in *TABLE 1.*

Day of run	6/10 sharp intermitted lateral knee pain that starts 3km into the run especially with uphill running
1 Day after run	0/10 resting pain. 6/10 sharp pain with *AGG*.
2 Days after run	Pain down to 4/10 with *AGG*.
3 Days after run	Pain down to 2/10 with *AGG*.
4 Days after run	0/10

TABLE 1*: 24 Hour pain pattern. AGG. = Aggravating factors: climbing stairs (down > up), flexing knee, turning in bed.*

History of symptoms:

The patient history included an initial onset of bilateral lateral knee pain that started six months ago while he was increasing his running training distance from 8km to 10km and 15km. Bilateral lateral knee pain was reported during every run, starting at 3km and aggravated to 6/10 when running uphill.

Two months from onset of pain the pain had become more severe (8/10) which led the patient to consult a physiotherapist. He was assessed by a qualified physiotherapist and diagnosed with ITBS. Treatment consisting of hamstrings, ITB and TFL stretches soft tissue mobilization and strengthening of the GM (*APPENDIX II)*. Core strengthening was also addressed. He attended physiotherapy twice per week and continued with exercises three times per week.

Although the rehabilitation reduced the intensity of the pain form 8/10 to 6/10, the pain persisted. Three months from onset of pain the patient went to a podiatrist for an assessment. The patient was advised to get stability shoes and orthotics were made for him.

He continued with the exercises given by the physiotherapist three times a week and carried on training for the 21km race. He was only able to run a maximum of twice per week due to the pain. Five months from onset of pain he ran the Two Oceans Half Marathon, which he completed in his goal time. He did however experience severe 9/10 lateral knee pain during and after the race.

He then rested for a month in which time he continued stretching and strengthening as before. When he restarted running one month ago, six months from onset of pain, he became aware of the familiar lateral knee pain, although less severe (6/10) than before. The pain was only felt on the right.

During the interview the patient's expectations were discussed. He felt that nothing regarding treatment had worked effectively He stated that he was irritated that he could not run regularly. The patient had done some research on the internet regarding ITB release surgery and was considering this as a last resort.

Tests and measures:

During the interview, all special questions regarding medical history were asked. No red flags were detected. To establish any other underlying cause of pain the following structures were examined:

- lateral meniscus
- patellofemoral joint
- superior tibulo-fibula joint
- common peroneal nerve
- hip joint
- lumbar spine
- sacroiliac joint

The above were structures ruled out as possible causes of the pain. The lower limb neurological exam was negative.

The physical examination showed that the patient stands in genu valgum, increased lumbar lordosis, hyperextended knees, hindfoot supination and slight forefoot pronation bilaterally. Active and passive movements of the right and left knee had full range of flexion and extension, with a 6/10 painful arc at 30-40º active and passive flexion. With palpation, 6/10 tenderness was reported bilaterally over iliotibial band insertion at lateral femoral condyle and the tubercle of Gerdy.

Muscle strength tests were done for the hip external rotators and GM muscles and graded according to the Oxford grading scale. Tests positions were done as described by Kendall et al(1993) It was found that hip lateral rotator strength was Grade 4 bilaterally and GM Grade 4 bilaterally on the Oxford scale.

Muscle length tests were performed on the hamstrings muscles, TFL and ITB bilaterally. Goniometry measurements were obtained for the hamstrings length. Hamstrings length was measured with the patient in supine and the hip in 90º flexion. The knee was then passively extended by the clinician until tissue resistance limited the movement. The knee flexion angle was then measured in relationship to the neutral position, which refers to full knee extension. The measurements were 36° and 34º for right and left respectively.

The Ober's test (Kendel et al,1996) was positive bilaterally showing a tight ITB with both knees 11cm from the plinth and increase of extension to 20º. Modified Ober's test (Kendal et al, 1996) was positive bilaterally with right knee 6.5cm from the plinth and left knee 5.5cm from the plinth showing a tight TFL. Noble's test (Magee 2002) was 6/10 bilaterally. Thomas test (Magee 2002) was positive bilateral for tight ITB/TFL.

Dynamic tests included the Dynamic Step Down Test (DSDT), lunges and double leg squats. During a DSDT on the right there was a severe medial collapse of the knee with right pelvic drop, a compensatory left hip internal rotation as well as a Trendelenberg sign was noted (Fig. 2, APPENDIX III). During left DSDT, less severe medial knee collapse and fair pelvic control was noted. During a double-leg squat a right more than left medial knee collapse, lateral weight shift to the right, increase lumbar extension as well as approximately 5cm of knee over toe position was observed. During right lunges approximately 10º contralateral pelvic drop, severe medial knee collapse and a slight lateral weight shift to the right was observed. During left lunges approximately 10º contralateral pelvic drop, mild medial knee collapse with no apparent lateral weight shift to the left was observed.

MANAGEMENT:

The aim of management was to determine whether KT is an effective treatment method of ITBS. The functional goal of management was to enable the patient to run pain free. The chronicity of this patient's pain, despite a rehabilitation program, as well as the patient's expectations and thoughts regarding surgery, played a role in the management. This intervention involved no hands-on treatment. It describes a strapping technique that was incorporated into an already existing exercise program. Part of the management, and case report objective, was to determine whether KT could effectively facilitate GM.

Firstly the Dynamic Step Down Test (DSDT) was performed. A software program called Sportsmotion Pro-Trainer Analysis was used to record the test with a video camera and measure the knee, hip and pelvis angles afterwards. The patient was asked to perform a DSDT from a 25cm step while being recorded on a video camera (*APPENDIX III*). He was allowed one practice round to familiarize himself with the task.

Secondly, surface EMG on the GM and TFL were tested during a DSDT. The test was performed using four double-differential, preamplified, bipolar grounded surface electrodes. The purpose of this test was to detect any changes in the timing of these muscles during the step down task (*APPENDIX IV*).

Thirdly, the hip Abduction/ Adduction strength ratio was tested using a Cybex Kin-Com 125E+. The leaver arm was set at 39cm. The angle in which the test was performed was -10 to 30º and the movement velocity was set at 30º per second (*APPENDIX V*). The patient was positioned in side lying with the leg being tested placed in full knee flexion, slight hip internal rotation and -10º abduction. From this starting position the patient was instructed to perform five repetitions of hip abduction/adduction at maximal effort.

The patient was asked to perform these tests one after the other without KT. The patient was then strapped with KT to facilitate GM and thirty minutes later all the tests were repeated. The data was captured and later compared.

The facilitation of GM with KT was incorporated into the patient's existing rehabilitation program. The patient was taught how to apply KT correctly and then asked to strap himself before going on a run. He was reassessed at one and at four months from the initial assessment.

The patient adhered to the protocol and strapped his GM before every run, as well as stretched frequently throughout. The patient was, however, not fully adherent to the exercise program and only completed the exercise program one to two times per week.

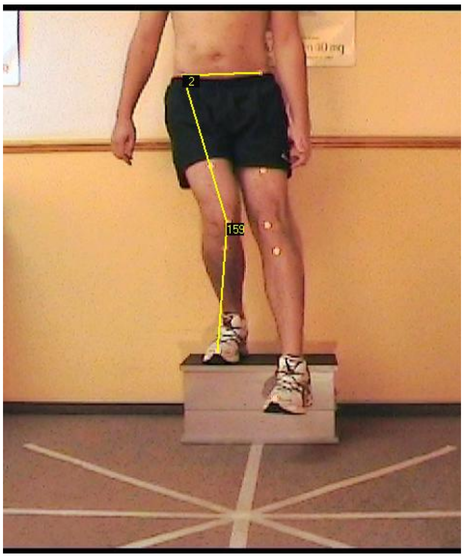
Figure 1: Application of KT to facilitate GM (From Kinesio Taping Lower Extremity Work Book (2),Pg 30 Kinesio Taping Association)

1.Patient position: side lying with the leg in the neutral position. Apply the base of the KT to the greater trochanter

2. Stabilise the base of the KT over the greater thochanter and pull the skin distally and anteriorly to increase the tissue tension. Apply the anterior "Y" tail to the posterior superior iliac spine following the anterior border of gluteus medius

3. Flex, adduct and internally rotate the hip. Flex the knee. Stabilise the base of the KT over the greater trochanter and pull the skin distally and anteriorly to increase the tissue tension. Apply the posterior "Y" tail to the sacrum, enclosing the gluteus medius.

OUTCOMES:

(A) 

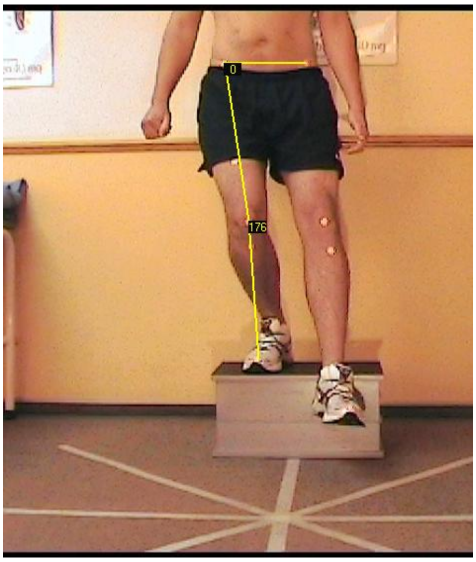
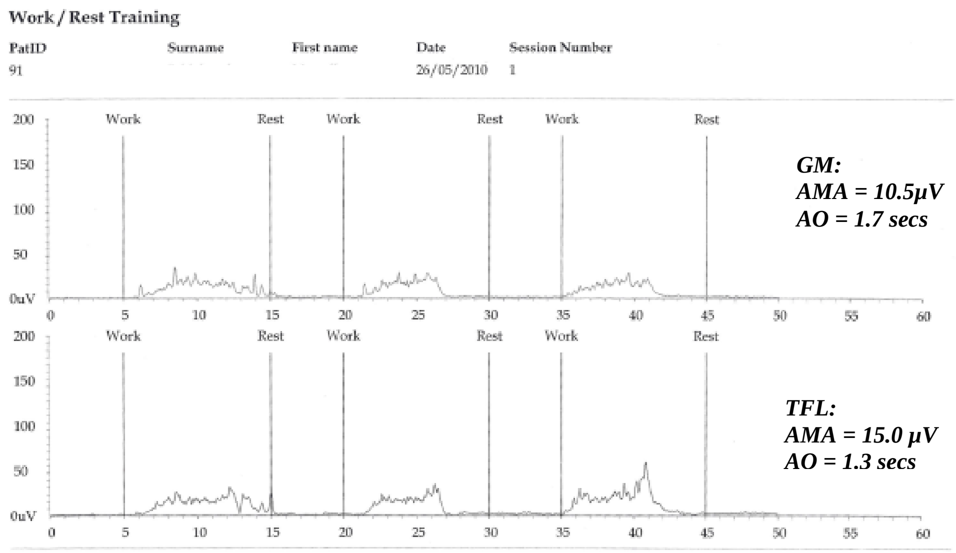
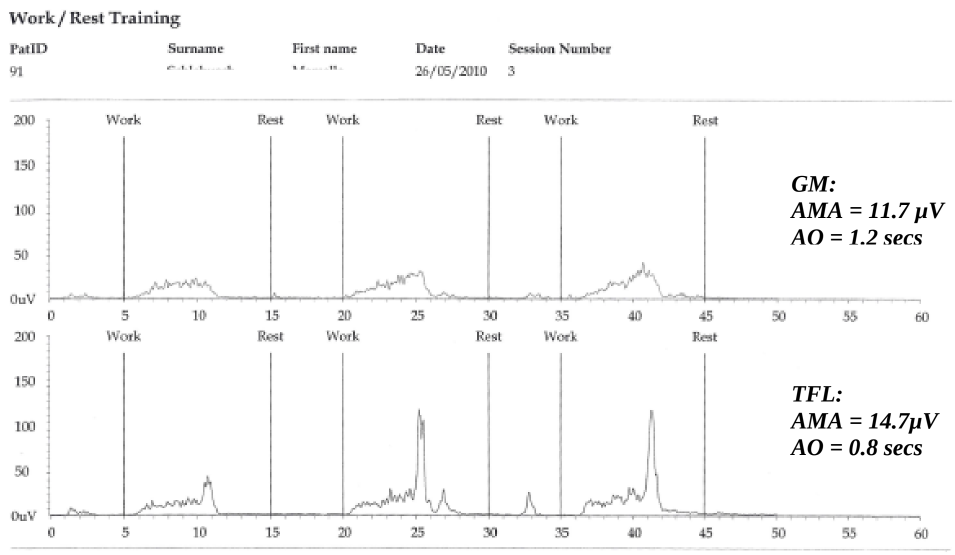
(B) 

FIGURE 2. Sportsmotion Pro-Trainer Analysis: Patient performing the Dynamic Step-Down Test without Kinesio Tape (A) and with Kinesio Tape (B).

During the DSDT of the right leg (*FIGURE 2A*) it was noted that the patient demonstrated an excessive amount of hip adduction and medial knee collapse (Valgus) of 21º, a slight and pelvic drop of 2º and a lateral shift to the right was also noted as well as increased internal hip rotation on the Left. After the GM was facilitated with the KT and the test repeated (*FIGURE 2B*) it was noted that the patient had increased right knee control, decreased medial collapse (4º) on the right, less compensatory internal rotation on the left as well as better pelvic control with a nil degrees drop.



GRAPH 1: Surface EMG of Gluteus Medius (Channel A/Top) and Tensor Fascia Lata (Channel B/Bottom) ***before KT.*** *AMA= Average Muscle Activity. AO = Average Onset*



GRAPH 2: Surface EMG of Gluteus Medius (Channel A/Top) and Tensor Fascia Lata (Channel B/Bottom) ***after KT*** *AMA= Average Muscle Activity. AO = Average Onset*

From the graphs above the following was noted: The Average Onset (*AO* on Graphs) between Channel A (GM) and Channel B (TFL) did not change before KT (GRAPH 1) or after KT (GRAPH 2). In both scenarios TFL activated 0.4 secs before GM. The change in Average muscle activity (*AMA* on graphs) of both GM and TFL before and after KT was very small. GM improved with 1.2 µV and TFL decreased favorably with 0.3µV after KT.

CYBEX RESULTS:

# OF REPS(30/30): 5		WITHOUT KINESIO TAPING				WITH KINESIO TAPING			
		HIP ABDUCTION		HIP ADDUCTION		HIP ABDUCTION		HIP ADDUCTION	
		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
PEAK TORQUE	Ft-lb	84	55	94	118	69	59	89	101
PEAK ANGLE	degrees	-6	-9	17	27	-8	-9	23	16
AVERAGE TORQUE	Ft-lb	52	27	73	90	48	44	73	82
PK TQ/BW	%	47	31	53	66	39	33	50	57
COEFF. OF VAR.	%	10	9	10	9	10	9	10	9
AGON/ANTAG RATIO	%	142	339			151	189		
TOTAL WORK	J	48	25	68	84	46	42	69	78

TABLE 2: Cybex results of hip abduction/adduction strength with and without KT.

PEAK TORQUE = highest muscular force output at any moment during a repetition;
PK TQ/BW = Peak Torque per Bodyweight. Represented as a percentage normalized to bodyweight and compared to an established goal (established goal for hip Abduction =40 %; established goal for hip Adduction = 50 %);
COEFF. OF VAR.= Coefficient of Variant. Determines the reproducibility of the test based on the amount of variation between repetitions (accepted ≤ 15 %);
AGON/ANTAG RATIO = the Reciprocal muscle group ratio. For Hip abd/add the normal is 120 %.

From the results in *TABLE 2*: Agonist/Antagonist ratio *(AGON/ANTAG RATIO)* changed from 339 % without KT to 189 % with KT. Although this is still above the normal (normal for hip abd/add = 120 %, which means that hip abduction must be equal to 80 % of hip adduction), this is a noticeable improvement in the hip abduction/adduction ratio. The *PK TQ/BW* in both abduction and adduction improved with KT to values closer to the established goal as described in the Table.

In the summary of right hip abduction/adduction ratio (*APPENDIX V*) it is seen that there was a 58.8 % improvement of hip abduction strength from Test One (without KT) to Test Two (with KT). There was a pleasing 9.5 % decrease in adductor strength measured from Test One to Test Two.

Re-assessment and Long-term follow-up:

Outcomes measures recorded during initial evaluation were re-assessed at one month and four months from initial evaluation. These included changes in impairments, functional (running) ability, the Noble's test, palpation and the Ober's and Modified Ober's test.

	One month post intervention	**Four months post intervention**
Changes in Impairments (Active Knee Flex/Ext)	2/10 painful arc 30-40º	Pain free full range of movement
Functionally (Running)	2-3/10 starting at 5km and only lasts a few hours following a run	0/10 during running (up to 17km)
Noble's Test	0/10	0/10
Ober's and Modified Ober's	Positive with tight ITB bilaterally	Negative
Palpation	1/10 over right ITB insertion at lateral femoral condyle and the Tubercle of Gerdy	0/10

TABLE 3: Re-assessment of Outcomes at one month and four months from start of intervention

At four months from initial assessment the patient reported that he had been able to run pain free for the last two months. He had been able to increase his frequency of training and is running up to 17km pain free. He had discarded thoughts of going for surgery.

The same biokinetist retested DSDT, surface EMG and Cybex as described before, with the patient performing the tests without KT. The results were compared to initial assessment results.

The DSDT showed a decrease of medial collapse compared to medial collapse measured with and without KT during initial assessment (*APPENDIX III)* but there was still a 3º pelvic tilt.

With the Surface EMG there was a 39.5µV increase of GM activity while TFL activity decreased with 6.9µV during a DSDT *(APPENDIX IV)*.

Results from the Cybex hip abduction/adduction ratio showed an improvement of both hip abduction strength as well as the abd/add ratio *(APPENDIX V)*.

DISCUSSION:

This report describes the treatment of a recreational runner with ITBS and a primary complaint of lateral knee pain, who responded favorably to a KT intervention targeting the facilitation of GM. Clinical and functional goals were achieved with an intervention that did not include traditional treatment interventions. Although KT was incorporated into a pre-existing strengthening program (*APPENDIX II),* the patient was not fully compliant to the exercise program. Due to the non-compliance it could be assumed that the results in this study are possibly due to the effects of the KT alone, as he was extremely compliant to the application of KT.

Fairclough et al (2007) discussed the relevance of considering weak hip musculature when treating patients with chronic ITBS. Frederickson et a l(2000) compared hip abductor strength of the affected leg in long distance runners with chronic ITBS to the uninvolved leg. A prospective study by Noehren et al (2007) and work by Ferber et al (2010) found that female runners who develop ITBS presented with excessive hip adduction. Both authors commented that, although it was expected that increased hip adduction would cause greater eccentric demand on hip abductors, no differences in abduction moment was found. Both authors suggested further investigation into the timing of activation using EMG. Nevertheless, by addressing the identified weak hip abduction in this patient, improvement was noted both subjectively and objectively. This supports the work done by Frederickson et al (2000) and Fairclough et al (2007).

Due to the conflicting evidence regarding the effectiveness of KT, this treatment modality was pre- tested to determine whether it could effectively facilitate GM. Fu et al (2008) found that KT did not enhance muscle strength in Quadriceps and Hamstrings muscles in healthy athletes. They did however find that KT provides tactile input which has been reported to improve motor control. In this study pre-testing of KT showed improved neuromuscular control during a DSDT as well as improved hip abduction/adduction ratio (measured with Cybex). The neuromuscular control could be attributed to the proprioceptive input provided by the tape and supports results from Fu et al (2008). Training with KT on GM would assist motor learning and correct movement patterns. Halseth et al (2008), however, found that there were no proprioceptive changes in ankles in healthy subjects.

Although this case study showed improvement in hip abduction strength with KT of GM, the effect of KT on muscle power has not been confirmed (Fu et al, 2008). There is a great need for good quality studies investigating the effectiveness of KT in all aspects.

A four month follow-up evaluation without KT showed significant improvement in GM activity during a DSDT measured with surface EMG. GM activity increased almost five times (from 11.7µV to 51.2 µV) while TFL activity slightly decreased *(APPENDIX IV).* Hip abduction/adduction ratio measured with the Cybex showed an agonist/antagonist ratio of 169%. Although this is still above the normal ratio of 120%, it is a great improvement from the initial ratio of 339%. A comparison of right hip abduction and adduction strength without KT on initial assessment, and at four months, show a desirable improvement of 105.9% in hip abduction strength and 6.0% adduction strength *(APPENDIX V).*

During the DSDT a 3º pelvic drop was still present *(APPENDIX III).* It should be considered that this could be due to other underlying dysfunctions such as weak gluteus maximus muscles and poor core stability. These factors should not be ignored and further rehabilitation addressing these dysfunctions should be addressed.

Noehren et al(2007), Ferber et al (2010) and Hamill et al (2006) all identified hip weakness as a cause of ITBS in runners. None of the above studies were aimed at treatment of the identified cause. In this study lateral knee pain due to ITBS was eliminated by specifically focusing on strengthening and improving neuromuscular control of an identified weak GM.

Within four months, objective tests (Ober's Test, Noble's Test, palpation over Tubercle of Gerdy) were negative and pain free. The patient was able to run pain free and increase frequency and distance. These results support findings by Fredericson et al (2000). In their study 92 % of subjects with ITBS were able to return to sport pain free following a six week rehabilitation program aimed at strengthening hip abduction. At six months all athletes had returned to full participation.

There are limitations noted in this study. Firstly, during pre-testing of KT surface EMG, there was no change in the timing of the GM during activity with or without KT. It is necessary to consider that the placing of the KT interfered with the positioning of the electrodes. Further studies using needle EMG should be done to accurately measure the timing of the GM and TFL during activation.
Secondly, although initial Cybex results testing KT efficacy showed massive improvement in hip abduction/adduction, it cannot without a doubt be attributed to improved GM facilitation from KT. It should be considered that the possibility exists that the KT could have an effect on some of the other hip abductors, thus giving result to the improvement. More specific strength tests should be done on individual muscle function to determine the true efficacy of KT on the muscle.
Thirdly, due to the chronicity of the symptoms in this patient, whether the hip abduction weakness was the cause or the result of the ITBS cannot be determined. The physiotherapy knowledge base would benefit from prospective studies of biomechanical comparison of runners who develop ITBS compared to those that don't.
Finally, the findings of this case study should be followed up in a randomized control trail with a large sample size, so that findings can be analyzed statistically.

The patient in this case report was selected based on his clinical presentation of chronic ITBS suspected to be due to proximal weakness. The treatment choice was based on the patient's unsuccessful attempt of traditional physiotherapy treatment of strengthening exercises and stretches.

CONCLUSION:

This case report suggests that KT is an effective treatment modality in treatment of ITBS with identified weak GM. It secondly suggests that improved neuromuscular control of the KT on GM during running resulted in a complete decrease of lateral knee pain attributed to chronic ITBS and full return to sport. These findings answer the objectives for this study; namely to determine whether KT can significantly facilitate GM and secondly, determine the efficacy of KT on the GM in a male runner presenting with chronic ITBS.

It is proposed that KT should be considered in the management of patients with ITBS who present with similar clinical findings. This could especially be effective in those patients where traditional course of treatment has not helped, or who show a lack of compliance to exercise therapy.

Although the outcomes of this report were positive, caution should be taken in determining cause and effect based on a single patient. Further research is indicated to better determine the effects of KT on muscle strength and activation.

ACKNOWLEGEMENTS:

I would like to thank Jannie Kliengbiel (Biokinetist) for his help in performing and interpreting the biokinetic tests for this study.
I would also like to thank Olivia Schiller (Supervisor), Tanya Bell, Suzanne Rogers and Kelly Hamilton for their guidance.

REFERENCE:

Bell-Jenje TC. Lower Quarter CD: Functional Exercises for patients. 4th Edition 2008.

Chen WC, Hong WH, Huang TF, Hsu HC. Effects of Kinesio taping on the timing and ration of Vastus Medialis Obliques and Vastus Laterlis muscle for person with patellofemoral pain. ISB Congress,Podium Sessions, 3 July 2007 (Presentation 0216).

Fairclough J, Hayashi K, Toumi H, Lyons K, Bydder G, Phillips N, Best TM, Benjamin M. Is iliotibial band syndrome really a friction syndrome? Journal of Science and Medicine in Sport. 2007;10:74-76.

Ferber R, Noehren B, Hamill J, Davis I. Compertitive female runners with a history of iliotibial band syndrome demonstrates atypical hip and knee kinematics. Journal of Orthopedic Sport Physical Therapy 2010; 40:2 52-58.

Fredericson M, Cookingham CL, Chaudhari AM, Dowdell BC, Oestreicher N, Sahrmann SA. Hip abductor weakness in distance runners with iliotibial band syndrome. Clinical Journal of Sports Medicine 2000(10); 3:169-175.

Fu TC, Wong AMK, Pei YC, Wu KP, Chou SW, Lin YC. Effects of Kinesio taping on muscle strength in athletes-A pilot study. Journal of Science and Medicine in Sport 2008;11:198-201.

Hamill J, Miller R, Noehren B, Davis I. A prospective study of iliotibial band strain in runners. Clinical Biomechanics 2008;23:1018-1025.

Kendell McCeary E, Peterson Kendell F, Provance PG. Muscle Testing and Function, 4th Edition, Lippinkot Williams and Wilkens, 1993, p. 57-59, 220-222.

Kinesio Taping Association. Kinesio Taping Lower Extremity Work Book (2), 2nd English Edition, Tokyo. 2005, p.30.

Magee DJ, Orthopedic Physical Assessment, 4th Edition, Elsevier Sciences (USA), 2002, p. 631- 632.

Miller RH, Lowery JL, Meardon SA, Gillette JC. Lower extremity mechanics of iliotibial band syndrome during an exhausting run. Gait and Posture 2007;26:407-213.

Noehren B, Davis I, Hamill J. ASB Clinical Biomechanics Award Winner 2006 Prospective study of the biomechanical factor associated with iliotibial band syndrome. Clinical Biomechanics 2007;22:951-956.

Powers C. The influence of abnormal hip mechanics on knee injury: A biomechanical perspective. Journal of Orthopaedic and Sports Physical Therapy 2010 (40); 2:42-51.

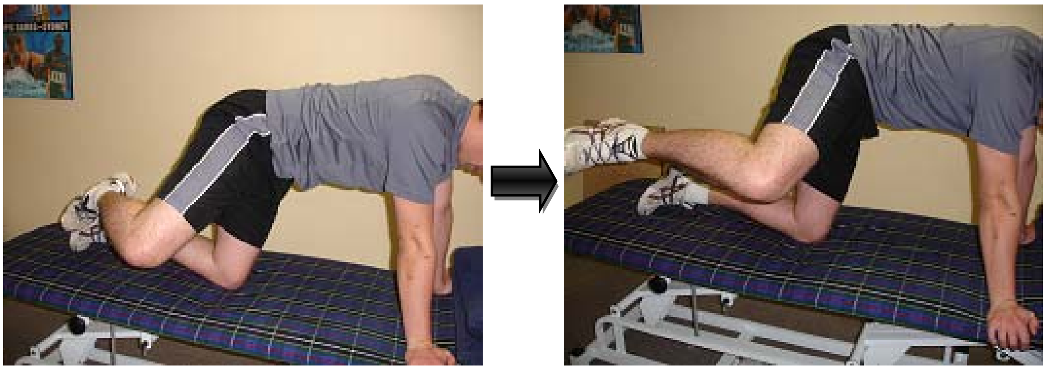
Slupik A, Dwornik M, Bialoszewski D, Zych E. Effects of Kinesio taping on bioelectrical activity of Vastus Medialis muscle. Preliminary report. Orto Traumotol Rehabil. 2007(9);6:644-651.

Taunton J, Ryan B, Clement B, McKenzie C, Lloyd-Smith R, Zumbo D. A retrospective case-control analysis of 2002 running injuries. British Journal of Sports Medicine 2002; 36:95-101.

Thelen MD, Dauber JA, Stoneman PD. The clinical efficacy of Kinesio tape for shoulder pain: a randomized, double-blinded, clinical trial. Journal of Orthopaedic and Sports Physical Therapy 2008 (38); 7:389-395.

APPENDIX II: *From: Bell-Jenje TC. Lower Quarter CD: Functional Exercises for patients. 4th Edition 2008*

Exercise 1: Figure 4. Starting position: hip and knee at 45º, head, shoulder back and hip in a line. Patient actively externally rotate hip. 40-60 repetitions daily.



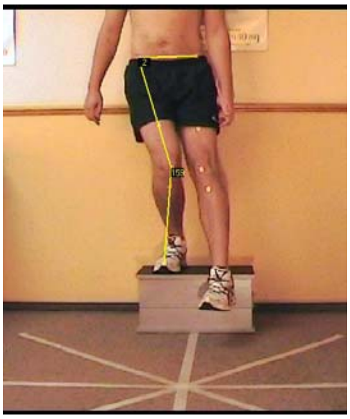
Exercise 2: Jane Fonda. With hips kept parallel the patient performs an active abduction and external rotation.

Stretch 1: ITB. 3 X 30sec, daily

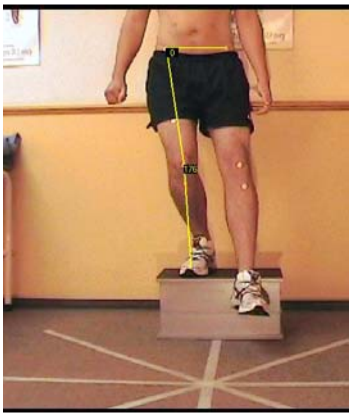
Stretch 2: Hamstrings. 3 X 30sec daily

APPENDIX III:

Dynamic Step Down Test (A) First Assessment without KT; (B) First Assessment with KT; (C) Four months Follow-up without KT



(A) First Assessment without KT
21° Valgus

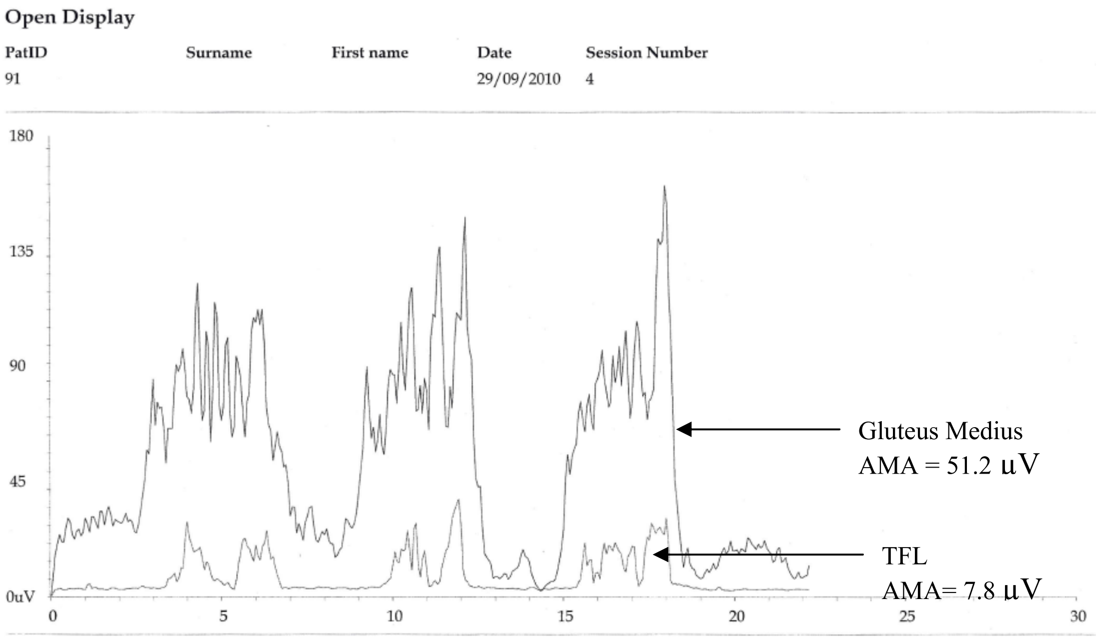


(B) First Assessment with KT
4° Valgus

(C) 4 Month post Assessment without KT
3° Valgus

APPENDIX IV:

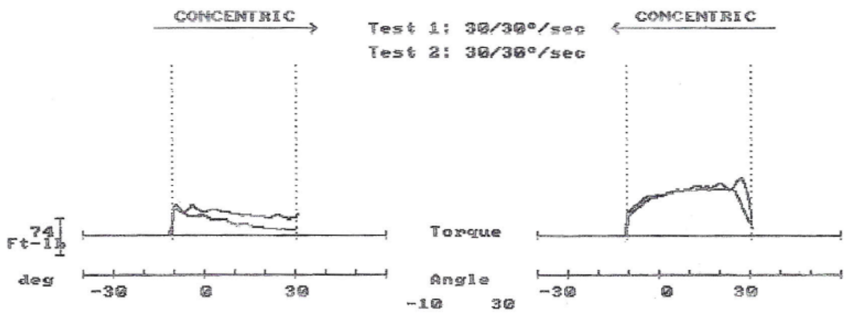
Four Month Follow-up: surface EMG GM and TFL without KT



Four month follow-up surface EMG during a DSDT. *AMA= Average Muscle Activity.*

APPENDIX V: Cybex Comparisons

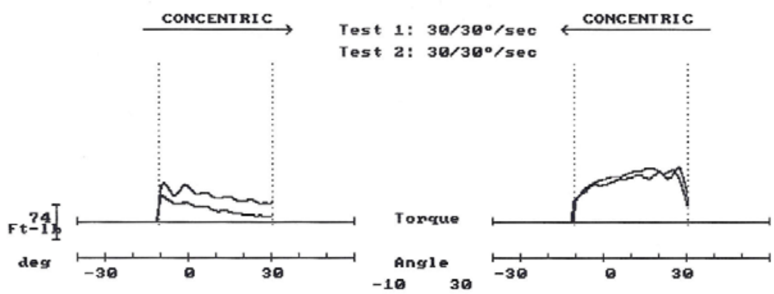
Procedures	Test ONE	Test TWO
Date :	26.05.10	26.05.10
Side :	RIGHT	RIGHT
Muscle Grp. :	AB/AD	AB/AD
Lever Arm :	39 cm	39 cm
Angles :	-10 to 30 deg	-10 to 30 deg
R-T Gravity :	5 Ft-lb	5 Ft-lb
Velocity :	30	30
File :	557.CHA	561.CHA



Test ONE :	26 J	RIGHT	Test ONE :	84 J
Test TWO :	41 J	RIGHT	Test TWO :	76 J
Difference :	58.6 %		Difference :	-9.5 %
			CV:	9%

Initial assessment; *Cybex summary comparison of right hip abduction/adduction ratio with and without KT*

Procedures	Test ONE	Test TWO
Date :	26.05.10	29.09.10
Side :	RIGHT	RIGHT
Muscle Grp. :	AB/AD	AB/AD
Lever Arm :	39 cm	39 cm
Angles :	-10 to 30 deg	-10 to 30 deg
R-T Gravity :	5 Ft-lb	7 Ft-lb
Velocity :	30	30
File :	557.CHA	1080.CHA



Test ONE :	26 J	RIGHT	Test ONE :	84 J
Test TWO :	53 J	RIGHT	Test TWO :	89 J
Difference :	105.9 %		Difference :	6.0 %
			CV:	7%

Four-Month follow-up comparison*; right hip abduction/adduction strength without KT*