Evaluation of Gait Speed after Applying Kinesio Tape on Quadriceps Femoris Muscle in Patients with Knee Osteoarthritis

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Abstract

BACKGROUND: Knee osteoarthritis is a chronic degenerative disease, known as the most common cause of difficulty walking in older adults and subsequently is associated with slow walking. Functional decline, increased risk of falls and the presence of pain are, in many studies, related to the muscle weakness caused by osteoarthritis especially weakness of the quadriceps muscles. Many studies have shown that the strength of the quadriceps femoris muscle can affect gait, by improving or weakening it. Kinesio Tape is a physiotherapeutic technique, which reduces pain and increases muscular strength by irritating the skin receptors.

AIM: This study aimed to verify if the application of Kinesio Tape on quadriceps femoris muscle increases gait speed while decreasing the time needed to accomplish the 10-meter walk test in patients with knee osteoarthritis and also in subjects without knee osteoarthritis.

METHOD: In this study, we observed the change of gait speed with the help of the 10-meter walk test before, one day and three days after the application of Kinesio Tape in quadriceps femoris muscle. We compared the results of the time needed to perform the 10-meter walk in two groups. In the first group, the Patients group, participated 102 out-patients with a clinical diagnosis of primary knee osteoarthritis, while in the second group, the Control group, participated 73 subjects with a main excluding criterion a clinical diagnosis of primary knee osteoarthritis.

RESULTS: Our results indicated that there was a significant decrease of time needed to perform the 10-meter walk test in both groups three days after application of Kinesio Tape on quadriceps femoris muscle. However, there was not a significant change one day after the application of Kinesio Tape compared before its application in both groups.

CONCLUSIONS: Our results indicated that there was a significant decrease in time needed to accomplish the 10-meter walk test. Kinesio Tape is a technique that can be used especially when changing walking stereotypes is a long-term goal of the treatment.

Introduction

Osteoarthritis is a widespread, slowly developing disease, with a high prevalence increasing with age, also known as a metabolically active, dynamic disease that includes both destruction and repair mechanisms that may be triggered by biochemical and mechanical insults [1]. In developed countries, knee osteoarthritis (OA) affects between 17% and 30% of the elderly population over 65 years of age, with greater incidence, prevalence and severity in women than in men [2] [3]. Functional decline, increased risk of falls and presence of pain are, in many studies, related to the muscle weakness caused by OA [4] [5] especially the weakness of the quadriceps muscles [6].

Quadriceps weakness is one of the most common and disabling impairments seen in individuals with knee OA [7]. Sufficient quadriceps and hamstrings strength, both isometric and dynamic, is essential for undertaking basic activities of daily living such as standing and walking [8].

Patients with knee osteoarthritis have a problem walking and tend to walk slower than controls. It is shown that knee osteoarthritis is the
most common cause of difficulty walking in older adults [9] [10] and subsequently is associated with slow walking [11] [12]. In knee osteoarthritis, decreased walking speed is associated with joint space narrowing [13], increased concentrations of inflammation mediators [14], pain [15] and also quadriceps muscle weakness [16] [17].

Quadriceps femoris weakness, in particular, has been linked to functional impairment such as increased fall risk and slower walking speed, also is one of the earliest and most common symptoms of osteoarthritis [18] [19] [20]. It is also associated with adaptations in walking patterns that are theorised to put articular cartilage at risk.

For instance, subjects with knee OA who have weaker quadriceps femoris muscles exhibit less stance phase knee motion during walking. At self-selected walking speeds, it is the role of the quadriceps femoris muscles to control knee flexion during weight acceptance while the hamstring and gastrocnemius muscles are typically silent. However, in the presence of quadriceps femoris weakness, which occurs with ageing, and in the presence of knee OA, either the hamstring or the gastrocnemius muscles may be required to assist with knee control [21].

Muscle strength testing has revealed that those with knee OA have a 25% to 45% loss of knee extension strength and a 19% to 25% loss of knee flexion strength compared with similarly aged controls [22] [23] [24]. There are 3 factors thought to contribute to knee extension and flexion weakness in those with knee OA: muscle atrophy, failure of voluntary muscle activity, and apparent weakness from increased antagonist muscle co-contraction [25]. Decreases in muscle cross-sectional area (CSA) have been established in subjects with early OA degenerative changes [26] and those with severe knee OA [27]. Ikeda et al., [26] found that women with early degenerative changes in the knee joint had reductions in quadriceps CSA of up to 12%, compared with age-matched women without radiographic changes.

The aim of this study was to verify if the application of Kinesio Tape (KT) on quadriceps muscle changes gait speed while walking for 10 meters at normal speed, in patients with knee osteoarthritis and also in subjects without knee OA, before the application of KT, a day and three days after the application of KT on quadriceps femoris muscle.

Patients and Methods

In this study, we compared the results of the gait speed in two groups. The first group was the Patients group. The subjects (n = 102), aged 50-73 years (mean age 63.2), 67% of whom were female, were consecutive out-patients with a clinical diagnosis of primary unilateral knee osteoarthritis made by a rheumatologist. The main criterion for the selection of the subjects in this study was the diagnosis of knee osteoarthritis by X-ray. The second group was the Control group. The subjects (n = 73), aged 50-69 years (mean age 59.4), 70% of whom were female, were randomly chosen and the main criterion for their selection was that they were not diagnosed with knee osteoarthritis.

Criteria for excluding subjects from both groups in the study were other musculoskeletal diseases, total knee replacement, significant hip or spinal arthritis, neurological diseases and diseases that affect balance and coordination. The subjects were not in medical treatment. All of the subjects signed a written consent to participate in the study voluntarily.

Kinesio Tape (KT) was applied with a tonus regulation technique also called muscle technique on quadriceps femoris muscle. We measured the tape length in the maximal stretched position of the tissue. The application was done with the patient in this maximal stretched position. The tape was applied without stretch following the course of the muscle borders from one insertion to the opposite one.

In the patient’s group, the worse knee as assessed by X-ray was the “index” knee, while in the control group we randomly chose a knee where we applied the KT.

We observed the change of time while walking for 10 meters at normal speed for each patient, before, a day after and three days after the application of KT on quadriceps femoris muscle, with the help of a 10-meter walk test, where we measured and marked a 10-metre walkway adding a mark at 2-metres and 8-metres. The patient performed three trials, and we calculate the average of three trials [28].

Statistical Analysis

Continuous variables were presented as mean and standard deviation: mean ± SD (standard deviation). Categorical variables are presented as actual numbers (n) and percentages (%). Chi-square analysis was used to compare frequencies between groups and Student t-test, one-way ANOVA or non-parametric tests were used when necessary for quantitative analysis of the variables. The analysis was conducted using the SPSS (statistical software statistics package for social scientists) version 15.0. Statistical significance was considered to be the value of P ≤ 0.05.
Results

In this study, we compared the results of the time needed to perform the 10-meter walk test in two groups. In the first group, the Patients group participated in 102 out-patients with a clinical diagnosis of primary knee osteoarthritis, the mean age of the participants was 63.2 (range: 50-73).

Table 1: Data results on gait speed, of the Control group, in seconds before the application of KT (10 MWT before KT), one day after the application of KT (10 MWT 1 Day after KT) and three days after the application of KT (10 MWT 3 Days after KT) on quadriceps femoris muscle

|                  | Number | Mean value | Standard Deviation | Minimum value | Maximum value |
|------------------|--------|------------|--------------------|---------------|---------------|
| Control Group    |        |            |                    |               |               |
| 10MWT before KT  | 73     | 7.223      | 1.0052             | 5.247         | 9.610         |
| Control Group    |        |            |                    |               |               |
| 10MWT 1 day after KT | 73   | 7.082      | 0.9923             | 5.167         | 9.497         |
| Control Group    |        |            |                    |               |               |
| 10MWT 3 days after KT | 73   | 6.199      | 0.9098             | 4.567         | 8.193         |

Figure 1: Comparison of values of 10-meter walk test (10MWT) in the control group (CG) and the patients’ group (PG), before Kinesio Tape (KT) application (1), 1 day after KT application (2) and 3 days after KT application (3)

The worse knee as assessed by X-ray was the “index” knee. In the second group, the Control group, participated 73 subjects aged 50-69 years (mean age 59.4), with a main excluding criterion a clinical diagnosis of primary knee osteoarthritis.

Table 2: Data results on gait speed, of the Patients group, in seconds before the application of KT (10 MWT before KT), one day after the application of KT (10 MWT 1 Day after KT) and three days after the application of KT (10 MWT 3 Days after KT) on quadriceps femoris muscle

|                  | Number | Mean value | Standard Deviation | Minimum value | Maximum value |
|------------------|--------|------------|--------------------|---------------|---------------|
| Patients         |        |            |                    |               |               |
| 10MWT before KT  | 102    | 10.412     | 2.5025             | 6.173         | 16.277        |
| Patients         |        |            |                    |               |               |
| 10MWT 1 day after KT | 102  | 9.976      | 2.4712             | 6.160         | 15.847        |
| Patients         |        |            |                    |               |               |
| 10MWT 3 days after KT | 102  | 6.743      | 1.8205             | 4.123         | 10.807        |

The results show that 1 day after applying KT on quadriceps femoris muscle there was not a significant change of time needed to perform the 10-meter walk test in a comparison of the time needed a day before application of KT, in both groups: Control group P = 0.405 and in the Patients group P = 0.20.

The time needed to perform the 10-meter walk test three days after KT’s application changed significantly from the time needed before KT’s application on quadriceps femoris muscle in both groups: in the Control group P < 0.0001 and in the Patients group P < 0.0001.

The time needed to perform the 10-meter walk test three days after KT’s application changed significantly from the time needed 1 day after KT’s application on quadriceps femoris muscle in both groups: in the Control group P < 0.0001 and the Patients group P < 0.0001.

Discussion

Lack of information about the impact of elastic therapeutic tape in gait speed in this diagnosis led us to carry out this research. Our objective was to determine whether the application of KT on quadriceps muscle, in patients with knee osteoarthritis and also in subjects without knee OA, will lead on increasing gait speed while walking a 10-meter distance on normal speed.

The results of this study showed a significant decrease of time needed to accomplish the 10-meter walk test three days after applying KT on quadriceps femoris muscle. In graphic 1 is shown that the Patients group and the Control group finish the 10-meter walk test in a shorter time after applying KT on quadriceps muscle three days after the application. However, there was not a significant decrease of time needed to perform the 10-meter walk test one day after application of KT in both groups.

Based on these results, it can be inferred that applying KT facilitated muscle activation in the indexed knee by increasing gait speed and decreasing the time needed to perform the 10-meter walk test three days after applying KT. This suggests that applying KT leads in improving the walking speed through muscle facilitation in the indexed knee [29]. This is because KT effectively stimulated the proprioceptive sense, muscle spindles, Golgi tendons, etc., and strengthened muscles in the affected parts [30]. These results were in agreement with the results of previous studies, which reported that KT increases muscle activity, restricts excessive movement of the joint and increases gait speed [31] [32].
Kase et al., [33] and Thelen et al., [34] also recommend at least three daily actions of elastic therapeutic tape. Kase et al., mentions those three days after the application of KT can occur soft tissue changes, improvement of muscle function, an increase of blood circulation and lymphatic drainage. Thelen et al. found that after three days of KT application, was shown a significant decrease of the functional shoulder joint pain and increase of movement. Similar results as in our study were found in other studies where no significant differences were found immediately after KT application [35] [36]. Also, Chang et al., [37] found no change in grip strength immediately after applying Kinesio tape in healthy people.

The fact that the gait speed also changed in the subjects without knee OA makes us think that the application of KT has a placebo effect. There are anecdotal reports ranging from improvements in circulation to greater strength, but researchers suggest these improvements in performance are due to a placebo effect, not from the KT itself [40]. Ella Ward [41], claims that overall, KT and the placebo effect are relevant in sport and performance, as psychologists can manipulate this intervention to enhance athletic performance; avoiding more intrusive, unethical and expensive treatment methods.

However Słupik et al., [38] evaluated the effects of applying KT over the vastus medialis and found no change in muscle activity 10 minutes post-taping, but they found increased muscle activity 24 hours after Kinesio tape application. Also Lins et al., [39] evaluated the effects of KT application on the activity of the vastus lateral, rectus femoris, and vastus medialis muscles of healthy women who exercised and found no significant effects. The difference between these results may be due to different forms and tensions of Kinesio tape application. Different Kinesio tape techniques can provide different tactile stimulation intensities [30].

Limitations in this study were the sample size, with a greater sample size we could get better results. In this study, the effect of KT in increasing gait speed in knee OA and also in subjects without knee OA was statistically significant. This leads to the fact that the application of KT is effective in all subjects without any significance if they have knee osteoarthritis or not. Further studies are needed to investigate the effect of KT in gait speed on knee osteoarthritis.

In conclusion, there seems to be a significant increase of gait speed and a decrease of time needed to accomplish the 10-meter walk test three days after applying KT on quadriceps femoris muscle in the patient’s group and also the control group. However, there was not such a significant decrease of time needed to accomplish the 10-meter walk test one day after application in both groups.

Kinesio Tape is a technique that can be used especially when changing walking stereotypes is a long-term goal of the treatment. More clinical research is needed to investigate the effect of KT on gait speed on knee osteoarthritis.

References

1. Felson DT, Lawrence RC, Dieppe PA, et al. Osteoarthritis: new insights. Part 1: the disease and its risk factors. Ann Intern Med. 2000; 133:635–646. https://doi.org/10.7326/0003-4819-133-8-200010170-00016 PMid:11033593

2. Arden N, Nevitt MC. Osteoarthritis: epidemiology. Best Pract Res Clin Rheumatol. 2006; 20:3–25. https://doi.org/10.1016/j.berh.2005.09.007 PMid:16483904

3. Brandt KD, Dieppe P, Radin E. Etiopathogenesis of osteoarthritis. Med Clin North Am. 2009; 93:1-24. https://doi.org/10.1016/j.mcna.2008.08.009 PMid:19059018

4. Gür H, Cakin N. Muscle mass, isokinetic torque, and functional capacity in women with osteoarthritis of the knee. Arch Phys Med Rehabil. 2009; 84:1534-41. https://doi.org/10.1016/j.s0003-9993(03)00288-0

5. Foley SJ, Lord SR, Srikanth V, Cooley H, Jones G. Falls risk is associated with pain and dysfunction but not radiographic osteoarthritis in older adults: Tasmanian Older Adult Cohort study. Osteoarthritis Cartilage. 2006; 14:533-9. https://doi.org/10.1016/j.joca.2005.12.007 PMid:16460970

6. Slemenda C, Heilman DK, Brandt KD, Katz BP, Mazzuca SA, Braunstein EM et al. Reduced quadriceps strength relative to body weight: a risk factor for knee osteoarthritis in women? Arthritis Rheum. 1998; 41:1951-9. https://doi.org/10.1002/1529-0131(199811)41:11<1951::AID-ART9>3.0.CO;2-9

7. Hurley MV. The role of muscle weakness in the pathogenesis of osteoarthritis. Rheum Dis Clin North Am. 1999; 25:283-298. https://doi.org/10.1016/S0889-8597(05)70068-9

8. Nordesjo LO, Nordgren B, Wigren A, Kolstad K. Isometric strength and endurance in patients with severe rheumatoid arthritis or osteoarthritis in the knee joints. A comparative study in healthy men and women. Scand J Rheumatol. 1983; 12:152-156. https://doi.org/10.3109/03009748309102902 PMid:6857173

9. Hall WJ. Update in geriatrics. Ann Intern Med. 2006; 145(7):538–43. https://doi.org/10.7326/0003-4819-145-7-200610030-00012 PMid:17015872

10. Cesari M, Kritchevsky SB, Penninx BW, Nicklas BJ, Simonsick EM, Newman AB, et al. Prognostic value of usual gait speed in well-functioning older people–results from the Health, Aging and Body Composition Study. J Am Geriatr Soc. 2005; 53(10):1675–80. https://doi.org/10.1111/j.1532-5415.2005.53501.x PMid:16181165

11. Ayis S, Ebrahim S, Williams S, Juni P, Dieppe P. Determinants of reduced walking speed in people with musculoskeletal pain. J Rheumatol. 2007; 34(9):1905–12. PMid:17696267

12. Studenski S, Perera S, Patel K, Rosano C, Faulkner K, Inzitari M, et al. Gait speed and survival in older adults. JAMA. 2011; 305(1):50–8. https://doi.org/10.1001/jama.2010.1923 PMid:21205966 PMCid:PMC3080184

13. McDaniel G, Renner JB, Sloane R, Kraus VB. Association of knee and ankle osteoarthritis with physical performance. Osteoarthritis Cartilage. 2011; 19(6):634–638. https://doi.org/10.1016/j.joca.2011.01.016 PMid:21310252 PMCid:PMC3097285

14. Penninx BW, Abbas H, Ambrosius W, Nicklas BJ, Davis C, Messier SP, Pahor M. Inflammatory markers and physical function among older adults with knee osteoarthritis. J Rheumatol. 2004; 31(10):2027–2031. PMid:15468370

15. Nebel MB, Sims EL, Keeve FJ, Kraus VB, Gulak F, Caldwell DS, Pells JJ, Queen R, Schmitt D. The relationship of self-reported
pain and functional impairment to gait mechanics in overweight and obese persons with knee osteoarthritis. Arch Phys Med Rehabil. 2011; 90(11):1874. https://doi.org/10.1016/j.apmr.2009.07.010 PMid:19887211 PMCid:PMC3144251

16. McAlindon TE, Cooper C, Kirwan JR, Dieppe PA. Determinants of disability in osteoarthritis of the knee. Ann Rheum Dis. 1993; 52:258-62. https://doi.org/10.1136/ard.52.4.258 PMid:8484690 PMCid:PMC1005622

17. Dekker J, Tola P, Aufdemkampe G, Winckers M. Negative affect, pain and disability in osteoarthritis patients: the mediating role of muscle weakness. Behav Res Ther. 1993; 31:203-6. https://doi.org/10.1016/0005-7967(93)90073-4

18. Cesari M. Role of gait speed in the assessment of older patients. JAMA. 2011; 305(1):93-94. https://doi.org/10.1001/jama.2010.197 PMid:21205972

19. Stanaway FF, Gnjidic D, Blyth FM, Le Couteur DG, Nagananathan V, Waite L, Seibel MJ, Handelsman DJ, Sambrook PN, Cumming RG. How fast does the Grim Reaper walk? Receiver operating characteristics curve analysis in healthy men aged 70 and over. BMJ. 2011; 343:d7679. https://doi.org/10.1136/bmj.d7679 PMid:22174324 PMCid:PMC3240682

20. Witvrouw E, Victor J, Bellemans J, Rock B, Van Lummel R, Witvrouw ECM, Huijing PAAM, Slijker R, Verdonk R. A correlation study of objective functionality and WOMAC in total knee arthroplasty. Knee Surg Sports Traumatol Arthrosoc. 2002; 10(6):347-53. https://doi.org/10.1007/s00167-002-0302-2 PMid:12445121

21. Rudolph KS, Schmitt LC, Lewek MD. Age-related changes in strength, joint laxity, and walking patterns: are they related to knee osteoarthritis? Phys Ther. 2007; 87:1422-1432. https://doi.org/10.2522/ptj.20060137 PMid:17785376 PMCid:PMC2217585

22. Cheing GL, Hui-Chan CW. The motor dysfunction of patients with knee osteoarthritis in a Chinese population. Arthritis Rheum. 2001; 45:62-68. https://doi.org/10.1002/1529-0131(200102)45:1<62::AID-ART13>3.0.CO;2-W

23. Hassan BS, Mockett S, Doherty M. Static postural sway, proprioception, and maximal voluntary quadriceps contraction in patients with knee osteoarthritis and normal control subjects. Ann Rheum Dis. 2001; 60:612-618. https://doi.org/10.1136/ard.60.6.612 PMid:11350851 PMCid:PMC1753684

24. Pap G, Machner A, Awiszus F. Strength and voluntary activation of the quadriceps femoris muscle at different severities of osteoarthritic knee joint damage. J Orthop Res. 2004; 22:96-103. https://doi.org/10.1016/S0736-0266(03)00128-1

25. Busse ME, Wiles CM, van Deursen RW. Co-activation: its association with weakness and specific neurological pathology. J Neuroeng Rehabil. 2006; 3:26. https://doi.org/10.1186/1743-0003-3-26 PMid:17162592 PMCid:PMC1665451

26. Ikeda S, Tsumura H, Torisu T. Age-related quadriceps-dominant muscle atrophy and incident radiographic knee osteoarthritis. J Orthop Sci. 2005; 10:121-26. https://doi.org/10.1007/s00776-004-0976-0 PMid:15815957

27. Fink B, Egl M, Singer J, Fuerst M, Bubenheim M, Neuen-Jacob E. Morphologic changes in the vastus medialis muscle in patients with osteoarthritis of the knee. Arthritis Rheum. 2007; 56:3626-3633. https://doi.org/10.1002/art.22960 PMid:17968889

28. http://www.rehabmeasures.org/PDF%20Library/10%20Meter%20Walk%20Test%20Instructions.pdf

29. Choi YK, Nam CW, Lee JH, et al. The effects of taping prior to PNF treatment on lower extremity proprioception of hemiplegic patients. J Phys Ther Sci. 2013; 25: 1119-1122. https://doi.org/10.1589/jpts.25.1119 PMid:24259927 PMCid:PMC3818771

30. Kase K, Wallis J, Kase T. Clinical therapeutic application of the kinesio taping method. Tokyo (Japan): Ken Ikai Co Ltd., 2003.

31. Huang CY, Hsieh TH, Lu SC, Fu SC. Effect of the Kinesiotape to muscle activity and vertical jump performance in healthy inpatients. Biomed Eng Online. 2011; 10(1):70. https://doi.org/10.1186/1475-925X-10-70 PMid:21831321 PMCid:PMC3174125

32. Karlsson J, Andreasson GO. The effect of external ankle support in chronic lateral ankle joint instability. An electromyographic study. The American Journal of Sports Medicine. 1992; 20(3):257-261. https://doi.org/10.1177/036354659202000304 PMid:1636854

33. Kase K, Wallis J, Kase T. Clinical therapeutic applications of the kinesio tape method. Tokyo: Ken Ikai Co. Ltd., 2003:348.

34. Thelen MD, Dauber JA, Stoneman PD. (2008). The Clinical Efficacy of Kinesio Tape for Shoulder Pain. Journal of Orthopaedic and Sports Physical Therapy, 2008; 38:389-395. https://doi.org/10.2519/jospt.2008.2791 PMid:18591761

35. Kim H, Lee B. The effects of kinesio tape on isokinetic muscular function of horse racing jockeys. J Phys Ther Sci. 2013; 25(10):1273-7. https://doi.org/10.1589/jpts.25.1273 PMid:24259774 PMCid:PMC3820175

36. Vercelli S, Sartorio F, Foti C, Colletto L, Virton D, Ronconi G, et al. Immediate effects of kinesiotaping on quadriceps muscle strength: a single-blind, placebo-controlled crossover trial. Clin J Sport Med. 2012; 22(4):319-26. https://doi.org/10.1097/JSM.0b013e31824c835d PMid:22450591

37. Chang HY, Chou KY, Lin JJ, Lin CF, Wang CH. Immediate effect of forearm Kinesio taping on maximal grip strength and force sense in healthy collegiate athletes. Phys Ther Sport. 2010; 11(4):122-7. https://doi.org/10.1016/j.ptsp.2010.06.007 PMid:21055705

38. Stupnick A, Dwornik M, Bialoszewski D, Zych E. Effect of Kinesio Taping on bioelectrical activity of vastus medialis muscle. Preliminary report. Ortop Traumatol Rehabil. 2007; 9(6):644-51. PMid:18227756

39. Lins CA, Neto FL, Amorim AB, Macedo LB, Brasilie JS. Kinesio Taping does not alter neuromuscular performance of femoral quadriceps or lower limb function in healthy subjects: randomized, blind, controlled, clinical trial. Man Ther. 2013; 18(1):41-5. https://doi.org/10.1016/j.math.2012.06.007 PMid:23182011 PMCid:PMC3499887

40. Stedje HL, Kroksie RM, Docherty CL. Kinesio Taping and the circulation and endurance ratio of the gastrocnemius muscle. Journal of Athletic Training. 2012; 47(6):635-642. https://doi.org/10.4085/1062-6050-47.5.15 PMid:22796389

41. Ward E. Sports performance, placebo effects and kinesio-tape, 2013. https://sportandperformancepsych.wordpress.com/2013/08/29/sport-performance-and-placebo-effects/