Original Article

doi: 10.16926/par.2020.08.05

The effects of kinesiotaping applied to delayed-onset muscle soreness of the quadriceps femoris

Dariusz Boguszewski[1ABCDE], Sylwia Szkoda[1BD], Jakub Grzegorz Adamczyk[2CD], Sylwia Piesio[1BD], Dariusz Białoszewski[1DE]

[1]Departament of Rehabilitation of Medical Faculty, Medical University of Warsaw, Poland
[2]Institute of Theory of Sport. Academy of Physical Education of Józef Piłsudski in Warsaw, Poland

Authors' Contribution: A – Study Design, B – Data Collection, C – Statistical Analysis, D – Manuscript Preparation, E – Funds Collection

Abstract

The aim of this work was to estimate the effectiveness of kinesiotaping (KT) in the reduction of delayed-onset muscle soreness (DOMS) of the quadriceps femoris. 41 young women were examined. In the study, two groups applied kinesiotaping – the first with a relaxing application (Group 1); and the second with a lymphatic one (Group 2). Women from the control group used no treatment to help in the exertion restitution. All of the women performed a vertical jump test and training of their lower limbs (5 series of squat jumps). The research tools were the VAS scale (for the estimation of pain) and the Borg Scale (for a subjective estimation of the intensity of effort). The measurements (the vertical jump test and the intensification of the pain) were repeated 24, 48, 72 and 96 hours after the training where the exertion occurred. In all of the groups, the greatest regress of the vertical jump test was observed between the first and the second measurement – and this difference was statistically essential ($p<0.01$). The least fall in power was noticed in the women who had received the lymphatic KT application; while the greatest fall in results of vertical jump test was observed in the persons with the KT relaxing application. The greatest level of pain in Groups 1 and 2 was noted during the second measurement, which was 24 hours after the training; whereas in the control group, the greatest pain was observed in the third measurement. It can be concluded that the kinesiotaping has a bearing on the acceleration of the regeneration and increased the efficiency of the examined muscles.

Keywords: kinesiotaping, DOMS, quadriceps femoris muscle, recovery

Address for correspondence: Dariusz Boguszewski - Rehabilitation Department, Medical University of Warsaw, Poland, e-mail: dboguszewski@wum.edu.pl

Recevied: 31.07.2019; Accepted: 15.09.2019; Published online: 4.03.2020

Cite this article as: Boguszewski D, Szkoda S, Adamczyk J, Piesio S, Białoszewski D. The effects of kinesiotaping applied to delayed-onset muscle soreness of the quadriceps femoris. Phys Activ Rev 2020; 8(1): 39-45. doi: 10.16926/par.2020.08.05

INTRODUCTION

Delayed-onset muscle soreness (DOMS) usually develops between several to a dozen hours after intense physical effort. Its culminant intensity appears between the second and the third day after the effort, and can last for up to 5-7 days. It mostly appears after eccentric effort, and is characterised by pain and intensive muscular tension. This may be because eccentric effort causes a much greater threat of damage to the muscle fibres, as during its progress the tension per motor unit is much greater than occurs during concentric efforts [1, 2].

As to the reason for delayed-onset muscle soreness, one can consider the increase of the concentration of injurious metabolites (among other things lactate) in the muscles. However, this thesis has not been confirmed, because both these factors do not always correlate at the same time. At present, we can ascertain that the reason for DOMS is more complex. It begins with damage to the muscle fibres in the progress of the effort, as described above, which causes local inflammation. Then there is an infiltration of neutrophilic leucocytes, and 24-48 hours later, also macrophages. These substances, together with mediators of the inflammation, cause stimulation of the nerve ends which conduct pain. Symptoms of this inflammable reaction can include swelling and warming up of the tissues, causing a further increase in the painful sensation of the muscles. Instead of a reduction, the quantity of calcium ions in the intra-plasmal reticulum, together with the swelling of the tissues causes stiffness of the muscles after the effort. The chemical mediators of inflammation, such as prostaglandin, diminish the level of the sensibility of the nociceptors in the muscles. This results in a strong painful sensation during the action of a gentle mechanical impulse, such as e.g. a muscle contraction [3].

The influence of delayed-onset muscle soreness on physical activity has not been sufficiently explained. However, one can notice such symptoms as: a decrease of muscular power; a diminution of joint mobility; and disturbances in the co-ordination of motor units during muscle contraction. If one starts renewed physical efforts too early, it can set up compensatory mechanisms which will lead to further damage of the tissues [4]. However moderate physical activity could decrease the muscle pain after strenuous exercises [5].

Until now, researchers have used various methods to aid in the exertion restitution and the DOMS reduction (most often these were massages, saunas or cryotherapy). However, the research results on the efficiency of these methods are not univocal [6-10]. Kinesiotaping (KT) has been widely used in clinical practice. However, it is unknown whether which type of them is more effective in specific purpose [11-13]. KT method is based on mechanical and sensory interaction of tissues. In place of KT application the space between skin surface and fascia increased. Thanks that circulation of blood and lymph is better. This phenomenon may contribute to the process of self-healing. Therefore the main aim of this study was to estimate the influence of relaxing and lymphatic kinesiotaping applications on the reduction of the effects of delayed-onset muscle soreness in the quadriceps femoris muscles.

MATERIAL AND METHODS

Participants

Forty one women, aged from 24 to 26 years, took part in the research, where they were randomly divided into three groups (Tab. 1). All persons from Group 1 (n=13) and Group 2 (n=14) directly applied the chosen kinesiotaping (KT) application after the training of the lower limbs – in Group 1 a relaxing application was applied; and in Group 2 a lymphatic one. The persons assigned to Group 3 – the control group (n=14) – were not subjected to any treatment to help in the exertion restitution.

DOMS protocol

The investigative tools were a test of the vertical jump test and a test consisting of squat jumps. For the estimation of the intensification of pain, the Visual Analog Scale (VAS) was applied. Additionally, measurements were made of the pulse rate (before and after the training) and the subjective estimation of the intensity of effort with the Borg Scale (after the training) [14].

Table 1. Participants' characteristics (mean value ± standard deviation).

Groups	Number of people [n]	Age [years]	Body mass [kg]	Body height [cm]
Group 1 (KT – relaxing)	13	24.2 ±0.5	57.3 ±4.5	167 ±0.5
Group 2 (KT – lymphatic)	14	24.6 ±1.1	57.2 ±5.2	165.2 ±0.5
Group 3 (Control)	14	24.8 ±1.4	57 ±5.3	165.8 ±0.6

All of the studied persons performed the vertical jump test and the test of the training of the muscles of the lower limbs in five series of squat jumps, with a 60-100% maximum possibility of performance (the first series until the refusal was a 100% possibility; Series 2-4 had a 60-80% possibility; and the fifth series continued until the refusal). Plyometric training was performed because according to many research, because plyometric training is considered to the best way to appearance of DOMS [15-17]. After the training, the first measurement of the pain intensity was made (Measurement 1). Then the vertical jump test was repeated and the level of the intensity of pain was measured (with the VAS – visual-analogue scale for the estimation of pain) after 24 hours (Measurement 2); 48 hours (Measurement 3); 72 hours (Measurement 4); and 96 hours (Measurement 5). The persons in the KT study groups had the KT applied about two hours after the training, and the women from Group 1 and 2 kept on the KT applied on the first day for five days.

Kinesiotaping intervention

The kinesiotaping application was situated on the front surface of thigh. The relaxing application had a shape of the capital letter "I", with ends cut for the purpose of avoiding the knee-cap. It was stuck down from the final attachment to the first one. The examined person lay on her back on the couch with one leg straight and one leg bent. The tape was stuck onto the bent limb without stretching from the tuberosity of the tibial bone around the knee-cap. Then the leg was straightened for the purpose of distancing the attachments and further tape was stuck without stretching to the anterior inferior iliac spine (Figure 1). The lymphatic application had a shape of a "double fan". The examined person lay on her back with straight legs. The base was stuck to the region of the inguinal lymph nodes, while the tails of the tape were wound around the thigh towards the caudal paracentric and caudal side. The whole application was stuck to the skin without stretching (Figure 1) [18].

A B

Figure 1. KT applications – and lymphatic (A), relaxing (B)

Statistics methods

Statistical analyses were conducted using Statistica version 12. The scores were statistically analysed. Normality of distribution was determined by Shapiro-Wilk test. Changes in VAS scores and vertical jump test results were examined using the Friedman's ANOVA test with post-hoc testing via Fisher's least significance difference. Between-group differences were assessed using the Mann-Whitney U test. Statistical significance was set for all statistical procedures at p ≤0.05.

RESULTS

In all of the groups, the greatest regress of the vertical jump test results was observed between the first and the second measurement – and this difference was statistically essential. The greatest progress was noted between the third and fourth measurements in the persons from Group 1. The least fall in power was noticed in the women to whom the lymphatic KT application had been applied, while the greatest fall in power occurred in the persons with the relaxing KT application (Table 2).

The highest level of pain in Groups 1 and 2 was noted in the second measurement, which was recorded 24 hours after the training; whereas in the control group, the greatest pain was recorded in the third measurement. In the studied groups, we observed a significantly lower result almost every subsequent day. On the fifth day, the level of pain complaints in the women from Group 2 was close to 0 (Table 3). In the persons from the control group a significantly higher result (2.93) was observed in the last measurement than in the women from the other study groups.

There were not observe any essential differences between the groups in the values of their pulse rates at rest and following an exertion (after the training of the lower limbs). The intensity of the effort measured with the Borg Scale was similarly rated by all of the study groups (Table 4).

Table 2. Differences between results of vertical jump tests

Groups	Before the training	24 h	48 h	72 h	96 h	p
Group 1 (KT – relaxing)	28.69 ±4.44	26.88** ±5.11	27.00 ±5.51	27.85* ±4.93	28.54* ±4.41	0.000
Group 2 (KT – lymphatic)	29.14 ±3.98	28.57*** ±3.79	28.71 ±3.85	29.00* ±3.96	29.14 ±3.98	0.004
Group 3 (Control)	28.67 ±3.45	27.14*** ±3.67	27.29 ±3.85	27.79** ±3.87	28.29* ±3.41	0.006

* p<0.05, **p<0.01, ***p<0.001 – differences between current and previous measurement

Table 3. Differences between pain level

Groups	Before the training	24 h	48 h	72 h	96 h	p
Group 1 (KT – relaxing)	2.00 ±3.24	5.92*** ±1.11	5.23 ±1.69	3.00*** ±1.53	1.23*** ±1.16	0.000
Group 2 (KT – lymphatic)	0.00	4.79*** ±1.05	3.79*** ±1.12	2.00*** ±0.96	0.29*** ±0.47	0.000
Group 3 (Control)	0.86 ±2.17	7.00*** ±0.91	7.71* ±1.32	4.86*** ±1.09	2.93*** ±1.21	0.000

* p<0.05, **p<0.01, ***p<0.001 – differences between current and previous measurement

Table 4. Heart rate measurements and Borge Scale results

Groups	Heart rate measurement before the training	Heart rate measurement after the training	Borge Scale results after the training
Group 1 (KT – relaxing)	76.00 ±13.86	143.08 ±31.88	15.62 ±1.44
Group 2 (KT – lymphatic)	76.21 ±9.74	150.86 ±12.47	15.57 ±1.51
Group 3 (Control)	75.71 ±8.62	148.14 ±17.46	15.43 ±1.16

DISCUSSION

The sports training causes a series of changes in the muscular tissue. Such as, among other things, fatigue, damages of muscle fibres, inflammable changes, pain occurring in progress of effort. So in the efficient training-process, applied charges are equally important to the competitor as the properly planned and performed exertional restitution is. Accordingly, various external impulses accelerating and increasing efficiency of restitution to full ability to work, called biological renovation, are applied [19-21].

There are practical means of pedagogical, psychological and biomedical influence used in the biological renovation. They have a very broad spectrum of activity. The most numerous and diverse group are physiotherapeutic treatments, also the new, alternative forms, like kinesiotaping. Their selection cannot be accidental. The planning and programming of the biological renovation should be individualised and well-thought-out [22-29].

Kinesiotaping is a method that has been universally practiced only for a short time. Its originator, Dr. Kenzo Kase, thought that through the use of tapes one could obtain different physiological effects. Among other things, this would include: the reduction of pain by the stimulation of the nervous system; strengthening of weakened muscles; reduction of swellings and subcutaneous haemorrhages; and a correct alignment of the joints [18, 30]. Own research proved positive effect of KT on DOMS symptoms. Boguszewski et al. [5], in the research concerned biceps brachii muscle, in thirty four healthy women, confirm the effectiveness kinesiotaping application on pain intensity after physical effort. Similar results presented Bae et al. [31, 32], Kruszyniewicz et al. [33], Lee et al. [34]. Authors suggest influence of KT applications on psychological condition.

However, research regarding the efficacy of kinesiotaping on the functioning of the motor unit has not been univocal. An experiment run by Chang, et al. [30] proved a lack of dependence between the KT application and the force of hand muscles. He applied kinesio tape onto the forearm, then checked its effectiveness by means of a dynamometer measuring the power of a hand squeeze and the subjective estimation of the feeling of the power. In spite of a lack of objective changes in the maximum power of the grasp, each participant reported an increase of the feeling of power [30]. Conversely, Halseth, et al. [35] studied the influence of tapes on the deep sensibility (bathyesthesia) of the talocrural joint. According to these authors, the tapes resulted in an improvement of the proprioception. Słupik, et al. [36] examined the influence of tapes on the bioelectric activity of the quadriceps of the thigh, where tape was applied to the muscles, and the bioelectric activity of the muscles was checked with a subcutaneous electromyogram. They observed that the bioelectric activity of the muscle increased after the first and the third day from the usage of the application, and that this higher level of activity remained up to 48 h after the removal of the tapes. They also concluded that the application of the tape did not cause any immediate effect. Therefore, applying tapes directly before physical activity has no rational explanation [36].

Up to now, kinesiotaping has been proven as a factor influencing the normalisation of muscular tension, the diminution of pain complaints and lymphedemas, and having corrective and stabilising properties for chosen structures [37-40]. However, there were no reports in the literature concerning the correspondence between the usage of the KT application and the reduction of muscle pain from exertion. Most often, massage, cryotherapy or other physiotherapy treatments have been used to treat DOMS. Research into DOMS and its prevention has been the subject of research often enough, but so far the existing results of the experiments are not unequivocal.

The present work has proven that kinesiotaping applications (especially lymphatic one) can help with the diminution of delayed-onset muscle soreness. However, one ought to remember that this research was done on a comparatively small number of persons, and the pain feelings were checked in a subjective manner. Consequently, in order to evaluate the real influence of kinesiotaping on DOMS, other studies will have to widen this research by, for example, including a group of men and finding a more objective method of rating the intensity of pain.

CONCLUSIONS

Kinesiotaping accelerated the regeneration of muscles after the subjects' maximum physical effort. Therefore, the suggestion that KT aids in exertion renovation, as a physiotherapeutic method, is well-founded. Both applications brought to light the analgesic properties of kinesiotaping, suggesting that this treatment could be used as a supplement to pain therapy. The application of lymphatic kinesiotaping proved to be the most efficient treatment in restoring the efficiency of the muscles. This could be connected to improvements in the circulation. Our results underlie the need for further research, with the participation of a more numerous study group and with the utilisation of other (more objective) investigative tools.

REFERENCES

1. Farthing JP, Chilibeck PD. The effect of eccentric and concentric training at different velocities on muscle hypertrophy. Eur J Appl Physiol 2003; 89(6): 578-586.
2. Proske U, Morgan DL. Muscle damage from eccentric exercise: mechanism, mechanical signs, adaptation and clinical application. J Physiol 2001; 537: 333-345.
3. Micklewright D. The effect of soft tissue release on delayed onset muscle soreness: A pilot study. Phys Ther Sport 2009; 10(1): 19-24.
4. Ahtiainen JP, Pakarinen A, Alen M, Kraemer WJ, Hakkinen K. Muscle hypertrophy, hormonal adaptations and strength development during strength training in strength-trained and untrained men. Eur J Appl Physiol 2003; 89: 555-563.
5. Boguszewski D, Oko B, Szkoda S, Adamczyk JG, Białoszewski D. Influence of physical activity on reduction of delayed onset muscle soreness. Cent Eur J Sport Sci Med 2015; 12(4): 83-90.
6. Best TM, Hunter R, Wilcox A, Haq F. Effectiveness of sports massage for recovery of skeletal muscle from strenuous exercise. Clin J Sport Med 2008; 18(5): 446-460.
7. Burgess TL, Lambert MI. Efficacy of cryotherapy on recovery after muscle damage training. International SportMed Journal 2010; 11(2): 258-277.
8. Scoon GSM, Hopkins WG, Mayhew S, Cotter JD. Effect of post-exercise sauna bathing on the endurance performance of competitive male runners. J Sci Med Sport 2007; 10(4): 259-262.
9. Urbaniak M, Milańczyk A, Smoter M, Zarzycki A, Mroczek D, Kawczyński A. The effect of deep tissue massage therapy on delayed onset muscle soreness of the lower extremity in karatekas – a preliminary study. J Combat Sports Martial Arts 2015; 6(1): 7-13.
10. Willems MET, Hale T, Wilkinson CS. Effects of manual massage on muscle- specific soreness and single leg jump performance after downhill treadmill walking. Medicina Sportiva 2009; 13(2): 61-66.
11. Boguszewski D, Oko B, Adamczyk JG, Białoszewski D. Evaluation of the effectiveness of kinesiotaping in reducing delayed onset muscle soreness of the biceps brachii. Biomed Hum Kinet 2016; 8: 88-94.
12. Magalhães I, Bottaro M, Freitas JR, Carmo J, Matheus JPC, Carregaro RL. Prolonged use of Kinesiotaping does not enhance functional performance and joint proprioception in healthy young males: Randomized controlled trial. Braz J Phys Ther 2016; 20(3): 213-222
13. Serra MVGB, Vieira ER, Brunt D, Goethel MF, Gonçalves M, Quemelo PRV. Kinesio Taping effects on knee extension force among soccer players. Braz J Phys Ther 2015; 19(2): 152-158.
14. Korzeniowska K, Szałek E. The pain, Farm Wspol 2010; 3: 9-14.
15. Singh A, Sakshi G, Singh SJ. Effect of plyometric training on sand versus grass on muscle soreness and selected sportspecific performance variables in hockey players. J Hum Sport Exerc 2014; 9(1): 59-67.
16. Loturco I, Abad CCC, Nakamura FY, Ramos SDP, Kobal R, Gil S, Pereira LE, Burini FHP, Roschel P, Ugrinowitsch C, Tricoli, V. Effects of far infrared rays emitting clothing on recovery after an intense plyometric exercise bout applied to elite soccer players: a randomized double-blind placebo-controlled trial. Biol Sport 2016; 33(3): 277-283.
17. Fonseca RT, Nunes RDAM, de Castro JBP, Lima VP, Silva SG, Dantas EHM, Vale RGDS. The effect of aquatic and land plyometric training on the vertical jump and delayed onset muscle soreness in brazilian soccer players. Hum Mov 2017; 18(5): 63-70. doi: 10.1515/humo-2017-0041
18. Kase K. Illustrated Kinesio Taping, Ken'l – Kai Information, Tokyo 2002.
19. Miladi I, Temfemo A, Mandengué SH, Ahmaidi S. Effect of recovery mode on exercise time to exhaustion, cardiorespiratory responses, J Strength Cond Res 2011; 25(1), 205-210.

20. Noce F, Costa VT, Szmuchrowski LA, Soares DS, Tulio de Mello M. Psychological indicators of overtraining in high level judo athletes in pre- and post-competition periods. Arch Budo 2014; 10: 245-251.
21. Sawczyn S, Jagiello W, Fetisov VI, Mishchenko VS. Dependence of work capacity recovery after strenuous training sessions upon individual predisposition of skilled wrestlers to work under different energy modes. Arch Budo 2015; 11: 197-207
22. Adamczyk JG, Krasowska I, Boguszewski D, Reaburn P. The use of thermal imaging to assess the effectiveness of ice massage and cold-water immersion as methods for supporting post-exercise recovery. J Ther Biol 2016; 60: 20-25.
23. Boguszewski D, Kwapisz E. Sports massage and local cryotherapy as a way to reduce negative effects of rapid weight loss among kickboxing contestants. Arch Budo 2010; 6(1): 45-49
24. Santosi OC, Brito CJ, Juniori EAP, Valido CN, Mendes EL, Nunes MAP. Cryotherapy post-training reduces muscle damage markers in jiu-jitsu fighters. J Hum Sport Exerc 2012; 3(7): 630-638
25. Han JH, Kim MJ, Yang HJ, Lee YJ, Sung YH. Effects of therapeutic massage on gait and pain after delayed onset muscle soreness. J Exerc Rehabil 2014; 10(2): 136-140.
26. Imitiyaz S, Vequar Z, Shareef MY. To compare effect of vibration therapy and massage in prevention of delayed onset muscle soreness (DOMS). J Clin Diagn Res 2014; 8(1): 133-136.
27. Zwolińska J, Weres A, Kwolek A, Furgał W. Assessment of the effectiveness of low-level laser therapy (LLLT) – and high intensity laser therapy (HILT) to reduce the symptoms of muscle fatigue – a comparative analysis. Polish J Sport Med 2014; 30(3): 157-167
28. Kalron A, Bar-Sela S. A systematic review of the effectiveness of Kinesio Taping® – fact or fashion? Eur J Phys Rehab Med 2013; 49(5): 699-709.
29. Pearcey GE, Bradbury-Squires DJ, Kawamoto JE, Drinkwater EJ, Behm DG, Button DC. Foam rolling for delayed-onset muscle soreness and recovery of dynamic performance measures. J Athl Train 2015; 50(1): 5-13.
30. 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): 122-127.
31. Bae SH, Lee YS, Kim GD, Kim KY. Quantitative Evaluation of Delayed Onset Muscular Soreness According to Application of Kinesio Taping. Adv Sci Tech Lett 2014; 47: 387-390.
32. Bae SH, Lee YS, Kim GD, Kim KY, The Effects of Kinesio-Taping applied to Delayed Onset Muscle Soreness on changes in pain. Int J BioSci Biotechnol 2014; 3: 133-142.
33. Kruszyniewicz J, Skonieczna-Żydecka K, Sroka R, Adler G. The Analgesic Efficacy of Kinesiology Taping in Delayed Onset Muscle Soreness (DOMS). Cent Eur J Sport Sci Med 2016; 13(1): 73-79.
34. Lee SY, Bae SH, Hwang JA, Kim KY. The effects of kinesio taping on architecture, strength and pain of muscles in delayed onset muscle soreness of biceps brachii. J Phys Ther Sci 2015; 27(2): 457-459.
35. Halseth T, McChesney JW, Debeliso M, Vaughn R, Lien J. The effects of kinesio™ taping on proprioception at the ankle. J Sport Sci Med 2004; 3(1): 1-7.
36. Słupik A, Dwornik M, Białoszewski D, Zych E. Effect of Kinesio Taping on bioelectrical activity of vastus medialis muscle. Preliminary report. Ortop Traum Rehab 2007; 9(6): 644-651.
37. Boguszewski D, Tomaszewska I, Adamczyk JG, Białoszewski D. Evaluation of effectiveness of Kinesiology Taping as an adjunct to rehabilitation following anterior cruciate ligament reconstruction. Preliminary report. Ortop Traum Rehab 2013; 15(5): 469-478. doi: 10.5604/15093492.1084361
38. Castro-Sanchez A, Lara-Palomo I, Mataran-Penarrocha G, Fernandez-Sanchez M, Sanchez-Labraca N, Arroyo-Morales M. Kinesio Taping reduces disability and pain slightly in non-specific low back pain: a randomized trial. J Physiother 2012; 58(2): 89-95.
39. Simsek TT, Turkucuoglu B, Cokal N, Ustunbas G, Simsek IE. The effects of Kinesiotaping on sitting posture, functional independence and gross motor function in children with cerebral palsy. Disabil Rehabil 2011; 33(21-22): 2058-2063.
40. Vercelli S, Sartorio F, Foti C, Colletto L, Virton D, Ronconi G. Immediate effects of Kinesiotaping on quadriceps muscle strength: a single-blind, placebo-controlled crossover trial. Clin J Sport Med 2012; 22(4): 319-326.