THE EFFECT OF KINESIO TAPING ON THE RESULT IN THE STANDING LONG JUMP

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ABSTRACT

This paper draws attention to a short-term experiment that aims to elucidate the effect of kinesio taping of the musculus triceps surae on performance in the standing long jump. We therefore dealt with an area that has not yet been sufficiently explored. For this reason, our aim was to determine and evaluate the effect of the application of kinesio taping on muscle strength in the standing long jump and to make a comparison with the results without the use of kinesio taping. The musculus triceps surae was selected for testing. Thus, we assume that the application of facilitation kinesio taping to the musculus triceps surae will influence the probands' performance in the standing long jump. The experiment was performed with a group of n=20 young probands, athletes aged 16.25 (± 0.76), without prior injury. In this context, we realise that we cannot generalise the results to cover the entire population, especially to injured individuals or after an accident.

Keywords: fitness preparation; kinesio taping; standing long jump; testing

Introduction

The effects of kinesio taping have long been the subject of research by various scientific teams. In order to determine the effect of kinesio taping on the result in a standing long jump motor test, it was necessary to study the theoretical background related to our research topic. For the sake of clarity, the theoretical background section presents selected studies that are related to the issues we deal with. To begin with, we would like to say that the most commonly mentioned effects of kinesio taping are increased muscle strength, improved blood and lymph flow, alleviated pain, increased joint movement, faster scar healing, reduced tone in hypertonic muscles and possibly the correction of poor posture, as stated in Kase et al. (2003) and Lee et al. (2012).

The effects of kinesio taping on a selected physical activity can be divided into four categories in scientific literature. In the first category, we would like to draw attention to effects on muscle strength, where Huang et al. (2011) tested whether kinesio taping and traditional taping applied to the musculus triceps surae had an effect on jump height. They simultaneously monitored the EMG of selected muscles. The results of the studies showed that kinesio taping applied to the calf muscle had an effect on the activity of the musculus gastrocnemius pars medialis, which was increased by kinesio taping, but had no effect on jump height. On the other hand, traditional taping did not influence the involvement of the muscles, decreasing jump height slightly. Another interesting testing was conducted by Mostert-Wentzel et al. (2012), who studied whether kinesio taping

had an effect on the explosive muscular strength of the musculus gluteus maximus in the vertical jump. The monitored set consisted of 60 young healthy athletes who were divided into two groups. A “Y” kinesio tape, recommended by the Kinesio Taping Association International (https://kinesio-taping.com/), was applied to group A, consisting of 30 people. An “I” placebo tape without stretching was applied to group B, consisting of 30 people. The results were compared without kinesio taping, immediately after application and after 30 minutes. The results showed that there was an improvement in both groups, the same for both group A and group B. The authors mentioned as a possible problem the absence of a third group to which none of the types would be applied. The authors see the reason for the improvement in the jump in the fact that skin and skin mechanoreceptors were stimulated in roughly the same area in both cases, both in group A and in group B. Other testing of the effect of kinesio taping on the gluteus maximus et medius was conducted by Strutzenberger et al. (2013), who found that kinesio taping applied to the above muscles improved the result in a 20 meter sprint, but reduced jump height. In contrast, Fu et al. (2008), who tested 14 healthy athletes, reported that there was no change in muscle strength in the musculus quadriceps femoris and hamstrings, neither immediately after kinesio taping was applied, nor 12 hours after application. When monitoring the effect of kinesio taping on physical performance, differences between the results of the athlete and non-athlete population were found. As an example, Vithoulk et al. (2010), who studied the effects of kinesio taping in non-athlete women, can be mentioned. A group of women were subjected to research to determine whether kinesio taping has an effect on increasing the muscle strength of the musculus quadriceps femoris. Three groups were tested in this study: without any tape, with a kinesio tape and with a placebo tape. Strength was measured using a dynamometer at a maximum torque of 60° and 240°. No significant changes in muscle strength were measured in all groups in the study. Wong et al. (2012) give the same conclusions. Wong et al. (2012) tested 30 healthy probands in flexion and the extension of the knee joint with and without kinesio taping of the musculus vastus medialis. Their study also found no demonstrable results suggesting that kinesio taping increases muscle strength.

As is clear from the above studies, the results of whether kinesio taping improves muscle strength are questionable. The only measurement similar to our measurement is presented by Huang et al. (2011), who measured the effect of kinesio taping of the musculus triceps surae in the vertical standing long jump, as opposed to our study, which focused on the horizontal standing long jump.

The second category which we believe could be influenced is that of exteroreceptors. Exteroreceptors can also be referred to as skin receptors that receive stimuli from the external environment, leading them to the central nervous system through nerve pathways to be processed, evaluated and, subsequently, responded to by the motor system. Skin receptors are divided into Merkel disks, Meissner corpuscles, Ruffini corpuscles, Vater-Pacini corpuscles and thermoreceptors, see Čihák (2011). It should be noted that stimulation of skin receptors by applying kinesio taping influences afferent pathways and the subsequent motor system response. In their study, MacGregor et al. (2005) state that if a tape is applied over the patella, more motor units are activated in the musculi vasti. The effect of skin stimulation by taping was also studied by Thedon et al. (2011), who analysed the effect of a tape applied to the Achilles tendon on upright posture before and after muscle fatigue. The results in this case showed that if the muscles are tired, posture can be improved through skin stimulation.

We would like to mention another category in connection with afferent transmission from muscle, tendon and joint receptors, which provide the central nervous system with information on the condition of all body segments of the musculoskeletal system. And, as Véle (2006) states, it is possible to influence movement through the use of proprioception. However, there are not yet many studies dealing with kinesio taping and its effect on proprioception, and their results are inconsistent. Halseth et al. (2004) studied the effect of kinesio taping on ankle area proprioception in healthy individuals, and their results did not indicate an increase in proprioception if kinesio taping was used. In contrast, De La Monte et al. (2008) give positive results in their study in terms of increasing proprioception if kinesio taping was used. Kinesio taping had a greater effect on the probands in the group of unhealthy individuals than on the healthy probands.

The last category we have in mind in relation to the effect of kinesio taping on the selected movement is the influence of nociception. Pain is very important information from the organism that something is wrong, so it is very important to assess what the body wants to tell us before pain is suppressed. There are several theories of pain. According to the “gate control theory” presented by Melzack and Wall (in Véle, 2006), there are two places in the human body where pain is interpreted and where it can be alleviated. At the spinal level, where it can be suppressed by stimulating thick fibres, for example by caressing, and in the brain, where pain can be suppressed by endorphins, such as those produced by sports. An integral part of the treatment of pain is the psychological component and the so-called placebo, as Véle (2006) states. García-Muro (2009) assessed the effect of kinesio taping on pain and the range of motion in the shoulder joint. The results showed that kinesio taping supported an increase in the range of motion, but had no effect on pain. Thelen et al. (2008) confirms that kinesio taping applied to a painful shoulder joint helps to increase the painless range of joint movement immediately after application, but on the third day after application the condition of the kinesio taping group was the same as in the placebo tape group.

Objectives And Tasks Of The Study

The aim of this study was to determine and evaluate the effect of the application of kinesio taping on muscle strength in the standing long jump and to make a comparison with the results without using kinesio taping. The musculus triceps surae was selected for testing. Thus, we assume that the application of facilitation kinesio taping to the musculus triceps surae will have an effect on the probands’ performance in the standing long jump. Measurement was conducted without kinesio taping and, subsequently, after kinesio taping was applied.

Tasks Of The Study

1. Conducting research into literature and gathering theoretical materials;
2. Setting the goals of the study;
3. Choosing a study methodology;
4. Conducting measurement and data collection;
5. Data analysis;
6. Data evaluation and interpretation.

Hypothesis

Based on the study of professional literature and practical experience with athletes and with the kinesio taping method, we formulated the following hypothesis:

H1: Correct application of a kinesio tape will increase muscle performance under the point of application – musculus triceps surae, thereby improving performance in the standing long jump.

Methodology

Brief characteristics of the monitored set

Necessary data were obtained from experimental measurements in which n=20 probands participated based on an informed consent. The tested group mainly consisted of secondary school students who had long practised sports at a competitive level. None of the probands tested had any leg injuries or previous kinesio tape testing experience. It was a heterogeneous group consisting of 16 men and 4 women. The average body height was 177.6 cm (± 6.6), the average age was 16.25 years (± 0.76), and the average body weight was 66.1 kg (± 7.02). All probands signed an informed consent and underwent the testing voluntarily. None of the probands were ill or injured at the time of measurement.

All probands had to meet the following criteria:

- no acute disease;
- no disease in the calf area;
- no lower limb disease;
- no previous lower limb injury;
- no chronic or acute pain;
- no internal disease;
- no neurological disease;
- full understanding of the task;
- active sporting activity at a competitive level.

Brief description of the work procedure

Prior to the start of the experiment, all probands were advised on the course of the experiment and signed an informed consent.

Both measurements were conducted in the Liberec POWER FITNESS gym, the second taking place 14 days after the first, always under the same temperature conditions (20°C) on the UnoBAT 50 sports surface. As mentioned above, the experiment took place on two dates. In order to prevent potential lower limb injuries, the measurement itself was preceded by a 15-minute warm-up in the following form: 7-minute jogging, 7-minute dynamic stretching, 6-minute static stretching focused primarily on the lower body.

On the first date, the first measured performance was the standing long jump without kinesio taping, with three repetitions. This was followed by a 5-minute break. After completing the measurements without using kinesio taping, kinesio taping was applied to proband No. 1. After the kinesio taping application was completed, the proband immediately went to the jumping sector, where his/her performance was measured in the standing long jump in three repetitions. Measurement of the performance achieved with kinesio taping was the same as that without kinesio taping. There was a 5-minute break between the two measurements. This procedure was repeated with the second through twentieth proband. On the second date, the methodical procedure of measurement was conducted in a similar way as in the first measurement.

Measurement without kinesio taping was done first on both dates, because if we had first applied kinesio taping, motoneurons would have been stimulated under the point of application, so the resulting measured values could be misleading; in addition, removal of a kinesio tape after a short application time may be very painful and could damage the probands' skin.

The results of the measurement of the standing long jump without and with the use of kinesio taping are shown in the results section in Table 1.

Method of kinesio tape application

TEMTEX blue kinesio tape was chosen. The probands were properly instructed before the tape application itself, so the entire course of tape application was known to them in advance. Their skin was shaved and degreased before application, which we consider to be very important for measurement, especially given good adhesion and maximum tape effect. The length of the kinesio tape was measured on each proband separately, depending on the size of his/her lower limb. Two tapes were applied to each proband. The first tape, "Y", 8–10 squares long, was applied from the Achilles tendon attachment to the beginnings of the musculi gastrocnemii. The second tape, "I", 4–5 squares long, was applied from the Achilles tendon attachment cranially. The initial position of the limbs for application was knee joint extension and dorsal flexion of the ankle. The tape was applied at average tension; the 2.5 cm anchor and the 1.5 cm base zones were applied

without tension. The application procedure was consulted and recommended by the kinesio taping specialist PhDr. Iva Hnátová, Ph.D.

The measured values were recorded in units (mm), converted to metres for easier processing and rounded to two decimal places. The average was then calculated from these values. The average values were processed; the results section in Chart 1 shows the overall average and the difference of the results.

Results

At the beginning of the results section, we would like to point out that the measurement took place on two dates and that 12 values were measured for each proband on each date. Table 1 shows the average values of the standing long jump without kinesio tape application from both dates and the average values of the standing long jump after kinesio tape application from both dates. All values are given in metres and, for the sake of clarity, rounded to two decimal places. The data were processed in Microsoft Excel.

Table 1 below shows the average values of the standing long jump with and without a kinesio tape, calculated from the six attempts made by each proband. The last column indicates whether there was any change in performance after a kinesio tape was applied and whether it was positive or negative. To evaluate the substantive significance we used the Cohen´s coefficient d because of its independence from the sample size.

Table 1 *Average values of the standing long jump and difference in performance with and without a kinesio tape*

Probands	Standing long jump without KT (m)	Standing long jump with KT (m)	Difference in performance with KT (m)
P1	2.25	2.31	**0.06**
P2	2.26	2.39	**0.13**
P3	2.32	2.44	**0.12**
P4	2.14	2.18	**0.04**
P5	2.33	2.35	**0.02**
P6	2.29	2.37	**0.08**
P7	2.42	2.4	**-0.02**
P8	2.07	2.2	**0.13**
P9	2.04	2.07	**0.03**
P10	1.99	1.98	**-0.01**
P11	2.53	2.46	**-0.07**
P12	2.38	2.42	**0.04**
P13	2.2	2.21	**0.01**
P14	2.48	2.47	**-0.01**
P15	2.17	2.35	**0.18**
P16	2.45	2.47	**0.02**
P17	1.81	1.83	**0.02**
P18	1.92	1.9	**-0.02**
P19	1.76	1.83	**0.07**
P20	1.71	1.8	**0.09**
$\bar{X}$	2.176	2.221	Cohen´s d = -0.1927
σ	0.237	0.230	Effect size (r) = -0.0959

For ease of reference, Chart 1 illustrates the performance achieved in the standing long jump with a kinesio tape (KT) and in the standing long jump without a kinesio tape (KT). The comparison of values shows whether or not the application of a kinesio tape had an effect on the probands. It can be seen at first glance from Chart 1 that the effect of kinesio taping on probands may be different. In general, the effect of kinesio taping on performance in the standing long jump was positive. There was an average increase in performance by 5 cm. Therefore, it can be stated that the hypothesis was confirmed. However, if we look at the results of the individual probands, they are very different. Five probands displayed deterioration in performance. The greatest deterioration occurred in proband No. 11, namely by 7 cm. The smallest improvement was achieved by proband No. 13, who improved by 1 cm. The greatest improvement was achieved by proband No. 15, who improved by 18 cm.

Since the results of the pilot study were positive, we can admit that kinesio taping may also have an effect on muscle strength and, therefore, contradict the studies (Fu et al., 2008; Janwantanakul, 2007; Vithoulk et al., 2010; and Wong et al., 2012) which indicate that kinesio taping has no effect on muscle strength. On the other side we have to mention small effect of kinesio taping. Cohen coefficient d is *d= -0.1927.*

If we look at the results of the individual probands, there are significant differences. We must take into account the fact that all probands are athletes in different sports. Every type of sport places great physical demands on athletes, and although compensatory exercises now form an important element, all athletes are specifically focused and trained to achieve the best results in their discipline; therefore, for example, swimmers cannot be expected to have high explosive strength of lower limbs. We must also take into account that every sport has a competition season in a different part of the year so physical fitness may vary throughout the year. Another factor that may influence athletes' performance is physical fatigue after training units or races. The probands could also have been influenced by fatigue from a large number of attempts, but due to the accuracy of the experiment, we decided not to reduce the number of attempts. A large number of attempts could have influenced the acquisition of a better form, which is also a very important factor in this experiment.

What we see as a drawback of the experiment is the fact that only attempts without a kinesio tape and with an applied kinesio tape were measured. There were no attempts in which a placebo tape was applied, which could clarify the question whether kinesio taping influences humans only mentally, not physiologically. A placebo tape has been applied in a large number of studies, so if it had been applied to my probands, the results could be compared.

The biggest drawback of this study is, unfortunately, the absence of the application of EMG to the relevant muscles to support the results obtained in this study. The EMG study thus prepared could then be compared with the results presented by Slupnik (2007), Murray (2000), as well as Huang et al. (2011), who applied EMG directly to the triceps surae.

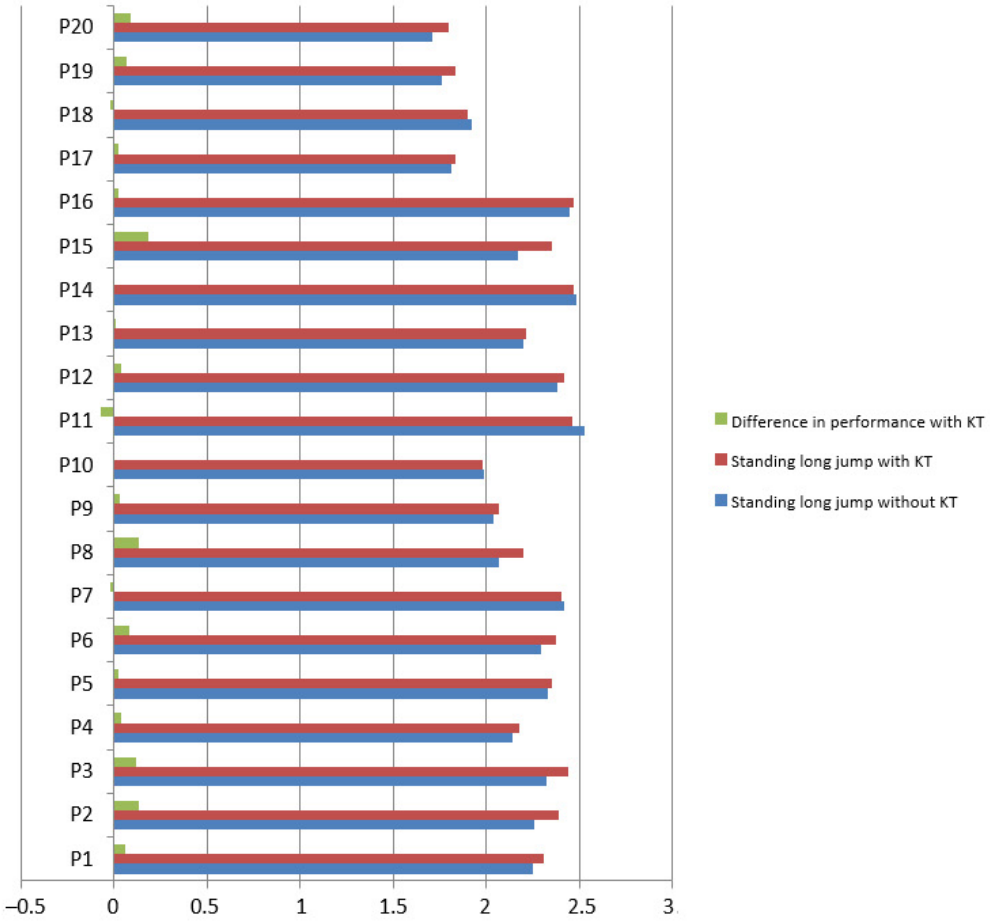

Figure 1 *Average values of the standing long jump and the difference in performance with and without a kinesio tape*

Discussion

In this study we assessed an influence of a kinesiology tape on musculus triceps surea on a standing long jump. The goal of this study was to evaluate an influence on a performance increase. Many foreign authors have dealt with similar topic, for example Huang et al. (2011), Vithoulk et al. (2010), Wong et al. (2012) and more. Based on the results of our experiment, we can say, that there is a positive effect of the kinesiology tape on standing long jump. We are aware of the size of the experimental group and we know very well we need a larger group of athletes to confirm the result.

There are many questions coming along the results. For example if the results of standing long jump improved due to increased muscle strength or if the tape helped to “harmonize” the tissues underneath it and actually activated the muscle and tissue functions physiologically. Functionality of muscle tissues is usually limited among athletes due the overwork hence the tissues cannot reach the maximal performance. We must also consider a variety of changes in a level of engagement of musculus triceps surae and its increasing effectivity on functionality of the particular muscle. Tape can also affect the timing of the musculus triceps surae in muscle chain that might play its role in the results. Different ways of influence bring changes in timing of muscle engagement. The muscles might also work in wrong stereotype patterns for example due to a unilaterality of a sport or the muscles could be in a hypertonia because of an abnormal training work and lack of regeneration.

We did not use a placebo tape in this experiment as was used in a study of Moster-Wentzel et al. (2012), when they applied a tape without a tension. We assume an increase of the performance within that group too due to fluid dynamic changes, eventually stimulation of skin receptors. We can also consider, although not probable, an effect of a mechanostransduction.

Conclusion

The aim of this paper was to point out the kinesio taping method using literature research and to experimentally verify its effect on muscle strength. There are still very few theoretical materials in the Czech Republic, so we have drawn from foreign literature, mainly from articles on the scientific portals available. We must state that some authors present a positive effect of kinesio taping on athletes' performance, but some negative. There are a large number of articles that ascribe great influence mainly to psychological effects. The most important part of the study is an experiment that was to explain whether or not kinesio taping has an effect on muscle strength. We must state that, unfortunately, no placebo tape was applied that would help to eliminate thoughts about the psychological effects of kinesio taping, which remains a question. In our opinion, the goal of the experiment was achieved. The selected group of probands showed an effect of kinesio taping on performance in the standing long jump. The question is whether, given the number of n=20 probands and a certain number of repetitions of jumps, the results of the field experiment can be considered significant. We used Cohen´s coefficient d for the quantification of effect size. This coefficient d *(d= -0.1927)* shows small effect.

In the next phase of the study, it would be very beneficial to apply EMG to the musculus triceps surae in order to monitor muscle involvement. We also see another necessary extension of the study in the application of a placebo tape to eliminate the psychological effects of KT.

References

Čihák, R. *Anatomie I.* Třetí, upravené a doplněné vydání. Praha: Grada, 2011. 552 p. ISBN 978-80-247-3817-8.

Fu, T., Wong, A., Pei, Y., Wu, K., Chou, S., Lin, Y*. Effect of Kinesio taping on muscle strength in athletes – A pilot study.* Journal of Science and Medicine in Sport, 2008. Volume 11, pp. 198–201. Available at http://liguria.aifi.net/files/2013/05/Effect-of-Kinesio-taping-on-muscle-strength.pdf. Retrieved 1 September 2013.

García-Muro, F., Rodríguez, A., Herrero-De-Lucas, A. *Treatment of myofascial pain in the shoulder with Kinesio taping. A case report.* Manual Therapy, 2009. Available at http://www.theratape.com/education-center/wp-content/uploads/2012/11/kinesio-study-myofascial-shoulder-pain.pdf. Retrieved 15 October 2013.

Halseth, T., Mcchesney, J., Debeliso, M., Vaughn, R., Lien, J. *The effects of kinesio taping on proprioception at the ankle.* Journal of Sports Science and Medicine, 2004. Volume 3, pp. 1–7. Available at http://www.jssm.org/vol3/n1/1/v3n1-1pdf.pdf. Retrieved 20 October 2013.

Hnátová, I. Oral communication, MOTUS Kinesiology Taping course. 13–14 April 2013.

Huang, Ch., Hsieh, T., Lu, S., Su, F. *Effect of the Kinesio tape to muscle activity and vertical jump performance in healthy inactive people*. BioMedical Engineering OnLine, 2011. Available at http://www.biomedical-engineering-online.com/content/10/1/70. Retrieved 4 September 2013.

Janwantanakul, P., Gaogasigam, CH. *Vastus lateralis and vastus medialis obliquus muscle activity during the application of inhibition and facilitation taping techniques.* Clinical Rehabilitation, 2005. Volume 19, pp. 12–19. Available at http://www.taping.hk/img/12.pdf. Retrieved 5 September 2013.

Kase, K., Wallis, J., Kase, T. *Clinical therapeutic applications of the kinesio taping method.* Tokyo: Ken Ikai Co. Ltd, 2003. 348 p. ISBN 978-1-528725-68-2.

Lee, Y., Chang, H., Chang, Y., Chen, J. *The effect of applied direction of kinesio taping in ankle muscle strength and flexibility*. 30th Annual Conference of Biomechanics in Sports, Melbourne, 2012. Available at https://ojs.ub.uni-konstanz.de/cpa/article/view/5232/4807. Retrieved 5 September 2013.

Macgregor, K., Gerlach, S., Mellor, R., Hodges, P. *Cutaneous stimulation from patella tape causes a differential increase in vasti muscle activity in people with patellofemoral pain.* Journal of Orthopaedic Research*, 2005.* Available at http://www.nutrifisio.com.br/documentos/cutaneous_stimulation_from_patella_tape_causes_a_differential57150.pdf. Retrieved 15 October 2013.

Mostert-Wentzel, K., Swart, J., Masenyetse, L., Sihlali, B., Cilliers, R., Clarke, L., Maritz, J., Prinsloo, E., Steenkamp., L*. Effect of kinesio taping on explosive muscle power of gluteus maximus of male athletes.* South African Journal of Sports Medicine, 2012. Volume 24, Number 3, pp. 75–80. Available at http://www.sajsm.org.za/index.php/sajsm/article/view/261. Retrieved 9 September 2013.

Murray, H. *Kinesio taping, muscle strength and ROM after ACL repair.* Journal of Orthopedic and Sports Physical Therapy, 2000. Available at http://www.theratape.com/education-center/wp-content/uploads/2012/10/Kinesio-Study-ACL-Repair.pdf. Retrieved 15 September 2013.

Nagano, A., Komura, T., Fukashiro, S. *Optimal coordination of maximal-effort horizontal and vertical jump motions – a computer simulation study*. BioMedical Engineering OnLine, 2007, Available at http://www.biomedical-engineering-online.com/content/6/1/20. Retrieved 14 September 2013.

Słupnik, A., Dwornik, M., Białoszewski, D., Zych, E. *Effect of Kinesio Taping on bioelectrical activity of vastus medialis muscle. Preliminary report.* Medsportpress, 2007. Volume 9, Issue 5, pp. 644–661. Available at http://www.indexcopernicus.com/. Retrieved 6 September 2013.

Strutzenberger, G., Moore, J., Griffiths, H., Schwameder, H., Irwin, G. *Effects of kinesio-taping on performance with respect to fatigue in rugby players: A pilot study.* 31st Conference of the International Society of Biomechanics in Sport. Taiwan, 2013. Available at https://ojs.ub.uni-konstanz.de/cpa/article/view/5598/5092. Retrieved 19 September 2013.

Thedon, T., Mandrick, K., Foissac, M., Mottet, D., Perrey, S. *Degraded postural performance after muscle fatigue can be compensated by skin stimulation.* Gait & Posture, 2011. Available at http://www.m2h.euromov.eu/documents/publications/publication_304.pdf. Retrieved 25 October 2013.

Thelen, M., Dauber, J., Stoneman, P. *The clinical efficacy of kinesio tape for shoulder pain*. Journal of Orthopaedic & Sports Physical Therapy, 2008. Available at http://www.jospt.org/doi/pdf/10.2519/jospt.2008.2791. Retrieved 11 October 2013.

Véle, F. *Kineziologie: přehled klinické kineziologie a patokineziologie pro diagnostiku a terapii poruch pohybové soustavy.* 2. rozšířené a přepracované vydání. Praha: Triton, 2006. ISBN: 80–7254–837–9. 375 p.

Vithoulk, I., Beneka, A., Malliou, P., Aggelousis, N., Karatsolis, K., Diamantopoulos, K. *The effects of kinesio taping on quadriceps strength during isokinetic exercise in healthy non-athlete women.* Isokinetics and Exercise Science, 2010. Volume 18, pp. 1–6. Available at http://www.doktorus.com/articles/Kinesio/Article%20Isokinetic%20Vithoulka%20Diamantopoulos%202010.pdf. Retrieved 18 September 2013.

Wong, O., Cheung, R., Raymond, C. *Isokinetic knee function in healthy subjects with and without Kinesio taping.* Physical Therapy in Sport, 2012. Volume 13, pp. 255–258. Available at http://www.levotape.co.uk/Uploads/Documents/Isokinetic%20Knee%20Function_Kinesio%20Tape_Wong2012.pdf. Retrieved 12 September 2013.