Research Paper Education

The Effect of Taping Applied in the Direction of Underlying Muscle Fibres on the Activity of this Muscle

Martina Vrbová Charles University in Prague, Faculty of Physical Education and Sport, Department of Physiotherapy,

Dagmar Pavlů Charles University in Prague, Faculty of Physical Education and Sport, Department of Physiotherapy,

ABSTRACT

The effect of taping was monitored in a clinical study of 20 intentionally selected healthy subjects. The effect of elastic tape applied in the direction of muscle fibres in two various ways (with tension from the beginning of the muscle to its attachment and vice versa) was evaluated compared to the situation without tape, in terms of the level of initial muscle activity and the onset of muscle fatigue during three-minute 30 % MVC isometric contraction measured using the median EMG signal frequency. The evaluated muscle was the biceps brachii on the non-dominant arm. Results were tested from the perspective of both material and statistical significance. Results proved neither a statistically nor a practically significant effect for either of the two tested tape application methods on initial muscle activation and muscle fatigue onset.

KEYWORDS taping, muscle activity, surface electromyography, biceps brachii

INTRODUCTION

Taping, the application of tape to the skin for preventive or therapeutic purposes, enjoyed increasing popularity and use in clinical rehabilitative practice and in performance sports. Despite this, the efficacy of taping has not yet been objectively proven to a sufficient extent. High-quality clinical studies providing a greater degree of proof from the perspective of currently required evidence-based medicine (physiotherapy) provide conclusions indicating that the only statistically significant effect of taping is on pain. Only a few articles of lesser methodological quality have addressed the effect of taping on muscle activity, with inconsistent results. These results indicate that taping may affect muscle activation immediately after application [4, 7, 15], though the greatest effect is probably not achieved until up to 24 hours after application [12]. With respect to the material used, study results indicate that under motionless conditions (i.e. isometric muscle contraction) or during medium-range joint range movement in the given segment, there is no difference between the use of non-elastic or elastic material on selected aspects of muscle activity [1]. Conclusions regarding the effect of tape application relative to the direction of the fibres of the underlying muscle (parallel or transverse) and the direction of tape tension on the activity of this muscle have been inconsistent so far. This clinical study focuses on testing the currently most frequent use of taping, i.e. the application of flexible kinesiology tape parallel to the fibres of the underlying muscle, either from the attachment to the beginning of this muscle, with therapeutic tension applied from the beginning to the attachment (with an ostensible inhibitory effect on the given muscle), or vice versa, with an assumed facilitating effect on the given muscle, as described by concepts using kinesiology taping materials such as Kinesio Taping®, Medi-taping®, K-Taping®, K-Active taping® and others.

METHODOLOGY

The research set consisted of 20 intentionally selected healthy subjects (8 women and 12 men, ages 21-40, average age 29.2) with regular physical activity at the level of recreational sports. The selected individuals must not have had any past injuries in the area of the arms and cervical spine, nor have experienced any movement-related pain in the past year. The research was approved by the ethics committee of the Faculty of Physical Education and Sports of Charles University on 18 April 2014 under reference no. 128/2014. The evaluated muscle was the biceps brachii on the non-dominant arm.

Tape made with flexible kinesiology material (BB Tape, Altermed Co., Ldt, Korea) was applied in the form of a simple "I" tape 5 cm in width along the long head of the biceps brachii from the elbow pit to the acromion (Tape1, with expected inhibitory effect) or from the acromion to the elbow pit (Tape2, with an expected facilitative effect) with 25 % stretching always immediately prior to measurement and immediate removal afterwards. Tape length was adjusted individually based on prior anthropological measurement.



Figure 1: Application of Tape 1 (A) and Tape 2 (B); the red arrow indicates the direction of tape application, the blue arrow the resultant therapeutic tension

First, the maximum voluntary contraction (MVC) was determined individually based on three maximum voluntary contractions against manual resistance with a 30-second pause between individual contractions. Each subject then absolved three measurements of isometric biceps brachii contractions at 30 % MVC, maintained using visual biofeedback, first without tape and then with Tape 1 and Tape 2 (the same tape application order was used for all test subjects). Measurements were performed in a corrected sitting position without back support, with the non-dominant arm at 90° ventral flexion in the shoulder joint, 90° flexion in the elbow joint, and with the forearm in supination. The position was fixed by supporting the elbow and propping the distal part of the forearm against

a special vertically adjustable bar (see Figure 2a, b). A 30-minute pause was taken between individual measurements for regeneration.



Figure 2: Initial position for measurement

The Tele Myomini 16 from Neurodata was used for surface electromyography. Two disposable stick-on Ag/AgCl electrodes coated with conductive gel, with an adhesive surface diameter of 3.8 cm and conductive surface diameter of 1 cm, were applied to the skin above the biceps brachii in its distal and medial part, always at least 5 minutes prior to the start of measurement. Inter-electrode distance was 2 cm. A reference electrode was placed on the spinous process of vertebra C7. The band-pass filtering frequency range for the measurement was 5-500 Hz, and the sampling frequency was 1500 Hz.

Records of individual measurements were subjected to frequency analysis using MyoResearch XP Master Edition 1.06 software from Noraxon Inc. USA. The median frequency was chosen as the monitored frequency characteristic. Changes in the frequency of the electromyographic signal during a three-minute recording were evaluated using regression analysis for a linear fit.

The following parameters for evaluating changes in the median frequency were chosen:

1. The constant term of the straight-line approximation for a straight line along which median frequency values are interspersed during a three-minute isometric contraction, the "Intercept" *(q)* (in Hz), designating the point where the regression line of the median frequency decline during the monitored three-minute interval intersects the Y axis. The greater its value, the greater initial activity of the monitored muscle (evaluated by the median frequency of the MG signal).
2. The linear term of the straight-line approximation for a straight line along which median frequency values are interspersed during a three-minute isometric contraction, the "Slope" *(k)*, in units of Hz/10 s, which indicates the magnitude of the average decline in EMG median frequency of the biceps brachii during its three-minute isometric contraction, thus the magnitude of metabolic fatigue, where external performance has not yet declined, but we can already see changes in the frequency signal of the EMG signal due to biochemical and metabolic changes in the monitored muscle. Due to the fact that the median value of the EMG signal declines during muscle activity as muscle fatigue progresses, *(k)* always takes on negative values. The greater the absolute value of *(k)*, the greater the mean decline in median frequency during the period.

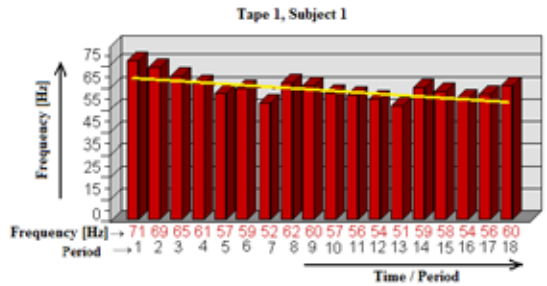

Figure 3: Example of initial data for one measurement along with the regression line

The difference between these parameters was monitored for measurement without tape always compared with a measurement using one of the two aforementioned tape application methods.

The data was further tested from the perspective of practical and statistical significance. Practical significance was stipulated based on the value of the effect size coefficient, specifically Cohen's *d*. IgorPro 6 software was used to test statistical significance. First, Levene's test was used to assess the homogeneity of variances. Its results did not indicate significant differences in homogenity in any of the test cases. The Shapiro-Wilk W test was then used to determine data normality and its distribution. The test confirmed normal data distribution. The above findings justify the use of parametric tests. The T-test was chosen for this purpose. For T-test calculations, the value of *r* was used, defined as the ratio of the intercept *(q)* or slope *(k)*obtained from measurements performed with Tape 1 or Tape 2 to their respective values obtained in measurements without tape.

For the T-test, null hypothesis H0 was stipulated, which assumes that the mean value of *r* does not vary from a value of 1 when using Tape 1 or Tape 2. The level of statistical significance was set to 0.05.

RESULTS

Nineteen test subjects were included in the final assessment (8 women and 11 men, ages 21-40, average age 29). One test subject's data was excluded from the assessment because median frequency values at the end of measurement with Tape 1 were greater than the initial frequency.

Table 1 show specific values of the Intercept parameter *(q)*, indicating initial muscle activity, and the Slope parameter *(k)*, indicating the rapidity of muscle fatigue onset, for measurements with Tape 1 and Tape 2 compared to no tape, along with calculated material and statistical significance values. Figures 4 and 5 show graphs of *q* and *k* parameter distribution values from measurements of all test subjects for no tape and with Tape 1 and 2.

Results did not confirm practical significance or statistical significance for the ability of Tape 1 or Tape 2 to affect the values of the Intercept (*q*) and Slope (*k*) parameters in any way, thus to change initial muscle activity or onset of muscle fatigue.

Weighted variance*	0,08	0,06	0,27	0,39
Weighted average*	1,00	0,99	0,83	0,91
Standard deviation	0,06	0,06	0,12	0,14
Cohen´s *d*	0,26	0,14	0,34	0,41

t (T-test)	0,76	0,41	1,02	1,23
T-test critical value p_{crit} [%]	45	69	32	24

Table 1: Resultant values for Intercept q and Slope k values and their related material and statistical significance values (the weight for weighted values is)

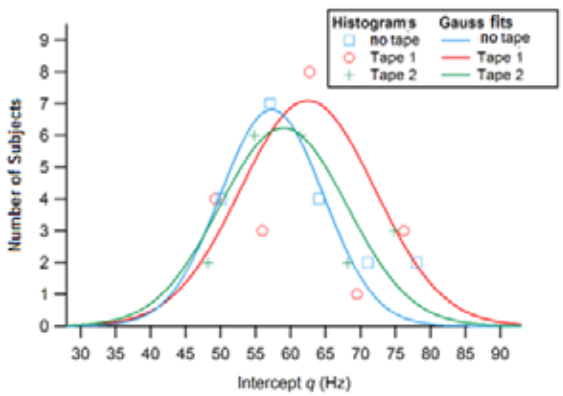

Figure 4: A graph of q value distribution from measurement of all test subjects for no tape and Tape 1 and 2

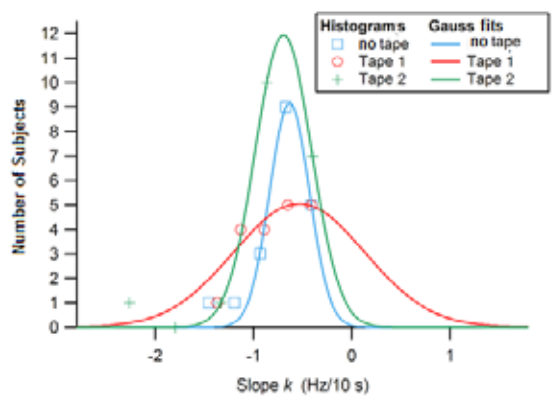

Figure 5: A graph of k value distribution from measurement of all test subjects for no tape and Tape 1 and 2

LIMITATIONS

The obtained results indicating the effect of flexible tape applied along muscle fibres immediately after its application on the activity of the underlying muscle during isometric muscle contraction are applicable to healthy individuals of both sexes from the normal population participating in recreational sports aged 21-40.

DISCUSSION

Results do not confirm facilitative or inhibitive effects of taping on muscle activity depending on tape tension direction from attachment to the start of the underlying muscle or vice versa that are described in methodological recommendations for the application of kinesiology tape.

Although it is possible to find high-quality studies confirming the clinically significant effect of tape on pain or improvement of muscle strength or other movement system functions evaluated using a comprehensive functional test [5, 8, 13] that do not evaluate the effect of applied tape on the activity level of one specific muscle, in the case of studies focusing directly on muscle activity, results are inconsistent and like in the case of this clinical study, not always support the claims of methodological recommendations of individual concepts for kinesiology tape application regarding the facilitative or inhibitive effects of tape depending on tape tension direction [4, 7, 15].

Direct evaluation of the effect of taping on muscle activity (e.g. using EMG) can be affected by the interconnectedness of the individual components of the sensory-motor system, as there are numerous compensation mechanisms that include the afferent and efferent pathways as well as higher central nervous system activity [10]. Though tape-induced local afferent or mechanical changes will very likely elicit a response in the sensory-motor system, this response is comprehensive, and individual components may participate to different degrees [14], which could also be the case for muscle activity. For this reason, identically applied tape need not always elicit the same change in muscle activity in various individuals.

The clinical study's methodology was based on the study by Rainoldi et al. (1999), which investigated the reliability of repeated continuous contractions of the biceps brachii of 30-second duration and 10 %, 30 %, 50 %, and 70 % of MVC intensity, 3x in a row, with a 5-minute pause. The same measurement was repeated 3 days later. The change in the frequency spectrum of the EMG signal was evaluated using its mean value. The study confirmed the reliability of measurement using an interclass correlation coefficient as sufficiently reliable for repeated measurements for the same test subject even when measured on various days, for lower isometric contraction intensities (i.e. 10 % and 30 % MVC). In this clinical, as opposed to Rainoldi et al. (1999), we used the frequency median to monitor spectral changes in the EMG signal, as according to Roy and De Luca (1989) it is less susceptible to noise and more sensitive to biochemical and physiological changes. The duration of repeated measurements was also increased to 3 minutes, and the corresponding regeneration pause between individual measurements was increased as recommended by Bernard (2006) to 30 minutes.

From the perspective of the taping method itself, the choice of isometric contractions may have a certain disadvantage due to the reduced ability to apply the tape material's mechanical effect compared to a dynamic situation. In the case of isometric contraction, the effect is more neurophysiological, as far as mechanical effects are concerned, kinesiology tape can primarily elicit decompression of the interstitial space [6] and trophotropic effects [2].

CONCLUSION

Given the constantly growing popularity and use of taping, one should be careful in expressing and considering the facilitative or inhibitive effect of taping on muscle activity depending on tape tension direction as has been stated up to now, as this notion regarding the effect of taping may not be entirely accurate.

IMPLICATIONS

The results of this clinical study may be beneficial both from the perspective of use of taping in clinical, sports, and normal daily practice, as well as for further research focused on this method.

REFERENCES

[1]Aytar, A., Ozunlu, N., Surenkok, O., Baltacı, G., Oztop, P., & Karatas, M. (2011). Initial effects of kinesio® taping in patients with patellofemoral pain syndrome: A randomized, double-blind study. Isokinetics and Exercise Science, 19(2), 135. [2]Bell, A., & Muller, M. (2013). Effects of kinesio tape to reduce hand edema in acute stroke. Topics in stroke rehabilitation, 20(3), 283-288. [3]Bernard, T. E. (2006). Design of Static Muscle Work, University of South Florida,College of Public Health, Web site: http://personal.health.usf.edu/ tbernard/HollowHills/SMWDesignM20.pdf [4]Fratocchi, G., Di Mattia, F., Rossi, R., Mangone, M., Santilli, V., & Paoloni, M. (2013). Influence of Kinesio Taping applied over biceps brachii on isokinetic elbow peak torque. A placebo controlled study in a population of young healthy subjects. Journal of Science and Medicine in Sport, 16(3), 245-249. [5]GonzáLez-Iglesias, J., Fernández-de-Las-Peñas, C., Cleland, J., Huijbregts, P., & Gutiérrez-Vega, M. D. R. (2009). Short-term effects of cervical kinesio taping on pain and cervical range of motion in patients with acute whiplash injury: a randomized clinical trial. Journal of Orthopaedic & Sports Physical Therapy, 39(7), 515-521. [6]Kase, K. (2005). Examination and Consideration of the Effects of the Stretch Rate of Kinesio Taping on the Skin: Second Report, Japan: Kinesio® Symposium 20, website: http://www.kinesiotaping.com/images/kinesio-association/pdf/research/2005-6.pdf [7]Oh, D. W. (2013). Activities of Upper Limb Muscles Related to the Direction of Elastic Tape Application in Healthy Adults: A Randomized Trial of Parallel-Aligned Versus Cross-Aligned Tape Application. Phys Ther Kor, 20(4), 9-15. doi:10.12674/ptk.2013.20.4.009 [8]Paoloni, M., Bernetti, A., Fratocchi, G., Mangone, M., Parrinello, L., Del Pilar Cooper, M. & Santilli, V. (2011). Kinesio Taping applied to lumbar muscles influences clinical and electromyographic characteristics in chronic low back pain patients. Eur J Phys Rehabil Med, 47(2), 237-244. [9]Rainoldi, A., Galardi, G., Maderna, L., Comi, G., Conte, L. L., & Merletti, R. (1999). Repeatability of surface EMG variables during voluntary isometric contractions of the biceps brachii muscle. Journal of Electromyography and Kinesiology, 9(2), 105-119. [10]Riemann, B. L., Myers, J. B., & Lephart, S. M. (2002). Sensorimotor system measurement techniques. Journal of athletic training, 37(1), 85. [11]Roy, S. H., & De Luca, C. J. (1989). Evolving characteristics of the median frequency of the EMG signal. Computer-aided electromyography and expert systems. Holland: Elsevier, 115-24. [12]Słupik, A., Dwornik, M., Białoszewski, D., & Zych, E. (2006). Effect of Kinesio Taping on bioelectrical activity of vastus medialis muscle. Preliminary report. Ortopedia, traumatologia, rehabilitacja, 9(6), 644-651. [13]van de Water, A. T., & Speksnijder, C. M. (2010). Efficacy of taping for the treatment of plantar fasciosis: a systematic review of controlled trials. Journal of the American Podiatric Medical Association, 100(1), 41-51. [14]Van der Esch, M., Steultjens, M., Harlaar, J., Knol, D., Lems, W., & Dekker, J. (2007). Joint proprioception, muscle strength, and functional ability in patients with osteoarthritis of the knee. Arthritis Care & Research, 57(5), 787-793. doi:10.1002/art.22779. [15]Young-Han P. (2013). Effects of Taping Application Type on Grip Power, Pinch Power, and EMG Activity. Science Journal of Public Health, 5 (1), 2013, pp. 239-243. doi: 10.11648/j.sjph.20130105.20