Medicina Sportiva
Med Sport 15 (1): 13-16, 2011
DOI: 10.2478/v10036-011-0005-1

ACUTE EFFECTS OF KINESIOTAPING ON MUSCULAR ENDURANCE AND FATIGUE BY USING SURFACE ELECTROMYOGRAPHY SIGNALS OF MASSETER MUSCLE

Abdullah Ruhi Soylu[1(A,C,D,E,G)], Rafet Irmak[2(A,B,E,F,G)], Gül Baltacı[3(A,B,E,G)]

[1] Hacettepe University, School of Medicine, Department of Biophysics, Ankara, Turkey
[2] Hacettepe University, Institute of Health Sciences, Program of Sports Physiotherapy, Ankara, Turkey
[3] Hacettepe University, School of Physiotherapy and Rehabilitation, Ankara, Turkey

Abstract

Introduction: Kinesiotaping (KT) is a therapeutic taping technique that works with the body allowing full range of motion. Its main usage areas are orthopedics, physiotherapy and sport medicine. It is useful in reducing pain, swelling and muscle spasms, as well as preventing sport injuries. It is also claimed that KT increases surface electromyography (sEMG) activity of muscles on some patients.

Purpose: The aim of the current study was to examine short-time effects of masseter KT on some sEMG parameters related to muscle fatigue and force during maximum voluntary contraction (MVC). Purpose of KT was to augment muscle strength by facilitating muscle contraction.

Methods: sEMG of left and right masseter muscles of 11 healthy subjects were recorded before and after masseter KT. The time duration of the implementation was 1 hour. Median frequency and slope of median frequency as an indicator of muscle fatigue, and maximum EMG linear envelope as an indicator of muscle force were measured before and after KT. Time to the peak of maximum MVC was also measured.

Results: The effects of KT on sEMG parameters are not statistically significant before and after KT for healthy subjects.

Conclusion: The described methods might aid researchers who want to study KT on appropriate subject groups having muscle weakness, sore, swelling and spasms.

Key words: *kinesiotaping, masseter, electromyography, muscle fatigue*

Introduction

Taping is a common approach in the field of physical therapy, orthopedics and sport medicine. In recent years a new material called Kinesiotape which consists of 100% cotton fibers and acrylic heat sensitive glue became popular [1]. The material and the original concept of the taping technique were introduced by Dr. K. Kase in 1973. Kinesiotape has approximately the same thickness as the epidermis and can be stretched longitudinally between 55% and 60% of its resting length. It is said that Kinesio tape is a skin like material by its mechanical properties [1]. It works with the body allowing full range of motion. Kinesio taping (KT) is used for pain management, mechanical support, inflammatory conditions and muscle strength [1]. It is also known that taping might increase surface electromyography (sEMG) activity of muscles on some patients [2]. Furthermore, it is claimed that taping supports muscle function [3], provides immediate sensorimotor feedback regarding functional abilities [4] and has no effect on strength [5]. Some researches argue that taping has no effect on EMG activity [6,7].

Surface electromyography (sEMG) provides a unique tool for assessment of muscular activation and internal loads on muscles, tendons, and other tissues. Muscle fatigue is a failure to maintain the required or expected force that is accompanied by changes in electrical activity of the muscle [8]. Piper [9] was the first to observe a reduction in the frequency of the surface EMG spectrum when a contraction was sustained. Besides such a frequency shift, Cobb and Forbes [10] found a consistent increase in the amplitude of surface recorded EMG. Since then, the studies can be divided into investigations directed at discovering signs of fatigue and/or causes of fatigue. Dimitrova & Dimitrov's review [8] gives recent information on this issue.

Although there are some doubts on the usability of median frequency (MF, median frequency of EMG power spectral density) [8], it is widely used in biomechanics. Evidences for usability of MF are sufficiently strong, and it is commonly accepted that muscle fatigue shows a decrease in EMG MF [11-13]. Not only MF, but also the slope of MF during sustained contraction is used for evaluation of fatigue [14].

It is known that force and EMG linear amplitude (LE) are highly correlated [12,15,16], and integrated EMG or EMG linear envelope are widely used in many biomechanics studies.

The aim of the current study was to examine short-time effects of KT on a very strong muscle by using various sEMG parameters (MF and MF slope as indexes of muscle fatigue, maximum EMG LE and time to the peak of maximum EMG LE as index of muscle force). Masseter muscle was chosen because it is considered as one of the strongest muscles in the body (p63, 17). Purpose of KT was to augment muscle strength by facilitating muscle contraction. It is known that immediate effect of KT is enhanced force sense [5]. In order to minimize sEMG variability, immediate effects of KT were examined.

Methods

Subjects, Kinesio Taping Procedure and EMG Measurement

Eleven healthy subjects (7 male, 4 female) volunteered to participate in the study. The mean (±SD) age, body weight and height were 30 ± 7 yr, 70.45 ± 14.42 kg and 171 ± 11 cm respectively. All subjects were right handed and have no masseter, chewing and dental problems.

Two I-bands were cut. One part of the first strip was placed slightly posterior to temporomandibular joint, with no tension while opening to mouth. Inferior part of the strip was placed to the rim of the chin as shown on the Figure 1.A. Superior tail of the other strip was placed in the direction of temporomandibular joint to the corner of the lip with 0-15% of available tension (Figure 1.A). The described technique can be accepted as modified version of Y-band [1].

Ag/AgCl electrodes with centre-to-centre distance 24 mm were placed longitudinally along bellies of the right and left masseter muscles. The aim of using both muscles was to double the sample size easily. There was 2 mm of air gap between adjacent parts of the two electrodes (Figure 1.B). Positive electrode was placed on the upper part of the masseter muscle. Reference electrode was placed on the bony part of the chin. Pass band of EMG amplifier, sampling rate, maximum inter-electrode impedance and CMMR were 10–500 Hz, 5000 Hz, 5 KΩ and 120 dB respectively. A notch filter was not used. EMG measurements were performed while the subjects were in the sitting position.

Two maximum voluntary contractions (MVC) of surface electromyography (sEMG) were recorded before KT with five-minute breaks. KT was applied by an expert, and after one hour, tapes were removed. Immediately after, two sEMG data of MVC were recorded with 5 min. breaks. At least nine-second of sEMG signals was recorded for each subject during MVC. Subjects reached maximum force level in two seconds by slightly increasing biting force, and then contracted masseter muscles maximally. Two channels of sEMG signals were recorded simultaneously. Contours of the electrodes were drawn with a marker on the face of the subjects to guarantee the reproducibility of recordings from the same electrode localizations before and after KT.

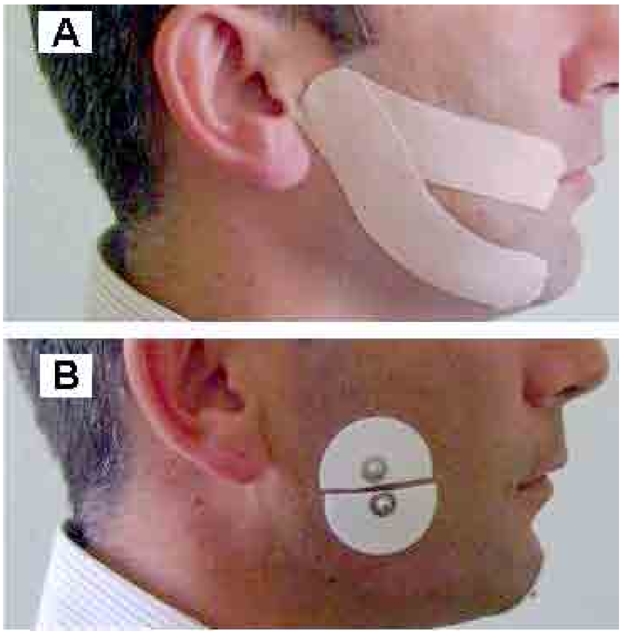

Fig. 1. *Application of KT (A) and sEMG electrodes (B) on a subject*

Calculation of EMG based parameters and statistics

Linear envelopes (LE) of sEMG signals with time-window one second were calculated to determine the maximum amplitudes (maxEMGLE) by using rms value of each time window. The time corresponding to the maximum amplitude (t_{max}) from starting of the contraction was calculated for each sEMG signal. Median frequencies (MF) at t_{max} and 3 seconds after t_{max} were calculated with time-window of 1 second. Slope of MFs were calculated from MF_1 (MF at t_{max}) and MF_2 (MF at t_{max} + 3 sec.) by using formula, MF/s = $(MF_2-MF_1)/3$.

Two MVC EMG signals have been recorded before and after KT. So, the greatest value of the two maxEMGLEs was chosen as maxEMGLE and, mean values of the two t_{max}, MF_1, MF_2 and MF/s variables were accepted as the corresponding muscles' t_{max}, MF_1, MF_2 and MF/s values to decrease variability and increase accuracy.

Kolmogorov-Smirnov test was used for normality check. Since all of the parameters (t_{max}, maxEMGLE, MF_1, MF_2, MF/s) were normally distributed, paired Student-t test (two-sided) was used to compare their means before and after KT.

Results

Means (± SD) of t_{max} (time to EMG LE peak), maxEMGLE (EMG LE at t_{max}), MF_1 (MF at t_{max} to t_{max}+1

Table 1. *Mean ± SDs of t_{max}, maxEMGLE, MF_1, MF_2, MF/s values of eleven subjects before and after KT*

PARAMETER	BEFORE KT		AFTER KT	
	Right Masseter	Left Masseter	Right Masseter	Left Masseter
t_{max} (ms)	3854 ± 1144	4070 ± 1275	3981 ± 1135	4260 ± 1072
EMGLE at t_{max} (mV)	0.39 ± 0.32	0.34 ± 0.27	0.40 ± 0.31	0.32 ± 0.24
MF_1 (Hz)	134 ± 37	133 ± 35	133 ± 35	134 ± 40
MF_2 (Hz)	125 ± 40	128 ± 39	122 ± 42	123 ± 42
MF/s (Hz/s)	-2.96 ± 2.36	-1.70 ± 3.53	-3.55 ± 4.68	-3.65 ± 3.68

See the main text for the explanations

s time interval), MF_2 (MF at t_{max}+3 to t_{max}+4 s time interval), MF/s of eleven subjects before and after KT were given in the Table 1. The results showed that there were no statistically significant differences between means of t_{max}, maxEMGLE, MF_1, MF_2, MF/s values (see Table 1) before and after KT.

Comparing mean MF_1 and MF_2 values of each sEMG signal group showed a statistically significant difference (mean-MF_2 < mean-MF_1) ($P<0.005$) as expected since sustained MVC of masseter muscles should show MF decrease due to the muscle fatigue.

Discussion

The purpose of KT application on masseter muscle was to increase the muscle strength by facilitating muscle contraction [1]. It was also known that taping can increase surface electromyography (sEMG) activity of muscles on some patients [2]. Our hypothesis was to see the effects of muscle strength augmentation on sEMG signals during MVC after KT. There were several reasons for choosing the masseter muscle: i) easy and practical applicability of KT, ii) reliable and practical maximal EMG measurement without a positioning device and, iii) it is one of the strongest muscles in the body (p63, 17), iv) its endurance is relatively low [18]. Although our research analyzes the masseter muscle, the results might be useful for other muscles that produce high force but medium or low endurance in sports science.

Suitable sEMG parameters for comparison could be MF and MF slope as indexes of muscle fatigue, maximum EMG LE and time to the peak of maximum EMG LE as indexes of muscle force and force slope. Therefore, possible outcomes of a short-time muscle strength augmentation during MVC could be, i) increase of maximum amplitude of sEMG LE, ii) changes in MF and MF-slope and, iii) alterations in time to the peak of maximum EMG LE. Due to the results, there were no statistically significant differences after and before KT for all calculated parameters. Probable explanations of these results might be either 'changes in the calculated parameters are so small that we could not detect them' or 'KT has no effect on sEMGs of healthy subjects'.

Possible error factors in our study were twofold, i) measuring sEMG from different localizations before and after KT due to electrode replacement and, (ii) short circuit of electrodes due to their close proximity. To eliminate these errors, contours of electrodes were drawn with a marker during the first sEMG measurement to place the electrodes to the same places after KT and, 2 mm air gap was placed between adjacent parts of the two electrodes.

In conclusion, the effects of KT on sEMG parameters are not statistically significant before and after KT for healthy subjects. As far as we know, there are no sEMG based muscle fatigue studies in taping literature and the described sEMG methods might aid researchers who want to study KT on appropriate subject groups having muscle weakness, sore, swelling and spasms.

Acknowledgements

This study has an approval of Hacettepe University Medical Ethics Committee. Project and decision codes are HEK 09/120 and HEK 09/120-16, respectively.

References

1. Kase K, Wallis J, Kase T. *Clinical therapeutic applications of the kinesio taping method*. Tokyo, Japan: Ken Ikai Co. Ltd, 2003.
2. Macgregor K, Gerlach S, Mellor R, Hodges PW. Cutaneous stimulation from patella tape causes a differential increase in vasti muscle activity in people with patellofemoral pain. *J Orthop Res* 2005; 23: 351-8.
3. Słupik A, Dwornik M, Białoszewski D, Zych E. Effect of Kinesio Taping on bioelectrical activity of vastus medialis muscle. Preliminary report. *Ortop Traumatol Rehabil* 2007; 9(6): 644-51.
4. Yasukawa A, Patel P, Sisung C. Pilot study: investigating the effects of Kinesio Taping in an acute pediatric rehabilitation setting. *Am J Occup Ther* 2006; 60(1):104-10.
5. 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.
6. Cools AM, Witvrouw EE, Danneels LA, Cambier DC. Does taping influence electromyographic muscle activity in the scapular rotators in healthy shoulders? *Manual Ther* 7; 2002; 7: 154–62.
7. Janwantanakul P, Gaogasigam C. Role of the Vastus Medialis Obliquus in Repositioning the Patella: A Dynamic Computed Tomography Study. *Am J Sports Med* 2008; 36: 741-6.
8. Dimitrova NA, Dimitrov GV. Interpretation of EMG changes with fatigue: facts, pitfalls, and fallacies. *J Electromyogr Kinesiol* 2003; 13: 13-36.

9. Piper HE. *Electrophysiologie menschlichen muskeln*. Berlin: Springer, 1912.
10. Cobb S, Forbes A. Electromyographic studies of muscle fatigue in man. *Am J Physiol* 1923; 65: 234-51.
11. De Luca, CJ. Myoelectric manifestations of localized muscular fatigue. *Crit Rev Biomed Eng* 1984; 11: 251-79.
12. De Luca CJ. The use of surface electromyography in biomechanics. *J Appl Biomech* 1997; 13: 135-63.
13. Merletti R, Knaflitz M, De Luca CJ. Electrically evoked myoelectric signals. *Crit Rev Biomed Eng* 1992; 19: 293-340.
14. De Luca CJ, Sabbahi MA, Roy SH. Median frequency of the myoelectric signal: effects of hand dominance. *Eur J Appl Physiol Occup Physiol* 1986; 55, 457-64.
15. Lawrence JH, De Luca CJ. Myoelectric signal versus force relationship in different human muscles. *J Appl Physiol* 1983; 54: 1653-9.
16. Merletti R, Parker P (Eds). *Electromyography: physiology, engineering, and nonInvasive applications*. New Jersey, USA: Wiley-Interscience, 2004.
17. Vizniak AN. *Muscle Manual*. 1st ed. Canada: Professional Health System Inc, 2010.
18. van Boxtel A, Goudswaard P, van der Molen GM, van den Bosch WE. (1983) Changes in electromyogram power spectra of facial and jaw-elevator muscles during fatigue. *J Appl Physiol* 1983; 54(1): 51-8.

Received: October 16, 2010
Accepted: February 15, 2011
Published: February 28, 2011

Address for correspondence:
Abdullah Ruhi Soylu
Hacettepe University
School of Medicine
Department of Biophysics
Ankara
Turkey
E-mail: arsoylu@hacettepe.edu.tr

Rafet Irmak: rafetirmak@gmail.com
Gül Baltacı: ybaltaci@hacettepe.edu.tr

Authors' contribution
A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection