International Journal of Sports Science 2015, 5(1): 16-18
DOI: 10.5923/j.sports.20150501.03

Can the Technique of Knee Wrap Placement Affect the Maximal Isometric Force during Back Squat Exercise?

Paulo Henrique Marchetti[1,2,*], Viviane de Jesus Pereira Matos[1], Enrico Gori Soares[1], Josinaldo Jarbas da Silva[1], Érica Paes Serpa[1], Daniel Alves Corrêa[1], Gustavo Martins[1], Guanis de Barros Vilela Junior[1], Willy Andrade Gomes[1]

[1]Department of Human Movement Sciences, Methodist University of Piracicaba, Piracicaba, São Paulo, Brazil
[2]Institute of Orthopedics and Traumatology, School of Medicine, University of São Paulo, Laboratory of Kinesiology, São Paulo, Brazil

Abstract The aim of this study was to investigate the acute effects on maximal isometric force with two different techniques of knee wraps placement (spiral and X) during back squat exercise. Twenty-one physical active participants were evaluated during this study. The back squat exercise position was set up individually, guaranteeing their thigh parallel to the floor, the arms crossed on the chest, and the feet were kept always in the same position for all trials and conditions. All subjects performed three maximal isometric back squat contractions in 4 different conditions: without knee wrap (WKW), with spiral knee wrap technique (SKW), with X knee wrap technique (XKW) and tensor (T). The peak force was acquired at a 100Hz sampling frequency, during 3 seconds, 5 minutes of resting and all conditions were randomized. The Rating of Perceived Exertion (RPE) was evaluated after each trial and condition. The results shows significant differences for peak force between conditions SKW vs WKW (P=0.044, ES=0.55, Δ%=10.8%), and XKW vs WKW (P=0.009, ES=0.62, Δ%=13.6%). The use of different knee wrap techniques (spiral and X techniques) presented an effective carry-over effect, but without differences between techniques, and the RPE was similar in all conditions.

Keywords Biomechanics, Exercise performance, Strength

1. Introduction

The knee wrap is an equipment commonly used by weightlifters, powerlifters and recreational resistance training subjects aiming to stabilize the knee, to improve the strength performance (gain mechanical advantage) or to improve the confidence during back squat exercises [1, 2]. The knee wrap is a long wrap of elastic material (tick canvas interwoven with rubber filaments) with approximately 2 meter long, which is wrapped around the knees as tight as possible [3, 4]. In general, when the knee is flexed against an external resistance during a squat exercise, the elastic material is stretched during the lowering phase, returning this energy during the lifting phase. This potential energy accumulated is transferred to the lifter and added to the strength performance of the movement in the concentric phase [1], and this additional effect on the strength performance is also known as carry-over effect. Only Three studies have reported the amount of *carry-over* of 19.8% in elite powerlifters [5], 25,1% in trained-men [3], respectively, during dynamic squat exercise. However, only one study [6] reported the carry-over of 21-22% in trained-men during isometric back squat at 90 degrees of knee flexion. However, to the best of our knowledge, no study has addressed the effects of different knee wrap placements in the peak force during the back squat exercise. There are few studies that investigated both kinematics and kinetics of the squat exercise using the knee wrap in powerlifters [5, 7] and trained subjects [4], however little has been known about its effects of loading capacity (carry-over effect). Eiter et al. [7] studied the use of knee wrap in powerlifters and analyzed the general characteristics of the back squat exercise (execution time, percentage of the transition cycle (upward-downward displacement) of the center of mass and the bar vertical displacement) with and without knee wrap, with no differences between them. Lake et al. [4] studied the use of knee wrap in trained subjects with and without knee wrap. The authors analyzed the ground reaction force, output of the mechanical force applied to the center of mass, vertical impulse, horizontal displacement of the bar, mechanical work and peak power. They observed that the elastic properties of the knee wrap increased the production of mechanical force (carry-over effect) and additionally modified the back squat technique.

Considering the strength training practice, normally, there are two main techniques of knee wrap placements. The "spiral technique", where the wrap is placed on the knee in a

* Corresponding author:
dr.pmarchetti@gmail.com (Paulo Henrique Marchetti)
Published online at http://journal.sapub.org/sports

spiral fashion; and "X technique", where the wrap is placed in a crossover fashion. The choice of one of two techniques is given at random by athletes. And, there is no previous study that has analyzed the differences between techniques for improving the strength performance. Therefore, the purposes of the present study was to investigate the acute effects on maximal isometric force with two different techniques of knee wraps placement (spiral and X) during back squat exercise.

2. Methods

2.1. Subjects

Twenty-one young, healthy, trained men were evaluated during this study (age 24 ± 4 years, body mass 82.6 ± 10 kg, height 176 ± 1 cm). All subjects were engaged in regular resistance training routine (hypertrophy loads: 3-4 exercises for lower limbs, 8-12 maximum repetitions) including squat exercise (2 sessions per week) for not less than one year. The number of subjects was determined by using the same variable from our previous study [6], and ten subjects were showed to be necessary based on alpha level of 0.05 and a power (1-β) of 0.80 [8]. All subjects who participated in this study had no previous trunk or lower limbs surgery/injury and they were evaluated with a minimum of 48 hours without training sessions. This study was approved by the University research ethics committee and all subjects read and signed an informed consent document prior to participating.

2.2. Procedures

Initially, all subjects were familiarized with the isometric back squat position in all conditions: without and with knee wrap (spiral and X technique) and tensor. Knee wraps (Maba Murphy Confecções Ltda, Brazil) were 0.02 x 0.08 x 2.00m and were composed of a heavy cotton fabric with interwoven elastic rubber filaments, similar to those used in previous studies [6]. All knee wraps were new and not previously used. The back squat exercise position was set up individually, guaranteeing their thigh parallel to the floor, the arms crossed on the chest, and the feet were always kept in the same position for all trials and conditions. A load cell (Cefise, Nova Odessa, Brasil) was calibrated and attached perpendicularly to the ground and in subject’s hip by using a belt. Then, each subject performed three maximal isometric squat contractions in 4 different conditions: without knee wrap (WKW), with spiral knee wrap technique (SKW), with X knee wrap technique (XKW) and with tensor (T). The same researcher applied the wraps as tightly as possible immediately before each trial, standardizing the number of wrap revolutions per subject. The same researcher performed all knee wrap techniques as described by Coutinho [5], for all subjects. All measures were performed at the same hour of the day, between 9am and 12pm. The present study analyzed the maximal isometric back squat exercise aiming to remove any other dynamic performance mechanism such as the elastic components of the muscle (stretch-shortening cycle) [9], or the effects of motion velocity [10].

The peak of force was acquired by CEFISE software (Cefise, Nova Odessa, Brasil) at a 100Hz sampling frequency, during 3 seconds and 5 minutes between contractions and conditions. All conditions were randomized and collected in one session. All the data were analyzed with a customized program written in Matlab (Mathworks Inc., EUA). The peak of force was filtered with a 4th-order 10 Hz low-pass zero-lag, Butterworth filter. The highest value of 3 trials was used for all analysis.

For assessing Rating of Perceived Exertion (RPE; CR-10 scale) during the exercise conditions, standard instructions and anchoring procedures were explained during the familiarization session. Subjects were asked to use any number on the scale to rate their overall effort for each condition. A rating of 0 was associated with no effort and a rating of 10 was associated with maximal effort and the most stressful exercise ever performed. Subjects were shown the scale 30 minutes after each condition and asked: “How was your workout?” [11-14].

2.3. Statistical Analysis

Normality and homogeneity of variances within the data were confirmed by the Shapiro-Wilk and Levene tests, respectively. One-way ANOVA were employed to compare the peak force and RPE of using knee wraps in all conditions (WKW, SKW, XKW, and T). Post-hoc comparisons were performed by using the *Bonferroni* test. Cohen’s formula for effect size (ES) was used and the results were based in the following criteria: <0.35 trivial effect; 0.35-0.80 small effect; 0.80-1.50 moderate effect; and >1.5 large effect, for recreational trained according to Rhea [15]. An alpha of 5% was used for all statistical tests. Test-retest reliability (ICC) was calculated and ranged between 0.97 and 0.99 for all dependent variables.

3. Results

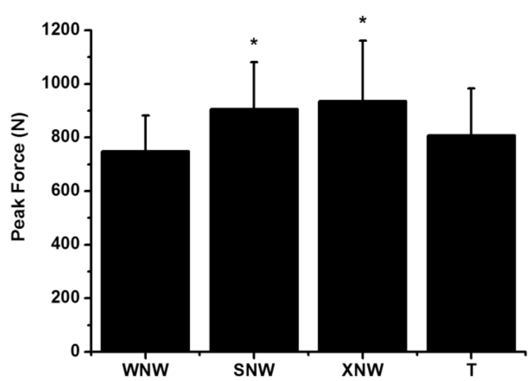

Figure 1. Mean ± standard deviation of the peak force during isometric back squat for different conditions (without knee wrap, spiral knee wrap technique, X knee wrap technique, and tensor, respectively).*Significant difference with WNW, *P*<0.05

There was a significant ($P<0.05$) main effect for peak force between conditions. There were significant increases for peak force between: SKW vs WKW ($P=0.044$, ES=0.55, Δ%=10.8%), and XKW vs WKW ($P=0.009$, ES=0.62, Δ%=13.6%). Figure 1 shows the mean and standard deviations of the peck force values for the four testing conditions. However, it was not observed significant differences for RPE between conditions (WKW=8.8±1.6, SKW=8.7±1.8, XKW=9.3±0.6, and T=8.9±1.7).

4. Discussion

Two major specific findings of this study were that the use of both spiral and X techniques presented an effective carry-over effect, but without differences on peak force between techniques (3%), and the RPE was similar in all conditions.

Related to *carry-over* effect observed during our study, we could verify an increase in the external load, that was due to the elastic energy stored in the knee wrap material under mechanical deformation, independent of the employed technique [5]. The knee wrap is composed of elastomeric material and polyester, and it has the ability to suffer large deformations and return elastically to its original shape, as springs. This elastic effect is due to the crosslink of the polymer, which, when stretched, results in a force capable of returning the material strands to their original conformations without any permanent deformation (plastic deformation) [16]. So, this elastic energy can be transferred into kinetic energy and added to the lifter [5].

Curiously, we did not observe differences on the peak force between the knee wrap techniques (spiral or X). Probably, the knee wrap positioning on the knee joint did not affect the maxima force during isometric contractions in trained-subjects. Additionally, there were differences between without knee wraps and both knee wrap techniques, corroborating the findings of Harman and Frykman [3] and Gomes et al., [6], though this study showed lower values of carry-over (10-13%).

Another main point to be considered was the increase of 7.5% in the peak force, from tensor condition, when compared to without knee wraps condition. It may be related to psychological aspects of using a placebo or a proprioceptive effect from the tensor pressure.

Finally, related to RPE results, this study observed similar values in all conditions, probably because all conditions presented the same relative intensity (maximal, 100%). And all knee wrap conditions did not present an additional effect on this subjective variable.

5. Conclusions

The use of different knee wrap techniques (spiral and X techniques) presented an effective carry-over effect, but without differences between techniques, and the RPE was similar in all conditions. However, a significant carry-over effect was observed during the back squat exercise by using the knee wrap, when compared to tensor or without knee wraps. For coaches, athletes and sport science practitioners the use of knee wrap under the presented conditions seem to increase the maximal isometric force during the squat exercise, independent of technique.

REFERENCES

[1] Totten, L., *Knee wraps.* J Strength Cond Res, 1990. 12: p. 36-38.

[2] Gomes, W.A., M. Coutinho, and P.H. Marchetti, *Revisão dos efeitos biomecânicos do uso de banda elástica no joelho durante o agachamento no levantamento básico.* . Revista CPAQV., 2013. 5(3): p. 1-15.

[3] Harman, E. and P. Frykman, *The effects of knee wraps on weightlifting performance and injury.* Nat. Strength Cond. J. , 1990. 12: p. 30-35.

[4] Lake, J., P. Carden, and K. Shorter, *Knee wraps affect squat performance.* Journal of Strength and Conditioning Research, 2012. 8(1): p. 1-16.

[5] Coutinho, M., *De volta ao básico: powerlifting - treinamento funcional, esporte de alto rendimento e prática coporal para todos.*2011, São Paulo: Editora Phorte.

[6] Gomes, W.A., et al., *Acute effects on maximal isometric force with and without knee wrap during squat exercise.* Int J Sports Sci., 2014. 4(2): p. 47-49.

[7] Eitner, J.D., R.G. LeFavi, and B.L. Rieman, *Kinematic and kinetic analysis of the squat with and without knee wraps.* J Strength Cond Res, 2011. 25(1): p. S41.

[8] Eng, J., *Sample Size Estimation: How many individuals should be studied?* Radiology, 2003. 227(2): p. 309-313.

[9] Brown, L.E., *Treinamento de força*2008, Barueri: Manole.

[10] Fukashiro, S., D.C. Hay, and A. Nagano, *Biomechanical behavior of muscle-tendon complex during dynamic human movements.* J Appl Biomech, 2006. 22(2): p. 131-147.

[11] Borg, G., *Escalas de Borg para a dor e o esforço percebido* 2000, São Paulo: Manole.

[12] Uchida, M.C., et al., *Does The Timing of Measurement Alter Session-RPE in Boxers?* Journal of Sports Science and Medicine, 2014. 13: p. 000-000.

[13] Foster, C., et al., *Differences in perceptions of training by coaches and athletes.* Sports Med., 2001: p. 3-7.

[14] Foster, C., et al., *A new approach to monitoring exercise training.* J. Strength Cond. Res., 2001. 15(1): p. 109-115.

[15] Rhea, M.R., *Determining the magnitude of treatment effects in strength training research through the use of the effect size.* Journal of Strength and Conditioning Research, 2004. 18(4): p. 918-20.

[16] Callister, J.W.D., *Ciência e engenharia de materiais: uma introdução.* Vol. 7. 2008, Rio de Janeiro: LTC.