Original Article

Effects of heel lock taping technique with elastic and non-elastic tape on ground reaction force during landing phase of vertical jump in athletes with chronic ankle instability

Teerapat Laddawong, Supat Bantadkan, Meth Pipatponglert, Thanisorn Tuntichat

Abstract

Introduction: Athletes with chronic ankle instability have higher ground reaction force during the landing phase of the vertical jump. This increases the risk of ankle injury. Heel lock taping techniques with non-elastic tape can decrease ground reaction force but cause side effects. Elastic tape can reduce the side effects, however, there is limited evidence that confirms a reduced ground reaction force with the elastic band.

Objective: To study the effect of heel lock taping with elastic and non-elastic tape on ground reaction force during the landing phase of vertical jump in athletes with functional ankle instability.

Method: Sixteen basketball and volleyball athletes with chronic ankle instability performed vertical jumps on a force plate to measure peak vertical ground reaction force and time to peak vertical ground reaction force. Four conditions including taping (elastic taping (ET), non-elastic taping (NET), combined taping (CT), and non-taping (NT)) were randomly tested on the separate consecutive days.

Results: Under the three taping conditions a decreased peak ground reaction force and an increased time to peak vertical ground reaction force were observed with significantly different mean differences compared to NT ($p < 0.05$). Between the three taping conditions, NET was the most effective compared to CT and ET.

Conclusion: All taping conditions can decrease peak vertical ground reaction force and increase the time to peak vertical ground reaction force during the landing phase in athletes with chronic ankle instability.

Keywords: Ground reaction force, Heel lock taping techniques, Chronic ankle instability

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Department of Physical Therapy, Faculty of Allied Health Sciences, Thammasat University

Corresponding Author: Mr.Teerapat Laddawong Department of Physical Therapy, Faculty of Allied Health Sciences, Thammasat University Phone: 080-2693561 E-mail: teerapat.l@allied.tu.ac.th

Introduction

Ankle injuries are most common in sports requiring jumping or immediate change of direction.[1] The athletes with most ankle injuries, especially sprained ankles are found in volleyball and basketball.[2] Recent studies have shown that the rate of a recurrent ankle injury in volleyball athletes is as high as 75%. Repeated ankle sprain will lead to chronic ankle instability (CAI). This will result in injuries to other structures.[2] CAI is caused by loss of ankle proprioception, neuromuscular control, and muscular strength.[3] Most ankle injuries happen during the landing phase of the vertical jump.[4, 5] According to the study of Caulfield B in 2004 found that athletes with CAI have higher ground reaction force (GRF) and faster time to peak force compared to athletes with healthy ankles during the landing phase of vertical jump.[4, 5] Changes in the ground reaction force and time to peak force result in an increased risk of ankle injury.[4] Therefore, the treatment that reduces GRF on the joint can help to reduce the risk of repeated injury. The most commonly used treatment for stabilizing the ankle is exercising muscles around the ankle and balance training exercises. However, this treatment requires a period of at least 4 - 6 weeks. In fact, athletes still have to practice and compete. Physical therapists need external support devices to help stabilize the athlete's ankle. Sports tape is a popular accessory used to help strengthen the ankle during training and competition. A recent study found that the use of non-elastic taping (NET) with a modified Gibney technique (a close basket weave plus heel lock technique) can reduce GRF while landing.[6, 7] However, the use of these methods limits the movement of the ankle, causes skin abrasion, reduces blood flow, and may reduce athletic performance.[8] The use of such techniques may not be appropriate for athletes with mild injuries or just ankle instability. So, for the benefit of athletes, selecting other techniques that have fewer shortcomings but can still reduce GRF is a better idea. Heel lock taping technique is a method that enhances the stability of the ankle at talocrural joint and subtalar joint. This technique is done by wrapping the tape in the "U" pattern around the ankle and the heel on both sides. This will help stabilize the ankle area without limiting movement too much.[9] However, until now no study has shown the use of Heel lock taping technique to reduce GRF in athletes with ankle instability.

Sports tape can be classified into two types: non-elastic taping (NET) and elastic taping (ET). Both types of tape have their own advantages and limitations. NET is a non-flexible tape. It can restrict movement and create stability. However, it may affect the performance of athletes and cause skin abrasion while ET does not limit the movement of athletes and does not irritate the skin. However, no studies have found that ET can reduce GRF in athletes with ankle instability.

Therefore, the purpose of this study is to study the effect of Heel lock taping technique with elastic and non-elastic tape on ground reaction force during the landing phase of vertical jump in athletes with chronic ankle instability.

Methods

This study has been approved by the Ethical Review Sub-Committee Board for Human Research Involving Sciences, Thammasat University. Volunteers enrolled in this study included 16 basketball and volleyball players aged 18 - 25 years. All participants had at least one history of sprain ankle, no history of foot sprain for at least three months prior to the study, and never participated in an ankle rehabilitation program. The Cumberland ankle instability tool (CAIT) is a standard evaluation form used to assess ankle instability. If the score from the assessment is less than or equal to 27 points, it is considered to be chronic ankle instability. Sixteen basketball and volleyball athletes with chronic ankle instability performed vertical jumps on a force plate to measure peak vertical ground reaction force and time to peak vertical ground reaction force. Three taping conditions, elastic taping

(ET), non-elastic taping (NET), and combined taping (CT) were tested in random sequence in comparison with non-taping (NT) each day for four days.

In the jump test, volunteers performed a vertical jump test at a height of 50% of the maximum jump height on the force plate for 3 times. Taping was performed by physiotherapists who have had at least 5 years of experience using the full Heel lock technique. Taping started at the posterior surface of the medial malleolus, continued downwards over the front of the ankle, around the heel, and with continuous traction back to the front of the ankle to the beginning.

A Kistler force plate was mounted on a flat surface and surrounded by a 3 cm high wooden frame to measure the peak GRF and Time-related to peak GRF. The force plate was set to record the data at a frequency of 1500 Hz. Recorded data included peak GRF and Time-related to peak GRF. Peak GRF was the maximum vertical force in newton (N) applied to the body (vGRF). Time-related to peak GRF was the time from the beginning of contact with the ground to the peak GRF in seconds or milliseconds.[10] Low-path Butterworth filtering at 35 Hz was applied to recorded raw data.

The mean difference between pre and post taping condition of each variable was statistically analyzed using SPSS version 24. This study used the mean difference calculated from pre-taping minus post-taping. Therefore, high vGRF and time to peak vGRF values indicate more reduced vGRF and increased time to peak vGRF by taping. Shapiro-Wilk Normality Test was used to test the distribution of data. The results show that the data is normally distributed. One-way repeated measure ANOVA was used to compare variables in each condition. Use the Least significant difference (LSD) test to find the differential pair. This study determined the level of statistical significance at p - value < 0.05.

Results

The 16 volunteer athletes enrolled in this study consisted of 11 males (68.75%) and 5 females (31.25%) and were aged between 18 - 25 years old. They included 9 basketball players (56.25%) and 7 volleyball players (43.75%). All participants were right-leg dominant with left ankle instability.

The results of this study found that the mean differences in peak and GRF between 4 taping conditions were significantly different (p=0.001). Therefore, comparing for differences between groups with Least significant difference (LSD) test. The study indicated that the mean differences of peak vGRF and time to peak vGRF in the taping conditions were significantly higher compared to the NT condition. Between the three taping conditions, the mean differences of peak vGRF and time to peak vGRF were significantly higher in NET condition than in NET and CT conditions. NET and CT conditions were not different (Tables 1 and 2).

Table 1 Mean difference and standard deviation of peak vGRF in each taping condition.

Conditions	F_v (N)	
	Mean ± SD	P - value
NT	1.50 ± 3.53	0.001*
NET	294.49 ± 48.87	
NT	1.50 ± 3.53	0.001*
ET	227.77 ± 57.67	
NT	1.50 ± 3.53	0.001*
CT	258.22 ± 50.04	
NET	294.49 ± 48.87	0.001*
ET	227.77 ± 57.67	
NET	294.49 ± 48.87	0.028*
CT	258.22 ± 50.04	
ET	227.77 ± 57.67	0.063
CT	258.22 ± 50.04	

NT = non-taping condition, NET = non-elastic taping condition, ET = elastic taping condition,
CT = combined taping condition, F_v = Peak vertical GRF (N)
* = Significant (P - value < 0.05) with one-way repeated measure ANOVA

Table 2 Mean difference and standard deviation of time to peak vGRF in each taping condition.

Conditions	TF_v (ms)	
	Mean ± SD	P - value
NT	0.70 ± 2.02	0.001*
NET	11.70 ± 6.25	
NT	0.70 ± 2.02	0.026*
ET	3.98 ± 3.25	
NT	0.70 ± 2.02	0.001*
CT	6.27 ± 3.54	
NET	11.70 ± 6.25	0.001*
ET	3.98 ± 3.25	
NET	11.70 ± 6.25	0.001*
CT	6.27 ± 3.54	
ET	3.98 ± 3.25	0.117
CT	6.27 ± 3.54	

NT = non-taping condition, NET = non-elastic taping condition, ET = elastic taping condition,
CT = combine taping condition, TF_v = Time to peak vertical GRF (ms)
* = Significant (P - value < 0.05) with one-way repeated measure ANOVA

Discussion

The study found that the three taping conditions (elastic taping (ET), non-elastic taping (NET), combined taping (CT)) can significantly reduce the vertical ground reaction force (vGRF) compared to non-taping (NT). Normally, the ankle must get a reaction force from the floor and then transfer it to the upper part of the body. Stability around the ankle helps to reduce the force on the ankle. All three taping conditions help to strengthen the ankle. The force on the ankle decreases. According to a study by Huang et al. in 2011, NET can reduce the ankle pressure by increasing stability and limiting the movement of the ankle.[11] However, Riemann et al. in 2002, suggested that ankle taping imposes higher stresses on the musculoskeletal system during dynamic activity, which improves the stability of the ankle. Taping helps to reduce GRF following ground contact.[7] Koyama et al. in 2014, reported that ankle taping helped to increase the stability of the ankle and to spread the force to other structures faster.[8]

When comparing the taping conditions, NET can significantly reduce vGRF over ET and CT. NET has the unfavorable effect to limit the movement of joints but because this increases the stability of the joints it can better reduce vGRF. It was also found that ET and CT had a comparable vGRF. Both taping conditions use elastic tape which allows the joints to move. It may not be possible to reduce vGRF with elastic tape to the same extent as with NET, but it allows the athlete to move more easily. It also reduces the side effects caused by allergies or skin irritation. In addition, Freeman et al., in 1965 said that elastic tape can increase the joint proprioception[12]. It plays a role in reducing both, injury and development of chronic diseases. The results show that the Heel lock taping technique applied with either NET, CT or ET can reduce vGRF.

Time-related to peak GRF is the time from the beginning of contact to the ground to the peak GRF in seconds or milliseconds. A recent study found that athletes with chronic ankle instability had a lower time related to peak GRF. This results in a greater risk of ankle injury. A study by Hubbard et al., in 2010 found that the reduction in time to peak GRF in athletes with chronic ankle instability reduced adaptation capacity of the ankle structure. There is an increased risk of ankle injury.[13]

In this study, it was found that the three taping conditions significantly increased the time to peak GRF when compared to NT. According to a study by Hubbard et al., in 2010, sports taping can increase the time to peak GRF compared to NT because the tape can reduce the slack of the structure around the ankle.[13]

When comparing the taping conditions, NET can significantly increase the time to peak GRF over ET and CT. This is consistent with the study of Bovonsunthonchai et al., in 2014 because NET provides more stability to joints than other taping conditions.[14]

From a practical point of view, using any of the three taping conditions with the heel lock technique can help to improve vGRF and time to peak vGRF values. Taping will help athletes with chronic ankle instability to lower the risk of ankle injuries. However, each taping condition has different advantages and limitations. For example, NET can better reduce vGRF but will cause a higher restriction of joint movement. Therefore, users should consider the taping condition that is best suited for the purpose and type of sport.

In conclusion, this study determined the vertical jump height at 50% of the maximum jump height to reduce the error tolerance and reduce the risk of injury to volunteers. Determining the height of

the jump can lower the GRF compared to the jump occurring during the match. In addition, this study did not determine the severity of chronic ankle instability. Future studies may simulate jumping tests that are like actual jumps. Additional kinematic information should be collected to better explain the effect of tape on a motion.

The three tape conditions, elastic taping (ET), non-elastic taping (NET), combined taping (CT) can significantly reduce the peak GRF and increase time to peak GRF when compared to non-taping (NT).

NET can significantly reduce the peak GRF and increase the time to peak GRF over ET and CT.

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บทคัดย่อ

ผลของการพันผ้าเทปเทคนิคฮิลล็อกด้วยผ้าเทปชนิดยืดหยุ่นและไม่ยืดหยุ่นต่อแรงปฏิกิริยาจากพื้นในช่วงลงถึงพื้นจากการกระโดดสูงในนักกีฬาที่มีภาวะข้อเท้าไม่มั่นคงเรื้อรัง

ธีรพัฒน์ ลัดดาวงศ์, สุพัฒน์ บรรทัดกาญจน์, เมธว์ พิพัฒน์พงษ์เลิศ, ฐานิสร ตันติชาติ
ภาควิชากายภาพบำบัด คณะสหเวชศาสตร์ มหาวิทยาลัยธรรมศาสตร์

บทนำ: นักกีฬาที่มีภาวะข้อเท้าไม่มั่นคงเรื้อรังจะมีแรงปฏิกิริยาจากพื้นในช่วงลงถึงพื้นจากการกระโดดสูงเพิ่มขึ้น ซึ่งทำให้มีความเสี่ยงต่อการบาดเจ็บข้อเท้าเพิ่มขึ้น การพันผ้าเทปเทคนิคฮิลล็อกด้วยผ้าไม่ยืดหยุ่นสามารถช่วยลดแรงปฏิกิริยาจากพื้นได้ แต่ก็มีผลข้างเคียงเกิดขึ้น ในขณะที่พันผ้าเทปชนิดยืดหยุ่นสามารถลดผลข้างเคียงของผ้าเทปได้ แต่ยังไม่มีการศึกษาที่ยืนยันผลของการช่วยลดแรงปฏิกิริยาจากพื้น

วัตถุประสงค์: เพื่อศึกษาผลของการพันผ้าเทปเทคนิคฮิลล็อกด้วยผ้าเทปชนิดยืดหยุ่นและไม่ยืดหยุ่นต่อแรงปฏิกิริยาจากพื้นในช่วงลงถึงพื้นจากการกระโดดสูงในนักกีฬาที่มีภาวะข้อเท้าไม่มั่นคงเรื้อรัง

วิธีการ: นักกีฬาบาสเกตบอลและวอลเลย์บอลที่มีภาวะข้อเท้าไม่มั่นคงเรื้อรังจำนวน 16 คน เข้าร่วมการทดสอบด้วยท่ากระโดดสูงบนแผ่นวัดแรงเพื่อวัดแรงปฏิกิริยาสูงสุดจากพื้นและระยะเวลาไปสู่จุดสูงสุดของแรงปฏิกิริยาจากพื้นในแนวตั้ง โดยทดสอบก่อนและหลังพันเทปที่สุ่มลำดับได้ในแต่ละวัน จำนวน 4 วัน ได้แก่ ผ้าเทปชนิดยืดหยุ่น ชนิดไม่ยืดหยุ่น ชนิดยืดหยุ่นร่วมกับไม่ยืดหยุ่น และไม่พันเทป

ผลการศึกษา: การพันผ้าเทปทุกแบบสามารถลดค่าเฉลี่ยความแตกต่างของแรงปฏิกิริยาสูงสุดจากพื้นและเพิ่มระยะเวลาไปสู่จุดสูงสุดของแรงปฏิกิริยาจากพื้นในแนวตั้งได้แตกต่างกันอย่างมีนัยสำคัญทางสถิติเมื่อเปรียบเทียบกับการไม่พันผ้าเทป ซึ่งเมื่อเทียบระหว่างเทปแต่ละแบบ พบว่าเทปชนิดไม่ยืดหยุ่นสามารถลดค่าเฉลี่ยความแตกต่างของแรงปฏิกิริยาสูงสุดจากพื้นและเพิ่มระยะเวลาไปสู่จุดสูงสุดของแรงปฏิกิริยาจากพื้นในแนวตั้งได้มากกว่าเทปชนิดยืดหยุ่นร่วมกับไม่ยืดหยุ่นและเทปชนิดยืดหยุ่นตามลำดับ

สรุปผลการศึกษา: การพันเทปทั้ง 3 แบบสามารถลดแรงปฏิกิริยาจากพื้นในแนวตั้ง และช่วยเพิ่มระยะเวลาไปสู่จุดสูงสุดของแรงปฏิกิริยาจากพื้นในแนวตั้งในช่วงลงถึงพื้นได้ในนักกีฬาที่มีภาวะข้อเท้าไม่มั่นคงเรื้อรัง

คำสำคัญ: แรงปฏิกิริยาจากพื้น, การพันผ้าเทปเทคนิคฮิลล็อก, ภาวะข้อเท้าไม่มั่นคงเรื้อรัง