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Effect of Kinesio Taping on Knee Symptoms in Patients with Hemophilia: A Prospective Study

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Background: Kinesio Taping is effective for treating knee symptoms in various diseases. However, the outcome of using this method in hemophilia patients with knee symptoms has not been previously studied.

Objective: To evaluate the therapeutic effects of Kinesio Taping on the knee symptoms in patients with hemophilia who had knee symptoms in the previous year.

Methods: Kinesio Tape was applied on the anterior thigh and knee in all subjects. To measure the outcome, we collected the visual analogue scale (VAS) score of the knee during walking, knee-flexion and knee-extension muscle strength, active knee-flexion and knee-extension range of motion, Hemophilia Joint Health Score of the knee, and 6-min walk test (6MWT) before and 2 days after the taping.

Results: Totally, 12 patients were enrolled during 2018. The VAS score decreased significantly from pre-taping (1.8 ± 2.3) to post-taping (0.7 ± 1.3) ($p = 0.021$). The post-taping distance of the 6MWT (418.9 ± 98.0 m) was significantly longer than the pre-taping distance (398.8 ± 98.6 m) ($p < 0.001$). No significant difference existed in the pre-taping and post-taping values of the other parameters. Only mild adverse effects such as itchy skin were observed in 4 patients after taping.

Conclusion: Two-day Kinesio Taping on the knee may reduce knee pain and enhance performance while walking in patients with hemophilia. (*Tw J Phys Med Rehabil* 2020; 48(1): 15 - 24)

Key Words: hemophilia, kinesio taping, knee pain, walk test

INTRODUCTION

Hemophilia, a congenital bleeding disorder caused by lack or insufficiency of the clotting factor, may lead to bleeding problems in any body parts. The annual preva-

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lence of hemophilia A and hemophilia B in Taiwan is 7.30 and 1.34 per 100,000 males, respectively.^[1] Current standard treatment for patients with hemophilia is clotting factors therapy, either on demand or in prophylaxis mode. Past literature has illustrated that prophylaxis of clotting factors could decrease the frequency of joint and other hemorrhages in patients with hemophilia.^[2] However, with either on demand or prophylaxis of clotting factors, patients with hemophilia have still experienced hemarthrosis.^[3,4] If the hemophilic arthropathy has progressed to status of joint destruction, the joint pain and the limitations in joint range of motion (ROM) may reduce quality of life.^[5] The most frequent joints for joint replacement are knee and hip, and it was estimated in a nationwide study that about 7% of patients with hemophilia received knee and/or hip replacement.^[6] In terms of relieving joint symptoms of patients with hemophilia in such situations, in addition to joint replacement, physical therapy has been considered as a suitable alternative.^[7]

Kinesio Tape, a thin elastic adhesive tape that contains no medications, was first invented by Kenzo Kase in 1996. Compared to conventional tape, Kinesio Tape can be stretched to up to 120%-140% of the original length, resulting in its elastic property. Application of Kinesio Tape on skin can lift the space of skin and soft tissue and increase blood circulation and lymph flow,^[8] which improve muscle function and offer more space to move.

The therapeutic effect of application of Kinesio Tape on the knee has been proven to minimize pain, increase muscle strength, improve gait pattern, and enhance functional outcome of patients with osteoarthritis and sports injury.^[9,10] One study has showed that Kinesio Taping to the quadriceps femoris muscle can effectively attenuate various types of pain and improve active ROM and proprioception in patients with osteoarthritis.^[11] Another study demonstrated that Kinesio Taping for patients with knee osteoarthritis resulted in superior short-term effects on walking task, pain, and knee-flexion ROM.^[12] In addition, the Kinesio Taping technique appeared to be beneficial for reducing postoperative pain, edema, and improving knee extension in the early post-operative rehabilitation period in patients with total knee replacement.^[13] Kinesio Taping could also increase the muscle strength in football athletes with a knee injury.^[14]

In a review of past literature, no papers have reported the effect of Kinesio Taping on the knee symptoms of patients with hemophilia. This study aimed to determine whether Kinesio Taping could be another treatment option for managing limited ROM, pain, and swelling, as well as increasing strength of knee and enhancing walking ability in patients with hemophilia. It has been hypothesized that Kinesio Taping could improve the knee symptoms in patients with hemophilia who experience any knee symptoms. We here conducted a prospective study to examine the impact of Kinesio Taping on the anterior thigh and knee among patients with hemophilia.

MATERIALS AND METHODS

Participants

The study was performed at the Hemophilia and Thrombosis Treatment Center of a regional hospital in Taiwan between January and December 2018. The Institutional Review Board for Human Studies of the hospital approved the study protocol (approval no. 201701209B0). The following criteria determined eligibility for inclusion in the study: (1) congenital hemophilia A or B confirmed by a hematologist; (2) unilateral or bilateral knee symptoms/signs such as pain, swelling, limited ROM, and subjective weakness in the past year or previous total knee replacement (TKR); (3) ≥ 20 years old; (4) comprehension skills to answer questions and comply with instructions; and (5) willingness to sign form of informed consent.

The exclusion criteria were: (1) infection at taping site (anterior thigh and anterior knee joint); (2) open wound at taping site; (3) cancer at taping site; (4) deep venous thrombosis of leg; and (5) previous skin allergic reaction to Kinesio Tape. After processing inclusion and exclusion criteria, a total of 12 patients were enrolled in this study. All participants signed the informed consent forms after explanation of the study procedures.

Demographic data such as age and gender were recorded. In addition, clinical data such as body mass index, hemophilia type (A or B), hemophilia severity (grouped into mild, moderate, and severe), inhibitors status (with or without), TKR procedures received or not, and current treatment mode of clotting factor (on demand

or prophylaxis) were obtained from medical records or by directly querying patients. Pettersson score^[15] was used to evaluate the degree of hemophilic knee arthropathy. Score ranged from 0 to 13, with a higher score indicating worse joint condition. Each knee's Pettersson score was measured by a radiologist according to the patient's most recent knee X-ray within one year prior to the taping. For patients with hemophilia who underwent TKR, the Pettersson score was not recorded for the knee on which the procedure was performed.

Tape application

The method of applying Kinesio Tape to both thighs and knees of participants was done according to the Kenzo Kase's Kinesio Taping Manual.^[16] Taping procedure was performed by a single physiatrist using an inverse Y-shaped Kinesio Tape. The taping procedures followed several steps: (1) participant was asked to lie on a treatment table in the supine position with the hip flexed at 30 ° and the knee flexed at 60°. If a participant could not perform the required angle of hip or knee, the participant was instructed to maintain his or her maximal flexion angle of the joint; (2) the tape was placed at the front thigh 10 cm distal to the anterior superior iliac spine, and the first 5 cm of tape was not stretched as the anchor; (3) the tape was stretched and extended to its 120% length and taped along the quadriceps femoris muscle aiming to superior pole of knee cap; (4) the tape was then bifurcated into two branches at the junction between quadriceps femoris tendon and the knee cap; and (5) the two branches were not stretched and were individually taped medially and laterally around the knee cap, and the terminals of the two branches ended at the site inferior to the knee cap. The completion after Kinesio Taping is shown in Figure 1.

Kinesio Tape and some adhesives could possibly irritate the skin. Although severe allergic reaction to Kinesio Tape seldom occurred,^[17] all participants were educated before the actual Kinesio Taping that they needed to remove the tape immediately if allergic reactions such as large areas of redness, swelling, severe itching, and bulla occurred after taping. Kinesio tape was removed after post-test was completed, and all adverse reactions were recorded.

Outcome measures

All outcome measures were performed before tape application (pretaping) and 2 days (48 hours) after the taping (post-taping). Primary outcome measures were checked before taping, including Visual Analogue Scale (VAS) of each knee, muscle strength of each knee's flexion and extension, and active ROM of each knee's flexion and extension. The secondary outcome measures were Hemophilia Joint Health Score (HJHS) version 2.1^[18] of each knee and six-minute walk test (6MWT).^[19] Two days after taping, VAS, muscle strength of knee flexion and extension, active ROM of knee flexion and extension, HJHS, and 6MWT were checked again.

While assessing VAS, each participant was asked about perceived knee pain during walking according to the numerical (0-10) pain rating scale.^[20] Maximal muscle strength was measured with a wireless hand-held dynamometer (microFET2, Hoggan Scientific, LLC, Salt Lake City, UT, USA). The maximal muscle strength of knee flexion and extension was tested in the sitting position with arms crossed and both calves and feet hanging off the treatment table. HJHS 2.1 contained eight domains, including swelling, duration of swelling, muscle atrophy, crepitus on motion, flexion loss, extension loss, joint pain, and strength. The score for each domain of each knee joint was scored according to its appearance, subjective perception, and performance.^[21] A higher score indicated a worse function of the domain. Each knee joint consisted of a Joint Total score, which was the summation of the scores of the eight domains in the knee joint. The HJHS was not designed for indicating the health status of joints on which surgery was performed in patients with hemophilia; thus, the HJHS score was not measured for knee on which TKR was performed.

A standard goniometer was used to measure the active ROM of knee joint according to the standard technique described in the book *Measurement of Joint Motion: a guide to goniometry*.^[22] Normal angles of ROM of the knee joint (flexion 150 ° and extension 0 °) were set based on the information obtained from the same book *Measurement of Joint Motion: a guide to goniometry*.^[23] For 6MWT, the total distance walked between two fixed points in 6 minutes was recorded. All measurements were performed by a single trained assistant.

Statistical methods

SPSS version 22 was used for all statistical analyses. Paired sample *t*-test was used to evaluate the difference of pretaping and post-taping VAS scores of knees, maximal muscle strength of knee flexion and extension, active ROM of knee flexion and extension, HJHS score of knees,

and total distance of 6MWT. For assessing the association of outcome measures, Spearman's correlation coefficient analysis was used to identify linear relationships between the change values (post-taping value minus pre-taping value) of the outcome measures. A *p* value of <0.05 was considered statistically significant.

Table 1. Demographic and clinical characteristics of participants

	Value
	Mean ± SD (range) or number (%)
Demographic characteristics	
Age (years)	43.7 ± 10.6 (31.4–66.9)
Sex	
Male	12 (100.0%)
Body mass index (kg/m ²)	25.2 ± 5.3 (15.0–37.1)
Clinical characteristics	
Hemophilia type	
A	11 (91.7%)
B	1 (8.3%)
Hemophilia severity	
Mild	1 (8.3%)
Moderate	3 (25.0%)
Severe	8 (66.7%)
Inhibitors	
With	3 (25.0%)
Without	9 (75.0%)
Total knee replacement	
Right	3 (42.9%)
Left	4 (57.1%)
Treatment mode of clotting factors	
On-demand	8 (66.7%)
Prophylaxis	4 (33.3%)
Pettersson score	
Right knee (n = 9)	
0	3 (33.3%)
1–6	4 (44.5%)
7–13	2 (22.2%)
Left knee (n = 8)	
0	4 (50.0%)
1–6	1 (12.5%)
7–13	3 (37.5%)

Table 2. Outcome measurements before and after Kinesio Taping

	Pretaping	Post-taping	p value
Outcome measurement of knees			
VAS (n = 24) during walking	1.8 ± 2.3	0.7 ± 1.3	0.021
Maximal muscle strength (n = 24) (Newton)			
Flexion	78.6 ± 24.1	82.2 ± 17.8	0.366
Extension	118.4 ± 45.6	125.7 ± 45.9	0.095
Active ROM (n = 24) (°)			
Flexion	76.8 ± 27.2	77.3 ± 26.4	0.745
Extension	-12.7 ± 10.2	-12.2 ± 10.1	0.748
HJHS (n = 17)			
Swelling	0.0 ± 0.0	0.0 ± 0.0	NA
Duration of swelling	0.0 ± 0.0	0.0 ± 0.0	NA
Muscle atrophy	0.4 ± 0.7	0.3 ± 0.7	0.332
Crepitus on motion	0.4 ± 0.6	0.2 ± 0.6	0.163
Flexion loss	2.4 ± 1.2	2.6 ± 0.9	0.332
Extension loss	1.6 ± 1.4	1.7 ± 1.3	0.835
Joint pain	0.0 ± 0.0	0.0 ± 0.0	NA
Strength	0.4 ± 0.5	0.2 ± 0.4	0.332
Joint Total score	5.1 ± 2.2	5.1 ± 1.9	0.872
Distance of 6-minute walk test (n = 12) (meters)	398.8 ± 98.6	418.9 ± 98.0	<0.001

VAS: Visual Analogue Scale; ROM, range of motion; HJHS: Hemophilia Joint Health Score; NA: not available.

Table 3. Correlation coefficients (r) between change values of outcome measures of knees

Variable	Muscle		Muscle		ROM-flexion	ROM-extension	HJHS-total ^a	6MWT
	VAS	strength-flexion	strength-extension	ROM-extension				
VAS	1.000	0.273	0.023	0.071	0.137	-0.202	-0.009	
Muscle strength-flexion	0.273	1.000	0.501 ^b	-0.130	0.221	-0.319	0.136	
Muscle strength-extension	0.023	0.501 ^b	1.000	-0.222	-0.029	-0.017	0.263	
ROM-flexion	0.071	-0.130	-0.222	1.000	0.107	-0.507 ^b	0.196	
ROM-extension	0.137	0.221	-0.029	0.107	1.000	-0.551 ^b	0.123	
HJHS-total ^a	-0.202	-0.319	-0.017	-0.507 ^b	-0.551 ^b	1.000	-0.316	
6MWT	-0.009	0.136	0.263	0.196	0.123	-0.316	1.000	

^a: n = 17; ^b: p value < 0.05. VAS: Visual Analogue Scale; ROM, Range of Motion; HJHS: Hemophilia Joint Health Score; 6MWT: 6-Minute Walk Test.

Table 4. Adverse reactions after Kinesio Taping

	Descriptions of adverse reactions
Case 1	Mild itching at taping site starting one day after Kinesio Tape application
Case 2	None
Case 3	Intermittent mild itchy skin at proximal anterior thigh on the second day after Kinesio Tape application
Case 4	Intermittent mild itchy skin at left lateral thigh on the second day after Kinesio Tape application
Case 5	None
Case 6	None
Case 7	None
Case 8	None
Case 9	Mild itching at taping site starting one day after Kinesio Tape application
Case 10	None
Case 11	None
Case 12	None



Figure 1. Status after Kinesio Taping.

RESULTS

A total of 12 participants were included in this study. Table 1 shows the demographic and clinical characteristics of these patients. All patients were male with an average age of 43.7 years. Among the 12 patients, 11 had hemophilia A, and one had hemophilia B. For hemophilia severity, eight were severe, three were moderate, and one was mild. Pettersson score was 0 for three right knees and four left knees, 1–6 for four right knees and one left knee,

and 7–13 for two right knees and three left knees.

Table 2 shows the difference of outcome measures before and after Kinesio Taping. VAS score for knee pain during walking significantly decreased from pretaping (1.8 ± 2.3) to post-taping (0.7 ± 1.3) ($p = 0.021$). Knee-extension strength (118.4 ± 45.6 vs. 125.7 ± 45.9 Newton; $p = 0.095$) showed a marginal significant difference between pretaping and post-taping. The post-taping distance for 6MWT (418.9 ± 98.0 meters) showed a significant increase as compared with the pretaping distance (398.8 ± 98.6 meters) ($p < 0.001$).

Table 3 shows the correlation coefficients between change values of outcome measures. Joint Total score of HJHS was negatively correlated with knee flexion ROM ($r = -0.507$, $p = 0.038$) and knee-extension ROM ($r = -0.551$, $p = 0.022$). Knee-flexion muscle strength was positively correlated with knee-extension muscle strength ($r = 0.501$, $p = 0.013$).

Table 4 lists the adverse reactions of Kinesio Taping of patient participants. Four of the 12 patients had a mild itch on their thighs. No other adverse reactions were recorded.

DISCUSSION

For patients with hemophilia, this was the first study to evaluate the impact of Kinesio Taping on knee symptoms of these patients. The results of this study suggest that the application of Kinesio Taping on knees of patients with hemophilia may significantly reduce knee pain during walking and also enhance walking distance. However, there was no significant improvement in knee flexion and extension ROM, knee strength, and knee joint health score with the application.

Mutlu et al. in their study evaluated the impact of applications of Kinesio Tape on patients with osteoarthritis.^[12] Compared with placebo taping (tape was not stretched while taping), a large decrease in knee VAS score and improvement of knee-flexion ROM were observed after Kinesio Taping, and the effect remained at one-month follow up.^[12] Aydogdu et al.^[24] in their study enrolled 28 patients with knee osteoarthritis for Kinesio Taping, and they found significant improvement in VAS score and knee-flexion ROM. Cho et al.^[11] in their study enrolled 46 patients with osteoarthritis to evaluate application of Kinesio Taping. They observed significant attenuation of pain during walking and improvement of knee ROM in patients receiving Kinesio Taping as compared with placebo group. Like the three previously mentioned studies, the major findings of the present study have also showed improvements in knee VAS scores; however, there was no improvement in knee ROM. It is thought that no improvement in knee ROM after Kinesio Taping could be due to the different pathogenesis of hemophilic arthropathy and osteoarthritis, resulting in different degrees of knee flexion limitation. More knee

flexion restrictions, resulting from knee joint destruction, could possibly decrease the effect of Kinesio Taping on ROM. For example, the average pre-intervention knee ROM of patients with osteoarthritis was greater than 99° in all the three studies. In the present study, no participant's knee-flexion and extension ROM could reach normal angles of the knee at pretaping, and average knee ROM was only around 64° .

Kaya Mutlu et al.^[12] in their study showed no difference in muscle strength of quadriceps femoris muscle and hamstring muscle in patients with osteoarthritis after Kinesio Taping. However, Anandkumar et al.^[25] illustrated that significant improvement of the peak quadriceps femoris muscle torque (both concentric and eccentric) was found in patients with osteoarthritis after application of Kinesio Tape. Aydogdu et al.^[24] in their study showed significant improvement of quadriceps femoris muscle strength, but no improvement in hamstring muscle strength after Kinesio Taping in patients with osteoarthritis. Although the impact of Kinesio Taping on the change of quadriceps femoris muscle and hamstring muscle strength in patients with osteoarthritis was inconclusive, it seemed that when improvement occurred, there was more impact on quadriceps femoris muscle strength than on hamstring muscle strength. Our present study also showed that Kinesio Taping had a positive impact on knee-extension strength in patients with hemophilia, although the difference was not large enough to reach the point of statistical significance. We considered that some factors could possibly affect muscle strength, e.g., the taping method of Kinesio Taping, strength testing method and equipment, and quadriceps femoris muscle and hamstring muscle status. In the future, more studies focusing on the effect of Kinesio Taping on knee strength may be needed to address the gaps in this topic.

In their study, Mutlu et al.^[12] showed better walking task score at the one-month follow up in patients with osteoarthritis of Aggregated Locomotor Function after the third Kinesio Taping application. Tani et al.^[26] in their study observed a significant decrease in the time needed to perform a 10-min walk test 3 days after the application of Kinesio Tape on patients with knee osteoarthritis. Kinesio Taping seemed to have a positive effect on walking performance. The present study also showed marked improvement of the distance for 6MWT after

Kinesio Taping. Correlation results showed that the change in value of 6MWT was not associated with change in values of other outcome measures. This implied that the Kinesio Taping-induced improvement of walking ability of these patients could not be explained by the improvement of a single domain, such as that of ROM, strength, pain reduction, or knee general health.

In reviewing past literature, few studies to date have discussed the effect of Kinesio Taping on knee swelling. Wageck et al.^[27] in their study illustrated that a four-day application of Kinesio Taping techniques did not have significant effect on swelling status in 76 older patients with knee osteoarthritis. In the present study, the score of the swelling domain showed no change before and after Kinesio Taping. However, most participants did not have knee swelling at the initiation of the study. Therefore, the effect of Kinesio Taping on knee swelling in patients with hemophilia has remained uncertain. Hemarthrosis of the knee in patients with hemophilia has frequently resulted in knee swelling. Future studies may be able to focus on the effect of Kinesio Taping on acute knee swelling due to hemarthrosis.

Four participants in the present study had the adverse effect of mild skin itching during the 2 days post Kinesio Taping. No participant reported any allergic reaction. One previous study estimated the incidence of allergic reaction after Kinesio Taping to be 1.6% (3/184).^[28] However, Kinesio Tape on skin could last for 3–4 days maximum. If allergic reaction occurs, it is generally advised to remove the tape as soon as possible and return to the clinic for medical treatment.

There are some limitations in our study. Firstly, because a limited number of cases were expected, no control group was designated for comparison; this somewhat decreases the strength of the results. Secondly, the follow-up period of this study is only 2 days, and it is not known how long the effect could last after Kinesio Taping on the knee. It is recommended that future studies assessing the effect of Kinesio Taping on knee symptoms in patients with hemophilia are designed as a large-scale randomized trial using repeated taping with alternate taping-free days and follow-up for a longer period (4 weeks, 8 weeks, etc.). In addition, the effect of application of Kinesio Taping on easily-bleeding major joints with acute-stage hemarthrosis may be another important

issue to be evaluated.

CONCLUSION

The study demonstrates that two-day Kinesio Taping on the knee may reduce pain in the knee during walking and improve walking performance in patients with hemophilia. Kinesio Taping is an easily-performed technique for clinical application. During the taping period, only few cases of mild itchy skin were observed after Kinesio Taping. Since Kinesio Taping provides a short-term therapeutic effect on the knee for patients with hemophilia, future studies should focus on the feasibility of adequate sets of repeated applications for a longer therapeutic effect.

CONFLICT OF INTERESTS

The authors declare that they have no potential conflict of interests with respect to the research, authorship, and/or publication of this article.

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肌能系貼紮對於血友病患者其膝關節症狀的影響： 一個前驅研究

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背景：肌能系貼紮能有效改善多種與膝關節症狀有關的疾病，但這種方式用於有膝關節症狀的血友病患者在過去並無文獻報告過其療效。

目的：評估過去一年有膝關節症狀的血友病患者接受肌能系貼紮的效果。

方法：肌能系貼紮在大腿前側與膝關節兩天，成效評估方面使用行走時疼痛視覺類比量表 (visual analogue scale)，膝關節的彎曲與伸展肌力、彎曲與伸展主動關節活動度、血友病關節健康分數 (Hemophilia Joint Health Score)，六分鐘行走測試，在貼紮前與貼紮後兩天作測量。

結果：在 2018 年期間共有 12 位患者參與研究。疼痛視覺類比量表分數由貼紮前的 1.8 ± 2.3 分顯著降到貼紮後的 0.7 ± 1.3 分 ($p = 0.021$)。六分鐘行走測試由貼紮前的 398.8 ± 98.6 公尺顯著增加到貼紮後的 418.9 ± 98.0 公尺 ($p < 0.001$)。其他成效評估分數貼紮前後無明顯差異。貼紮後的副作用很輕微，只有 4 位患者被觀察到有皮膚搔癢。

結論：兩天的肌能系貼紮能有效減少血友病患者的行走時膝關節疼痛並增加行走能力。(台灣復健醫誌 2020; 48(1): 15 - 24)

關鍵詞：血友病(hemophilia)，肌能系貼紮(kinesio taping)，膝關節疼痛(knee pain)，行走測試(walk test)