Research Article

Pilot Investigation of Ankle Taping Effects on Plantar Pressure Distribution and Ankle Range of Motion in Young Male Barefoot Runners with Chronic Ankle Instability

Behnam Gholami-Borujeni[1*], Hamed Babagoltabar-Samakoush[1], Mohammadhossein Ghasemi[2]

1. Department of Sport Biomechanics and Motor Behavior, Faculty of Sport Sciences, University of Mazandaran, Babolsar, Iran.
2. Department of Biomedical Science, Multi-departmental complex Vallisneri, University of Padova, Padova, Italy.

***Corresponding Author:** Behnam Gholami-Borujeni, Assistant professor,
Department of Sports Biomechanics and Motor Behavior, Faculty of Sport Sciences, University of Mazandaran, Babolsar, Iran.
Tel: 09139777107
E-mail: b.gholami@umz.ac.ir

Highlights
Ankle taping reduces forces on the lateral foot areas.
Taping decreases plantar pressures on the lateral foot regions.
Elastic taping is less restrictive of ankle range of motion.

ORCID ID:
Behnam Gholami-Borujeni: 0000-0002-7404-1556
Hamed Babagoltabar-Samakoush: 0000-0003-1333-6323
Mohammadhossein Ghasemi: 0000-0003-1796-5338

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Running Title: Ankle Taping and Plantar Pressure Distribution

Abstract
***Introduction*:** This study aimed to investigate the effects of four ankle taping conditions (high dye and low dye using both elastic and non-elastic tape) on plantar pressure distribution during the stance phase of running in novice runners with chronic ankle instability.

***Materials and Methods*:** This within-subject repeated-measures study design involved thirty-six (n = 36) novice runnerswith chronic ankle instability. Ankle range of motion were recorded using an electrogoniometer device and plantar pressure data were collected using a Footscan pressure platform during running under five taping conditions: no tape, elastic low-dye, elastic high-dye, non-elastic low-dye, and non-elastic high dye. Repeated measures ANOVA with Bonferroni's correction ($P < .005$) were conducted to compare outcomes across taping conditions.
Results: Elastic high dye taping resulted in the greatest reduction in plantar pressure and peak force in the lateral foot regions. Compared to non-elastic tapes, elastic tapes significantly reduced pressures and forces in these areas ($P < 0.005$). Elastic high dye was found to be the most effective taping condition overall for reducing lateral foot loading during running ($P < .005$). Non-elastic tapings reduced the range of motion of the ankle joint ($P <.005$).
Conclusion:
Elastic high dye taping may influence plantar pressure distribution and reduce lateral foot loading in young male runners with chronic ankle instability. However, as the findings were obtained under barefoot conditions, external validity is limited, and results should be interpreted as short-term biomechanical responses rather than indicators of clinical effectiveness.
Keywords: Ankle Injury; Range of motion; Athletic tape.

Introduction

Lateral ankle sprain is one of the most common sport injuries among athletes [1-3]. Chronic ankle instability (CAI) is a consequence of this sprain, as CAI occurs approximately in 40% of cases after the first sprain experience [4]. CAI is a musculoskeletal problem in which the patient reports frequent ankle sprains and the sense of giving way and instability in the ankle joint [5]. Track and field athletes with a history of ankle sprain have the highest rate (41%) of CAI among athletes [6]. This type of ankle instability may be functional with frequent giving way experience during daily activities [7, 8]. Individuals at risk of ankle inversion sprain typically exhibit greater plantar pressures in the lateral regions of the foot during walking and running [9, 10]. This shift is also reflected in a more laterally positioned center of pressure (COP) in individuals with CAI during the stance phase of gait [11]. Foot posture at initial contact has also been linked to ankle sprain recurrence [12]. Plantar pressure analysis can assess the placement and movement of the foot and ankle during daily activities [13]. Increased plantar pressure in the lateral foot region is a characteristic of a lateral ankle sprain injury [12].

Interventions that can redistribute plantar pressures may influence biomechanical factors associated with ankle sprain mechanisms [10]. Evidence demonstrated that kinsiotaping is an effective tool in reducing the incidence of recurrence ankle sprains [10]. Ankle taping increases participants' perceptions of confidence, stability, and reassurance [14, 15]. Ankle taping, particularly using low-dye and high-dye techniques, has been shown to alter plantar pressure patterns during gait [10, 16, 17]. High-Dye (HD) and Low-Dye (LD) tapes are two common types of taping for the ankle joint. While LD tape is restricted to the foot, HD tape begins at the foot and continues over the lower leg [10]. Some therapists use HD tape for CAI patients because they believe it would protect the rearfoot structures more effectively than LD tape [10]. According to research by Delahunt et al. (2009), HD tape effectively reduces the frequency of recurrent ankle sprains [14]. In contrast, Nolan and Kennedy (2009) showed that LD tape decreases peak plantar pressure in the lateral forefoot region [16]. According to previous studies, changes in plantar pressure distribution increase the risk of ankle sprain injury [11]. Studies have shown that ankle taping modifies plantar pressure distribution [16, 17], improves the function of the ankle and reduces the risk of recurrent ankle sprain [10]. To the authors' knowledge, the effects of ankle taping on plantar pressure distribution during running have not been investigated among athletes with CAI. Studying this in a running context is especially important, as the repetitive lateral loading during running may exacerbate instability-related risks.

Lower plantar pressures in the lateral foot regions reduce the risk of ankle sprains in people with CAI [14, 18] and the risk of overuse injuries in runners [19]. Previous studies have not investigated the effect of different tapings on plantar pressure distribution of people with CAI to reduce the risk of repeated sprains. In this study, we focused on novice heel-toe runners with CAI, as they may lack the compensatory movement strategies of experienced runners, potentially making them more responsive to external interventions like taping. Therefore, this study aimed to examine how different combinations of taping method (high-dye vs. low-dye) and tape type (elastic vs. non-elastic) affect plantar pressure distribution during running and ankle range of motion. An optimal taping method would reduce plantar pressure in the lateral foot region and creates a minimum restriction in the ankle's range of motion. We hypothesized that: 1. All taping conditions would reduce plantar pressure in the lateral foot regions compared to no tape. 2. Elastic tapings would be more effective than non-elastic ones in reducing lateral plantar pressures. 3. Elastic high-dye taping would preserve ankle range of motion better than non-elastic conditions.

Materials and methods

Participants

The participants in this study were 36 male novice heel-toe runners (age: 21.88 ± 2.30; height: 178.41 ± 8.83; mass: 73.68 ± 6.71; BMI: 23.16 ± 1.61). An a priori power analysis was conducted using G*Power software (version 3.1, Heinrich Heine University Düsseldorf, Germany) before data collection. Assuming a medium effect size (f = .25), an alpha level of .05, and a statistical power of .95 for repeated-measures ANOVA, the analysis indicated a required sample size of 31. For potential subject drop, 36 participants were recruited Inclusion criteria were based on the guidelines of the International Ankle Consortium [20]. Participants were required to score less than 24 on the Cumberland Ankle Instability Tool (18.02 ± 2.15) and greater than 5 positive responses on the Ankle Instability Instrument, both of which are widely accepted thresholds for identifying individuals with chronic ankle instability. The inclusion criteria were as follows: a history of unilateral acute ankle sprains that have caused pain, edema, and a dysfunction in the ability for at least one day, the experience of giving way at least twice in the previous six months [20]. Participants had an age range of 18–25 years and had a recreational running program for at least two years and three sessions per week. Participants were considered "novice runners," as they had no history of competitive or professional-level running. Only male participants were included to minimize variability associated with sex-based anatomical differences. This selection criterion is noted as a limitation in the discussion section. The exclusion criteria were the history of surgery, disorder, deformity and injury in the lower extremity and overweight (BMI > 30 $kg.m^{-2}$) [21]. All Runners had heel-toe running pattern (e.g., initial foot contact with the heel region and propulsion with the toe region), which was ensured by running on footscan device. This criterion was used to ensure homogeneity in foot-strike mechanics and to avoid the variability introduced by midfoot or forefoot striking patterns. Participants were informed about the study's objectives and signed a written consent form. The study was approved by the Local Ethics Committee (IR.SHAHROODUT.REC.1403.006) and complied with the Declaration of Helsinki (2008).

Testing procedure

All participants first attended a familiarization and screening session, during which eligibility criteria (e.g., CAI diagnosis, heel-toe running pattern) were confirmed. During this session, participants also completed barefoot running trials (no-tape condition) on the Footscan mat, which served as the baseline condition for subsequent comparisons. The four taping conditions—elastic low-dye (ELD), elastic high-dye (EHD), non-elastic low-dye (NELD), and non-elastic high-dye (NEHD)—were then tested across two experimental sessions conducted 72 hours apart to reduce fatigue and eliminate carryover effects from taping. In each session, participants completed running trials with two of the four taping conditions. The order of taping conditions within each session and the order of sessions (elastic vs. non-elastic first) were randomized using an online-generated randomization (https://www.randomizer.org/). Participants were instructed to avoid enthusiastic physical activity and to avoid using any ankle taping or bracing in the 24 hours before each session.

Plantar pressure data

Plantar pressure data were collected using a Footscan pressure platform (Rsscan International, Belgium; dimensions: 578 mm × 418 mm × 12 mm; 4096 sensors; sampling rate: 253 Hz), which was embedded in the middle of a 16-meter runway. Participants ran barefoot to eliminate the confounding effects of different footwear and to capture direct foot-ground interactions; however, we acknowledge that barefoot running may differ biomechanically from shod running, and this is discussed as a study limitation. The target running speed was 3.3 ± .5 m/s, monitored using infrared photocells (Newtest PowerTimer, Finland) positioned before and after the pressure platform. Running speed was controlled within ±0.5 m/s based on previous literature; however, exact speed matching across all conditions for each participant was not enforced [22]. Trials falling outside this range were excluded. Participants performed multiple running trials under each condition, and data collection continued until at least six valid runs were recorded. In each trial, both feet contacted the pressure mat, but only data from the CAI-affected side were extracted and analyzed to focus on the involved limb. Foot placement was adjusted through practice trials to ensure consistent contact of the CAI foot on the mat. The mean value of the six valid trials was used for analysis for each taping condition. The peak plantar pressure (N/cm^2) and peak plantar force (percent of body weight) for ten anatomical zones of plantar regions were calculated using the Footscan 7 Gait 2nd Generation software. The ten anatomical zones were as follows: the hallux (T1), the other toes (T2-T5), the first to fifth metatarsals (M1-M5), the midfoot (MF), the medial heel (MH) and the lateral heel (LH). The relative time of roll-over process was also calculated using the above-mentioned software (Figure 1).

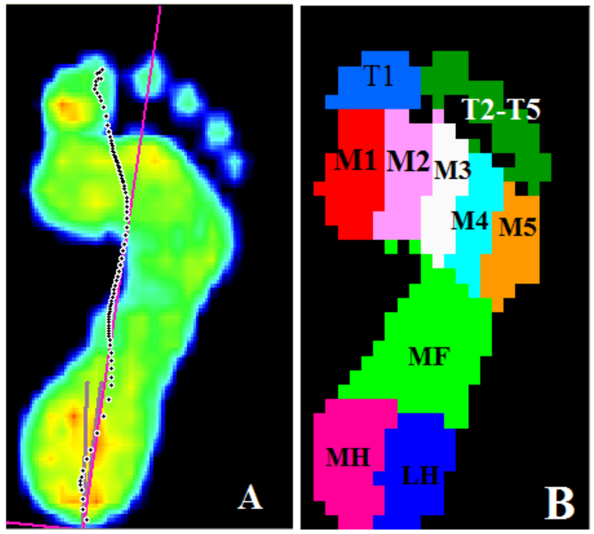

Figure 1. A, Scanning the plantar of the foot during running. B, Ten anatomical region of the foot.

Ankle range of motion

To measure ankle range of motion, participants sat on a bed with their knees at a 90° angle and no contact between their feet and ground. Using an electrogoniometer device (SG150; Biometrics Ltd, United Kingdom), plantar flexion and dorsiflexion range of motion of the ankle were measured for the foot CAI side. The Biometric SG 150 electrogoniometer used in this study has previously shown high reliability (ICC > .90). One axis of electrogoniometer was placed along the fibula and another adjacent to the fifth metatarsal. The ankle joint movements started from the 90° position [23]. Range of motion was assessed separately under each taping condition (NT, EHD, ELD, NEHD, NELD) to determine the impact of tape type and method on ankle mobility. Each participant was instructed and verbally guided through three practice repetitions before recording. After applying the respective taping technique, participants were immediately tested for active range of motion without tape removal. The average score of three tests was calculated for ankle plantar flexion and dorsiflexion range of motion.

Taping protocols

Four taping conditions were applied in this study: elastic low-dye (ELD), elastic high-dye (EHD), non-elastic low-dye (NELD), and non-elastic high-dye (NEHD). All tapes were applied by the same certified physical therapist with extensive taping experience to ensure consistency across conditions. While the participants lay supine with the ankles in a neutral position, elastic blue Kinesio Tex Classic (Kinesio Holding Corp., Albuquerque, New Mexico, USA) and non-elastic white rigid tape (All Products BVBA, Aalst, Belgium) were affixed. The high-dye and low-dye taping methods were applied according to Keenan et al. [24] and Vincenzino et al. [25] (Figure 2). For the elastic tapes, Kinesio Tape (KT) was used and applied with approximately 10–15% tension, following standard recommendations. To standardise elastic tape tension, the required segment length was first measured, and the tape was then cut approximately 10–15% shorter before application to achieve a consistent level of stretch. In the low-dye method, seven strips were anchored around the foot and ankle. In the high-dye method, 11 strips were anchored around the foot and ankle. In the high-dye method, one strip extended from the midfoot up to approximately

10–12 cm above the lateral malleolus, providing ankle support. For non-elastic tapes, rigid athletic tape was applied using the same anchor positions and sequence as the elastic versions, but without any stretch. Each participant received all four taping methods, but only two were tested per session (with 72-hour separation). The order of application was randomized. Tapes were kept in place during the entire running session unless loosened by sweat, in which case the area was cleaned, dried with a towel, and the tape was reapplied following the same protocol.

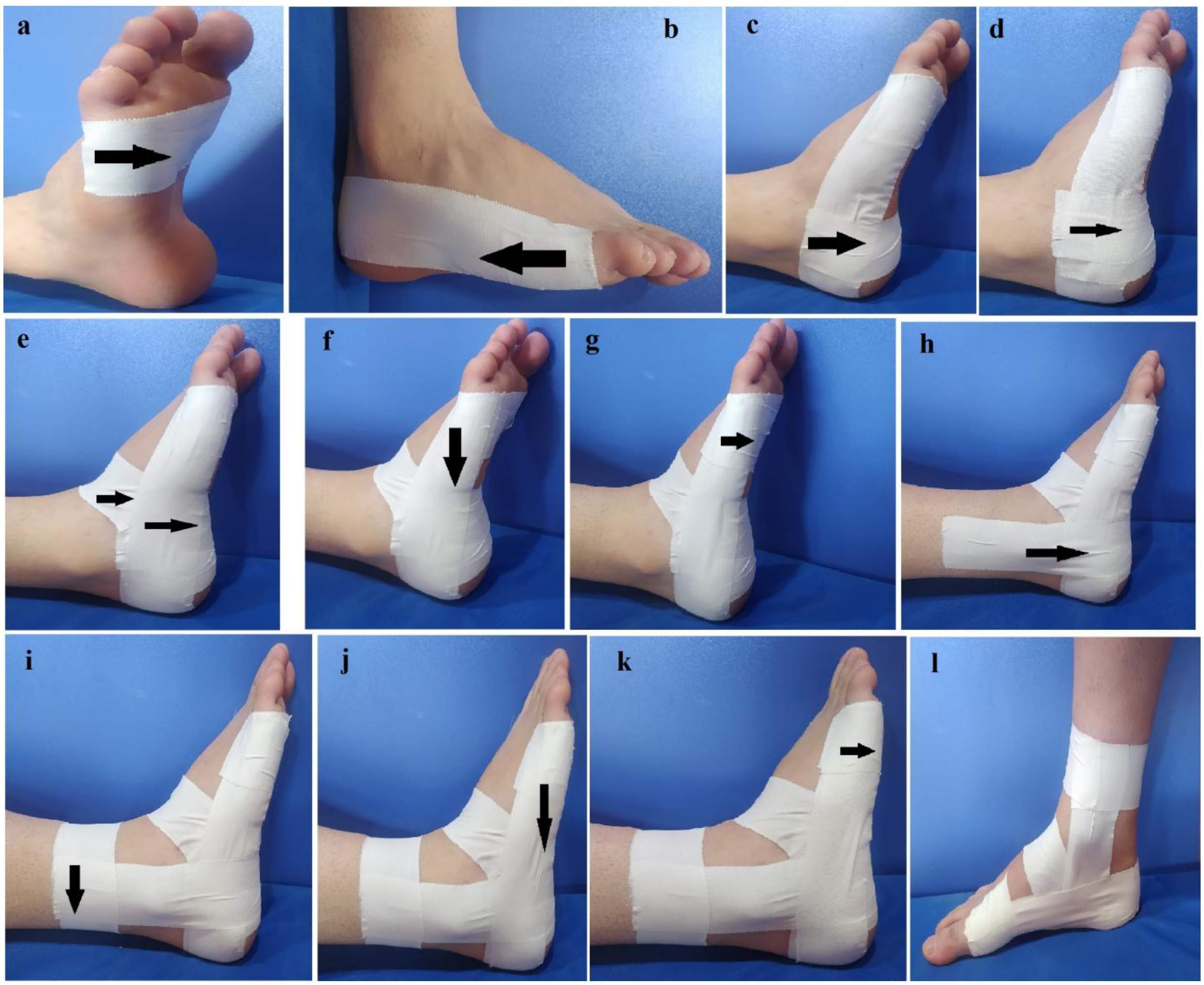

Figure 2. Images a to g show the stages of the low-dye taping method. Images a to k show the stages of the high-dye taping method.

Statistical analysis

In the present study, intraclass correlation coefficients (ICCs) were calculated across the six repeated trials per condition to assess within-condition consistency and support the use of mean values (ICC), and Munro's classification was used to determine the degree of reliability [26]. The ICC values for the peak force and peak plantar pressure indices were .8-.9 (high). The ICC for the range of motion of ankle dorsiflexion and plantarflexion was greater than .95 (very high) as was 0.95 (very high) for Roll-over contact time. The Shapiro-Wilk test showed a normal distribution for all dependent variables across different tapings ($P > .05$). The homogeneity of variances was also confirmed by Levene's test ($P > .05$). The one-way analysis of variance (ANOVA) test with repeated measures was used to compare each dependent variable among various taping methods (NT, ELD, EHD, NELD, NEHD), and pairwise comparisons were conducted using Bonferroni-adjusted significance thresholds. With five conditions, ten pairwise comparisons were made, resulting in an adjusted alpha level of .005 (.05/10). The assumption of sphericity was assessed using Mauchly's test and was met for all analyses ($P > .05$). The effect size for the partial eta squared was then assessed for the statistical analysis ($\eta^2 = .01$, .06 and .14 respectively indicate to small, medium and large effect sizes). All statistical analyses were performed with the Statistical Package for the Social Sciences (SPSS) software (ver. 20, SPSS Inc., Chicago, IL, US).

Results

The effect of various tapings on peak plantar pressures and peak force

Significant differences in plantar pressure and force were observed across the five taping conditions ($P < .001$), with large effect sizes in several foot zones. For example, partial $\eta^2 = .844$ for pressure in metatarsal region 4, indicating a large effect based on Cohen's guidelines ($\eta^2 > .14$). Similar large effects were observed in M5, lateral heel, and maximum force variables. Compared to the NT condition, EHD taping consistently produced the greatest reductions in peak plantar pressures and maximum force across the lateral foot regions, including metatarsals 4–5 and the lateral heel. ELD also showed significant reductions in these areas, although to a lesser extent. Among the non-elastic conditions, NEHD resulted in moderate pressure reductions in some lateral zones, while NELD had minimal impact. Pressure in the midfoot region was significantly reduced only with EHD taping ($P = .004$).In the medial heel region, only the non-elastic high-dye (NEHD) condition produced a statistically significant reduction compared to the no-tape condition ($P < .001$). Other taping conditions did not differ significantly from the no-tape condition in this area. Direct comparisons between elastic and non-elastic conditions revealed that elastic tapings consistently led to lower lateral foot pressures than their non-elastic counterparts ($P < .005$), especially in M4, M5, and lateral heel zones. A complete list of pairwise comparisons and P-values is provided in Table 1 and Table 2. Only comparisons with $P < .005$ were considered statistically significant, based on Bonferroni correction. The observed partial η^2 values for significant variables were notably high, ranging from .722 to .844, particularly in lateral foot regions such as M4, M5, and the lateral heel. According to Cohen's guidelines ($\eta^2 > .14$ = large effect), these values indicate large effect sizes, highlighting the strong practical impact of the taping interventions beyond statistical significance.

Given the number of outcome variables and repeated comparisons, we acknowledge the increased risk of Type I error, even with Bonferroni correction. To mitigate this, we have focused the interpretation on the strongest and most consistent effects, particularly those with both high statistical significance and large effect sizes.

Table 1. Result of peak plantar pressure ($N.\ cm^{-2}$) in various tapings during running. (Dye).

Variable	Mean ± SD					P							
	NT	NELD	NEHD	ELD	EHD	NT VS NELD	NT VS NEHD	NT VS ELD	NT VS EHD	NELD VS NEHD	ELD VS EHD	NELD VS ELD	NEHD VS EHD

Toe 1	21.49 ± 4.17	20.66 ± 5.09	19.57 ± 3.49	21.38 ± 2.61	22.23 ± 4.20	.999	.497	.999	.999	.999	.999	.999	.094
Toe 2-5	10.77 ± 2.54	10.38 ± 2.11	9.61 ± 1.85	9.83 ± 1.99	9.57 ± 2.05	.999	.714	.456	.283	.999	.999	.999	.999
M1	18.62 ± 3.24	18.96 ± 3.23	19.37 ± 4.50	18.56 ± 3.21	20.18 ± 3.48	.999	.283	.999	.723	.319	.085	.999	.999
M2	28.28 ± 3.21	27.64 ± 3.76	28.08 ± 4.22	26.81 ± 3.03	25.65 ± 3.30	.191	.999	< **.001**	**.003**	.999	.999	.342	.013
M3	22.65 ± 3.07	23.01 ± 3.24	21.80 ± 2.86	22.39 ± 3.07	21.18 ± 4.15	.999	.016	< **.001**	< **.001**	.070	< **.001**	.898	.725
M4	18.28 ± 4.10	17.22 ± 3.07	15.73 ± 2.96	15.50 ± 2.96	14.69 ± 2.92	**.002**	< **.001**	< **.001**	< **.001**	**.002**	< **.001**	< **.001**	< **.001**
M5	13.63 ± 4.10	13.23 ± 4.06	12.76 ± 2.93	11.93 ± 3.04	11.39 ± 02	.999	.022	< **.001**	< **.001**	.999	< **.001**	.005	< **.001**
MidFoot	12.20 ± 1.93	11.80 ± 1.89	11.72 ± 1.90	11.12 ± 1.99	10.60 ± 2.02	.295	.359	< **.001**	< **.001**	< **.001**	< **.001**	< **.001**	< **.001**
Heel Medial	30.62 ± 6.49	30.03 ± 6.56	29.47 ± 6.28	28.76 ± 6.67	27.92 ± 5.73	.020	< **.001**	.011	.028	.032	.999	.207	.720
Heel Lateral	35.67 ± 6.04	34.64 ± 5.93	33.04 ± 6.07	33.01 ± 5.85	30.97 ± 6.22	.043	< **.001**	< **.001**	< **.001**	< **.001**	.022	< **.001**	.018

Bold values indicates significant differences P < 0.005, NT: No Tape, NELD: Non-Elastic Low-Dye, NEHD: Non-Elastic High-Dye, ELD: Elastic Low-Dye, EHD: Elastic High-Dye.

Table 2. Result of peak force normalized with body weight percentage ($N.Kg^{-1}$) in various tapings during running.

Variable	**Mean ± SD**					**P**							
	NT	**NELD**	**NEHD**	**ELD**	**EHD**	**NT VS NELD**	**NT VS NEHD**	**NT VS ELD**	**NT VS EHD**	**NELD VS NEHD**	**ELD VS EHD**	**NELD VS ELD**	**NEHD VS EHD**
Toe 1	45.58 ± 8.83	43.80 ± 10.79	41.50 ± 7.40	45.33 ± 5.54	47.11 ± 8.90	.999	.407	.999	.999	.999	.999	.999	.091
Toe 2-5	22.85 ± 5.39	22.02 ± 4.47	20.39 ± 3.92	20.84 ± 4.23	20.28 ± 4.34	.999	.717	.435	.203	.999	.999	.999	.999
M1	39.48 ± 6.87	40.20 ± 6.85	41.06 ± 7.43	39.35 ± 6.81	42.78 ± 7.38	.999	.238	.999	.712	.309	.089	.999	.999
M2	59.96 ± 9.81	58.60 ± 7.98	59.53 ± 6.82	59.54 ± 6.73	56.96 ± 7.33	.199	.999	.999	.439	.999	.999	.999	.968
M3	50.29 ± 6.81	51.07 ± 7.21	48.40 ± 6.36	49.72 ± 6.81	47.02 ± 6.99	.999	.019	< **.001**	< **.001**	.080	< **.001**	.857	.729
M4	40.58 ± 7.89	38.24 ± 8.83	34.93 ± 6.59	34.42 ± 6.60	32.61 ± 6.48	**.003**	< **.001**	< **.001**	< **.001**	**.004**	< **.001**	< **.001**	< **.001**
M5	30.27 ± 8.69	28.26 ± 8.69	27.27 ± 6.89	26.85 ± 6.84	25.64 ± 6.81	< **.001**	< **.001**	< **.001**	< **.001**	< **.001**	< **.001**	< **.001**	< **.001**
MidFoot	27.45 ± 6.34	26.55 ± 4.26	26.37 ± 4.27	25.02 ± 4.47	23.86 ± 4.56	.259	.359	< **.001**	< **.001**	.999	< **.001**	< **.001**	< **.001**

Heel Medial	68.91 ± 14.61	67.58 ± 14.77	66.61 ± 14.20	65.01 ± 15.07	63.11 ± 12.96	.030	**< .001**	.022	.042	.201	.999	.240	.720
Heel Lateral	80.61 ± 13.65	78.30 ± 13.40	74.69 ± 13.72	74.58 ± 13.22	68.64 ± 14.06	.043	**< .001**	**< .001**	**< .001**	**< .001**	.012	**< .001**	.028

Bold values indicates significant differences P < 0.005. NT: No Tape, NELD: Non-Elastic Low-Dye, NEHD: Non-Elastic High-Dye, ELD: Elastic Low-Dye, EHD: Elastic High-Dye.

The effect of various taping methods on the roll-over contact time, and ankle range of motion

The general results of the one-way repeated measures ANOVA test showed that various taping caused a change in contact time ($P = .003$, $\eta^2 = .385$), dorsiflexion range of motion ($P < .001$, $\eta^2 = .982$), and plantarflexion range of motion ($P < .001$, $\eta^2 = .892$). Although a significant main effect was observed for contact time, none of the post-hoc comparisons met the Bonferroni-corrected threshold for significance. The significant main effect for contact time was not supported by post hoc analyses, suggesting that differences between conditions were not robust. The results for pairwise comparisons were as follows: in the dorsiflexion range of motion, there was a significant difference between the condition of NT and NELD (P = .001), NEHD (P < .001), NELD and NEHD (P < .001), and NEHD and EHD (P < .001). In the plantarflexion range of motion, there was a significant difference between the condition of NT and NEHD (P < .001), NELD and NEHD (P < .001), and NEHD and EHD (P < .001) (Table 3).

Table 3. Result of roll-over contact time, and ankle dorsiflexion and plantarflexion range of motion in various tapings.

Variable	**Mean ± SD**					**P**							
	NT	**NELD**	**NEHD**	**ELD**	**EHD**	**NT VS NELD**	**NT VS NEHD**	**NT VS ELD**	**NT VS EHD**	**NELD VS NEHD**	**ELD VS EHD**	**NELD VS ELD**	**NEHD VS EHD**
Contact Time (ms)	243.13 ± 38.09	240.44 ± 34.72	229.38 ± 40.07	237.22 ± 39.02	217.80 ± 38.75	.999	.013	.421	.038	.168	.190	.999	.999
Dorsiflexion range of motion (°)	24.22 ± 4.31	20.94 ± 5.30	18.41 ± 4.25	23.88 ± 4.52	23.55 ± 4.91	**.001**	**< .001**	.438	.437	**< .001**	.438	.008	**< .001**
Plantarflexion range of motion (°)	32.55 ± 7.62	28.63 ± 7.79	26.11 ± 8.78	32.22 ± 7.84	31.88 ± 8.17	**.010**	**< .001**	.436	.438	**< .001**	.428	.028	**< .001**

Bold values indicate significant differences P < 0.005. NT: No Tape, NELD: Non-Elastic Low-Dye, NEHD: Non-Elastic High-Dye, ELD: Elastic Low-Dye, EHD: Elastic High-Dye.

Discussion

The purpose of this study was to investigate the effects of different ankle taping techniques (elastic and non-elastic high-dye and low-dye) on plantar pressure distribution and ankle range of motion during running in young male runners with chronic ankle instability.The results of this study showed that various tapings change peak plantar pressures and peak forces in athletes with CAI. The results demonstrated that EHD taping produced the most substantial reductions in plantar pressure and force in lateral foot regions. This finding is consistent with the hypothesis that EHD may influence load distribution more effectively than other taping methods. Notably, the reductions in pressure with EHD were significantly greater than those observed with NEHD and ELD taping, particularly in metatarsals 4–5 and the lateral heel. Only elastic tapes reduced pressure and force in the midfoot region.

This study does not align with Vicenzino et al (2007) as they found that ankle taping increases lateral midfoot pressures during walking and jogging and decreases pressure at the medial forefoot and rearfoot during walking [27]. However, they used the Low-Dye taping in the ankle area of healthy subjects, and it seems that in their research, the natural gait pattern of their participants changed. The current study extends these observations to running, a more dynamic activity with plantar forces. This distinction is critical, as running imposes higher demands on the ankle joint and may require different stabilization strategies. Previous studies showed that individuals with CAI experience greater lateral foot pressures and forces during running and walking [11, 28].

Patients with CAI prefer to walk on the lateral part of the CAI foot [29], likewise, lower plantar pressures in lateral regions have been reported in association with altered lateral ankle loading patterns in individuals with ankle instability [30, 31], the current study did not assess injury incidence. Thus, any claims about injury risk reduction should be framed as hypothetical and require confirmation through longitudinal or prospective studies. Chinn et al. (2014) found that ankle taping during walking and jogging creates a more neutral ankle position and also corrects the impaired proprioception which may prevent from lateral ankle sprains [32]. From our findings, it seems that EHD provides better ankle support. This taping also influences foot kinematics during running and walking by controlling rearfoot eversion [10, 27, 33]. As a result, the EHD taping method can be a suitab, le option for individuals with CAI.

The results of this study showed that both types of non-elastic tapings decreased the range of motion of the ankle joint in both dorsiflexion and plantarflexion, while the elastic tapes did not reduce the range of motion. In line with this, Deschamps et al. (2016) and Dingenen et al. (2017) found that EHD taping increases dorsiflexion during running and walking [10, 33]. As reduced range of motion in ankle dorsiflexion is a strong predictor of the risk of ankle sprain [34], the use of elastic tapes seems more proper for CAI individuals.

Study limitations

Several limitations of this study should be acknowledged when interpreting the findings. First, the study assessed only the immediate (acute) effects of ankle taping within a single testing session; therefore, no conclusions can be drawn regarding long-term adaptations or clinical outcomes such as injury prevention or recurrence. In addition, although various taping techniques exist for the ankle joint, it was not feasible to investigate all methods in the present study. Therefore, only the most commonly reported taping techniques in the literature were selected. Second, the study was conducted under barefoot running conditions, which may limit the ecological validity of the findings, as footwear can influence plantar pressure distribution and may interact with taping effects. Third, patient-reported outcomes such as perceived stability, pain, comfort, or functional status were not assessed, limiting the clinical interpretation of the biomechanical findings. Fourth, the sample was restricted to young male novice heel-toe runners with unilateral chronic ankle instability, which limits the generalisability of the results to female athletes, experienced runners, individuals with different foot-strike patterns, or those with bilateral involvement. Fourth, although running speed was controlled within a predefined range, exact matching across conditions was not verified for each participant. In addition, tape tension was not objectively measured, and potential variations in tape adhesion during testing were not quantified. Furthermore, contralateral limb data and inter-limb symmetry were not assessed, limiting the ability to evaluate bilateral compensatory mechanisms. Finally, multiple dependent variables were analysed, and although Bonferroni corrections were applied for post hoc comparisons, the risk of Type I error across outcomes cannot be fully excluded.

Conclusion

Our results showed that various tapings can change plantar pressure and force on the lateral foot regions during running in novice runners with CAI. Elastic tapings were more effective in reducing the force and pressure on the lateral part of the foot compared to non-elastic tapings. Among the taping conditions tested, EHD taping produced the most favorable changes in plantar pressure distribution, particularly reducing lateral foot pressures, without compromising ankle range of motion. These findings suggest that EHD may be a promising taping option for redistributing plantar loads in young male novice runners with CAI. However, given the limited scope of measured outcomes and the absence of clinical or injury-based endpoints, further studies are needed before making definitive clinical recommendations.

Consent for publication

All authors have given their consent for the publication of this manuscript.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethical Considerations

Compliance with ethical guidelines

The objectives of the study were explained to the participants before the procedure, and then they signed an informed written consent form. This study was approved and registered by a Local Ethics Committee (IR.SHAHROODUT.REC.1403.006) and fulfilled based on the Declaration of Helsinki (2008).

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Authors' contributions

B. G: Conceptualization, Data curation, Statistical analysis, Project administration, Methodology, Supervision, writing – original draft, Writing – review & editing. **H.B:** Conceptualization, Data curation, Methodology, Writing – review & editing**. M. G:** Conceptualization, Writing – review & editing.

Conflict of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

.١ Herb C, Blemker S, Saliba S, Hart J, Hertel J. Chronic ankle instability patients exhibit higher variability in lower extremity joint-coupling variability during drop vertical jumps. Journal of Biomechanics. 2020;99:109479.
.٢ Picot B, Lopes R, Rauline G, Fourchet F, Hardy A. Development and validation of the Ankle-GO score for discriminating and predicting return-to-sport outcomes after lateral ankle sprain. Sports Health. 2024;16(1):47-57.
.٣ Samudra AD, Purwanto B, Utomo DN. Differences in limb muscle strength affecting vertical jump heights in soccer players after chronic ankle injury. Journal of Modern Rehabilitation. 2024.
.٤ Rosen AB, McGrath ML, Maerlender AL. Males with chronic ankle instability demonstrate deficits in neurocognitive function compared to control and copers. Research in Sports Medicine. 2021;29(2):116-28.
.٥ Torp DM, Thomas AC, Hubbard-Turner T, Donovan L. Biomechanical response to external biofeedback during functional tasks in individuals with chronic ankle instability. Journal of athletic training. 2021;56(3):263-71.
.٦ Lin C-I, Houtenbos S, Lu Y-H, Mayer F, Wippert P-M. The epidemiology of chronic ankle instability with perceived ankle instability-a systematic review. Journal of foot and ankle research. 2021;14(1):41.
.٧ Simon J, Garcia W, Docherty CL. The effect of kinesio tape on force sense in people with functional ankle instability. Clinical Journal of Sport Medicine. 2014;24(4):289-94.
.٨ Biz C, Nicoletti P, Tomasin M, Bragazzi NL, Di Rubbo G, Ruggieri P. Is kinesio taping effective for sport performance and ankle function of athletes with chronic ankle instability (CAI)? A systematic review and meta-analysis. Medicina. 2022;58(5):620.
.٩ Willems T, Witvrouw E, Delbaere K, De Cock A, De Clercq D. Relationship between gait biomechanics and inversion sprains: a prospective study of risk factors. Gait & posture. 2005;21(4):379-87.
.١٠ Deschamps K, Dingenen B, Pans F, Van Bavel I, Matricali GA, Staes F. Effect of taping on foot kinematics in persons with chronic ankle instability. Journal of science and medicine in sport. 2016;19(7):541-6.
.١١ Koldenhoven RM, Feger MA, Fraser JJ, Saliba S, Hertel J. Surface electromyography and plantar pressure during walking in young adults with chronic ankle instability. Knee Surgery, Sports Traumatology, Arthroscopy. 2016;24(4):1060-70.
.١٢ Mineta S, Inami T, Mariano R, Hirose N. High lateral plantar pressure is related to an increased tibialis anterior/fibularis longus activity ratio in patients with recurrent lateral ankle sprain. Open Access Journal of Sports Medicine. 2017:123-31.

.١٣ Morrison KE, Hudson DJ, Davis IS, Richards JG, Royer TD, Dierks TA, et al. Plantar pressure during running in subjects with chronic ankle instability. Foot & ankle international. 2010;31(11):994-1000.
.١٤ Delahunt E, O'Driscoll J, Moran K. Effects of taping and exercise on ankle joint movement in subjects with chronic ankle instability: a preliminary investigation. Archives of physical medicine and rehabilitation. 2009;90(8):1418-22.
.١٥ De Ridder R ,Willems T, Vanrenterghem J, Verrelst R, De Blaiser C, Roosen P. Taping benefits ankle joint landing kinematics in subjects with chronic ankle instability. Journal of Sport Rehabilitation. 2020;29(2):162-7.
.١٦ Nolan D, Kennedy N. Effects of low-dye taping on plantar pressure pre and post exercise: an exploratory study. BMC Musculoskeletal Disorders. 2009;10(1):40.
.١٧ Ruiz-Ramos M, Orejana-García ÁM, Vives-Merino I, Bravo-Llatas C, Lázaro-Martínez JL, Molines-Barroso RJ. Effectiveness of the Fixtoe Device ®in plantar pressure reduction: a preliminary study. BMC Musculoskeletal Disorders. 2022;23(1):475.
.١٨ Malmir K, Olyaei GR, Talebian S, Jamshidi AA, Mousavi S. Effects of peroneal muscle fatigue on ground reaction force profile during lateral hop landing. Journal of Modern Rehabilitation. 2018;12(2):105-12.
.١٩ Wilzman AR, Tenforde AS, Troy KL, Hunt K, Fogel N, Roche MD, et al. Medical and biomechanical risk factors for incident bone stress injury in collegiate runners: can plantar pressure predict injury? Orthopaedic Journal of Sports Medicine. 2022;10(6):23259671221104793.
.٢٠ Gribble PA, Delahunt E, Bleakley C, Caulfield B, Docherty C, Fourchet F, et al. Selection criteria for patients with chronic ankle instability in controlled research: a position statement of the International Ankle Consortium. journal of orthopaedic & sports physical therapy. 2013;43(8):585-91.
.٢١ Kosik KB, Johnson NF, Terada M, Thomas-Fenwick AC, Mattacola CG, Gribble PA. Health-related quality of life among middle-aged adults with chronic ankle instability, copers, and uninjured controls. Journal of athletic training. 2020;55(7):733-8.
.٢٢ Askari Z, Esmaeili H. Effect of trunk muscles fatigue on plantar pressure distribution in novice runners. Journal of Biomechanics. 2021;12.٢:١١٠٤٨٧
.٢٣ Yalfani A, Azizian M, Gholami-Borujeni B. Adding neurofeedback training to neuromuscular training for rehabilitation of chronic ankle instability: A 3-arm randomized controlled trial. Sports Health. 2024;16(5):797-807.
.٢٤ Keenan A-M, Tanner CM. The effect of high-Dye and low-Dye taping on rearfoot motion. Journal of the American Podiatric Medical Association. 2001;91(5):255-61.
.٢٥ Vicenzino B, Feilding J, Howard R, Moore R, Smith S. An investigation of the anti-pronation effect of two taping methods after application and exercise. Gait & posture. 1997;5(1):1-5.
.٢٦ Ghasemi MH, Anbarian M, Esmaeili H. Immediate effects of using insoles with various wedges on activation and co-contraction indices of selected trunk muscles during load lifting .Applied Ergonomics. 2020;88:103195.
.٢٧ Vicenzino B, McPoil T, Buckland S. Plantar foot pressures after the augmented low dye taping technique. Journal of Athletic Training. 2007;42(3):374.
.٢٨ Schmidt H, Sauer LD, Lee SY, Saliba S, Hertel J. Increased in-shoe lateral plantar pressures with chronic ankle instability. Foot & ankle international. 2011;32(11):1075-80.

.۲۹ Becker H, Rosenbaum D, Claes L, Gerngro H. Measurement of plantar pressure distribution during gait for diagnosis of functional lateral ankle instability. Clinical biomechanics (Bristol, Avon). 1997;12(3):S19-S.
.۳۰ Koldenhoven RM, Feger MA, Fraser JJ, Hertel J. Variability in center of pressure position and muscle activation during walking with chronic ankle instability. Journal of Electromyography and Kinesiology. 2018;38:155-61.
.۳۱ Chen J, HUANG H-s, Shuang R, ZHANG S, Xing X, Feng Z, et al. Characteristics and related factors of plantar pressure in the chronic ankle instability individuals. Journal of Peking University (Health Sciences). 2021;53(2):279.
.۳۲ Chinn L, Dicharry J, Hart JM, Saliba S, Wilder R, Hertel J. Gait kinematics after taping in participants with chronic ankle instability. Journal of athletic training. 2014;49(3):322-30.
.۳۳ Dingenen B, Deschamps K, Delchambre F, Van Peer E, Staes FF, Matricali GA. Effect of taping on multi-segmental foot kinematic patterns during walking in persons with chronic ankle instability. Journal of science and medicine in sport. 2017;20(9):835-40.
.۳٤ de Noronha M, Refshauge KM, Herbert RD, Kilbreath SL. Do voluntary strength, proprioception, range of motion, or postural sway predict occurrence of lateral ankle sprain? British journal of sports medicine. 2006;40(10):824-8.