

The effect of kinesiology tape on ankle balance abilities: A systematic review

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Abstract:

An ankle sprain is one of the most common musculoskeletal injuries and is often associated with the instability of the ankle, which limits the range of motion (ROM) and affects balance abilities. Thus, treating and preventing ankle sprain or chronic ankle instability is crucial. Kinesiology tape (KT) is an elastic tape that is widely used to support and stabilize the ankle joints and muscles without restricting the ROM. There is a limited study on reviewing the effect of the application of KT on ankles improving balance abilities, focusing on the taping technique and duration of application. Therefore, the purpose of this study is to review the existing literature on evaluating the effectiveness of kinesiology tape, its application technique, and duration. A search was conducted in electronic databases (Scopus and Web of Science) from 2011 to 2021 using the terms “kinesiology tape”, “ankle”, and “balance”. A total of 15 articles were selected from 68 total articles. The results of each study were summarized and compared. As a result, 13 articles showed significant improvement in KT application in individuals with and without ankle instability. Hence, it is recommended that the ankle-balance taping (ABT) technique and lateral ankle sprain-taping technique are both used in individuals with and without ankle instability. Moreover, it is suggested that the KT application for individuals with ankle instability is used for more than 24 hours while individuals without ankle instability just use it immediately before performing activities. This indicated that the KT application will help in treating and preventing ankle injuries in individuals with and without ankle instability. This systematic review provides evidence that KT application has advantages with balance abilities in individuals with and without ankle instability, based on previous and current studies.

Key Words: Ankle sprain, Chronic ankle instability, Range of motion, Kinesiology tape

Introduction

Ankle injuries are one of the most common musculoskeletal injuries in sports-related and recreational activities (Bell et al., 2011). According to Liu and Nguyen (1999), approximately 85% of ankle injuries are ankle sprains, and the possibility of the recurrence of ankle sprains is high (Janssen et al., 2014). It has been reported that more than 40% of individuals with ankle sprains may experience the feeling of “giving way” without structural limitations or ankle instability (Sekir et al., 2007). Due to that, the recurrence of ankle sprains may trigger chronic ankle instability (CAI), peroneal tendon pathology, anterior ankle impingement, and osteoarthritis — all of which required prolonged treatment (Sugimoto et al., 2009). Additionally, these injuries may be caused by decreased proprioception, altered postural control and reduced muscular strength (Hertel, 2002). Furthermore, an individual with an acute ankle sprain has functional limitations, due to severe pain that may limit the range of motion (ROM) and increase the instability of the ankle (Shin & Kim, 2017). Besides, according to Hertel (2000), ankle sprains increase the instability of the ankle, which affect static and dynamic balance. Hence, these factors can eventually have significant effects on individuals during daily activities and within sports.

Balance and postural control are essential factors in performing recreational activities and sports (Bell et al., 2011). Balance can be classified as static balance and dynamic balance. Static balance is known as the ability of the body to maintain a position when there is no physiological movement (Murray, 2013). Meanwhile, according to Butler et al. (2012), dynamic balance is defined as the ability to maintain the stability of the centre of mass (COM) when there is movement.

Kerkhoffs et al. (2012) stated that approximately 50% of ankle injuries are medically treated while 40% result in CAI. Thus, treating and preventing ankle sprain or CAI are of significant importance. Commonly, acute ankle injuries are treated with ice and compression, immobilization, and optimal functional treatment, which includes taping and bracing, manual mobilization and other therapies.

Ankle injuries can also be prevented by improving ankle functional performance through exercise, taping, and bracing. The use of elastic tape can be considered based on committee agreement in sports. Generally, ankle taping using non-elastic or bracing is used to further prevent ankle injury (Janssen & Kamper,

2013). However, some studies have shown that ankle taping using non-elastic or bracing interferes with normal function, which significantly restricted ROM (Metcalf et al., 1997).

Kinesiology tape (KT), known as clinical tape, was developed by a chiropractor, Dr Kenzo Kase, in the 1970s and has been widespread among athletes at the 2008 Olympics in Beijing, China. The KT is an elastic tape, and it can be stretched up to 140% of its original length. The KT can return to its original length and is reported to elevate the skin, allowing improved blood flow and drainage of the lymphatic fluid (Kase et al., 1998; Murray, 2001). Hence, KT is a rehabilitation taping technique designed to mimic skin and stimulate the body's natural healing process.

Despite a growing number of studies on the effect of KT taping on musculoskeletal injuries, there is still an insufficiency of study trials from which to collect data on the effect of KT application on ankles in improving balance abilities, including individuals with and without ankle instability. This systematic review aims to look at clinical trials, including randomized controlled trials, that compared the effect of KT application (intervention) on ankles (outcomes) in individuals with and without ankle instability.

Material & methods

Eligibility Criteria

The articles included were based on the following criteria:

- 1) *Currency*: within last 10 years (2011–2021);
- 2) *Population*: healthy individuals and individuals with ankle instability;
- 3) *Intervention*: taping applied to ankle joint and/or specific targeted muscle;
- 4) *Outcome*: measures relating to balance abilities; and
- 5) *Design*: randomized controlled trials or cohort studies.

Articles were excluded if they were not available in English or were full-text articles or publications. The titles and abstracts of all articles found were evaluated to determine whether the study matched the inclusion criteria.

Data Sources and Search

A comprehensive and systematic search for articles from journals published between 2011 and 2021 was performed. Two online databases, Scopus and Web of Science, were searched in May 2021 and updated in June 2021. The following search terms were used in both databases: “kinesiology tape”, “ankle”, and “balance”. Abstracts of all search results were reviewed to identify relevant articles. Full-text articles that we deemed relevant to the analysis were gathered. Additional publications were identified through manual searches of bibliographies of the related articles that we retrieved.

Data Collection Process

The following items were extracted from each included study:

- the sex and description of the individuals or athletes and level of participation;
- the intervention with KT, including the location and method of tape application;
- the time between tape application and balance testing;
- any attempts to blind subjects;
- the balance abilities measured; and
- the outcome measures used to obtain the result.

Results

The database searches resulted in a total of 68 articles as potentially eligible for inclusion. Sixty-four articles remained after duplicates were removed, and 20 articles remained after a review of titles and abstracts. Therefore, a total of 20 full-text articles were reviewed for eligibility. After full-text reviews, a total of 13 articles fit the inclusion criteria. However, there were two articles selected in the references of the selected articles that were eligible, for an overall total of 15 studies for this review. The characteristics and main results from reviewed studies are shown in Table 1.

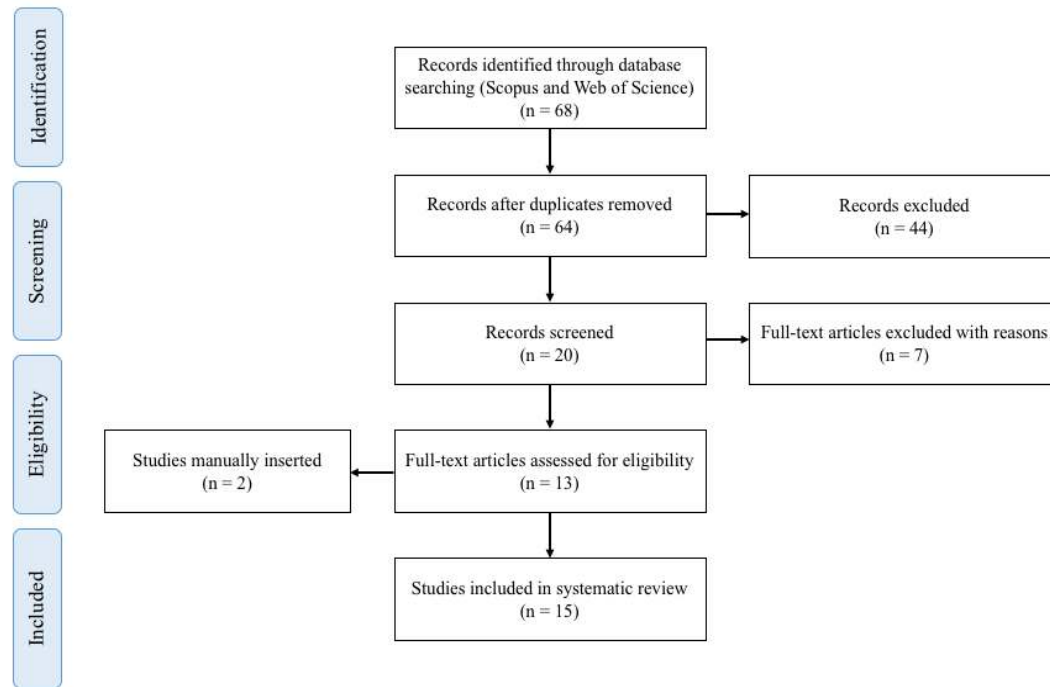


Fig. 1: Flow Diagram of Study-Selection Process

Table 1. Summary of Articles Concerning the Effect of KT on Ankle Balance Abilities Improvement

Study	Participant characteristics	Intervention with KT	Intervention with placebo/ other tape	Control condition	Outcome measures	Time between taping and testing	Result
Fayson et al., 2013	30 females free of ankle injury	30 participants, applied KT for prevention of a lateral ankle sprain	No taping intervention	The side of taping was determined by a coin flip	Static restraint as assessed using an instrumented ankle arthrometer and dynamic postural control was assessed using time-to-stabilization (TTS) measures	Pre-test, then taping, followed by immediate testing and after 24 hours of taping	KT improved in static restraint for stiffness. However, no significant differences on TTS
Domingo et al., 2015	15 male and 15 females with chronic ankle instability (CAI)	15 participants, applied KT for a lateral ankle sprain	15 participants, applied placebo taping	30 participants randomly assigned to intervention group and control group	Balance was assessed using sensory organization test (SOT)	Pre-test, then taping, followed by testing immediately, then after 7 days of use	KT and control group had improved in SOT scores during follow-up. However, no differences between both groups during follow-up in most parameters. The changes may be due to subjective increase in confidence
Kim et al., 2015	33-year-old man with 10 years of chronic ankle instability (CAI)	Participant applied KT with ABT technique	No taping intervention		Static balance was assessed using Balance Error Scoring System (BESS), dynamic balance was assessed using Star Execution Balance Test (SEBT), and ankle active range of motion was assessed using a universal goniometer	No exact time between taping and testing. However, the tape was applied for 2 months (average, 16 hours per day)	KT with ABT technique improved after repeated application over 2 months for static balance, dynamic balance and active ankle range of motion

Kim and Cha, 2015	20 male and 30 females without orthopaedic history of ankle joints	50 participants, applied KT at tibialis anterior and calf	No taping intervention		Balance ability was assessed using Good Balance and gait was assessed using pedometer	Pre-test, then taping, followed by testing immediately	KT showed a significant difference in all balance parameters, and gait velocity also significantly increased
Lee and Lee, 2015	9 young male soccer players with functional ankle instability (FAI)	3 participants, applied KT with ankle balance taping (ABT) technique	3 participants, applied placebo taping 3 participants, received no tape	9 participants randomly assigned to KT, placebo taping and no-tape group	Dynamic balance was assessed using Star Execution Balance Test (SEBT)	Taping, followed by testing immediately	KT with ABT improved in anterior and posterolateral reach distance compared to placebo taping and no-tape group
Lee and Lee, 2015	28-year-old amateur soccer player with Grade 2 medial ankle sprain	Participant applied KT with ankle inversion taping (AIT) technique	No taping intervention		Tenderness was measured using an algometer (pressure of 3 kg), dynamic balance was assessed using Star Execution Balance Test (SEBT), and ankle flexibility was assessed using weight-bearing ankle dorsiflexion	No exact time between taping and testing. However, the tape was applied for 2 months and was reapplied every day	KT with AIT improved dynamic balance and ankle flexibility and decreased medial ankle pain and self-reported functional ankle deficits
Jackson et al., 2016	30 participants with chronic ankle instability (CAI)	15 participants, applied KT at the tibialis anterior, tibialis posterior and peroneus longus	15 participants, received no tape	30 participants randomly assigned to KT and control group	Balance was assessed using Balance Error Scoring System (BESS)	Pre-test, followed by taping and testing after 48 hours of taping, then tape removed and testing after 72 hours of tape removal	KT improved after 24 hours of taping and retained even after 72 hours of tape removal
Lee and Lee, 2016	21-year-old woman with Grade 2 ankle inversion sprain	Participant applied KT with ankle eversion taping (AET) technique	No taping intervention		Functional dynamic balance was assessed using the Y-Balance Test (YBT)	No exact time between taping and testing. However, the tape was applied for 4 weeks (average, 15 hours per day)	KT with AET improved in functional dynamic balance, reduced ankle instability and pain
Kim and Cha, 2015	20 male and 30 females without orthopaedic history of ankle joints	50 participants, applied KT at tibialis anterior and calf	No taping intervention		Balance ability was assessed using Good Balance and gait was assessed using pedometer	Pre-test, then taping, followed by testing immediately	KT showed a significant difference in all balance parameters, and gait velocity also significantly increased
Lee and Lee, 2015	9 young male soccer players with functional ankle instability (FAI)	3 participants, applied KT with ankle balance taping (ABT) technique	3 participants, applied placebo taping 3 participants, received no tape	9 participants randomly assigned to KT, placebo taping and no-tape group	Dynamic balance was assessed using Star Execution Balance Test (SEBT)	Taping, followed by testing immediately	KT with ABT improved in anterior and posterolateral reach distance compared to placebo taping and no-tape group
Lee and Lee, 2015	28-year-old amateur soccer player with Grade 2 medial ankle sprain	Participant applied KT with ankle inversion taping (AIT) technique	No taping intervention		Tenderness was measured using an algometer (pressure of 3 kg), dynamic balance was assessed using Star Execution Balance Test (SEBT), and ankle flexibility was assessed using weight-bearing ankle dorsiflexion	No exact time between taping and testing. However, the tape was applied for 2 months and was reapplied every day	KT with AIT improved dynamic balance and ankle flexibility and decreased medial ankle pain and self-reported functional ankle deficits
Jackson et al., 2016	30 participants with chronic ankle instability (CAI)	15 participants, applied KT at the tibialis anterior, tibialis posterior and peroneus longus	15 participants, received no tape	30 participants randomly assigned to KT and control group	Balance was assessed using Balance Error Scoring System (BESS)	Pre-test, followed by taping and testing after 48 hours of taping, then tape removed and testing after 72 hours of tape removal	KT improved after 24 hours of taping and retained even after 72 hours of tape removal
Lee and Lee, 2016	21-year-old woman with Grade 2 ankle inversion sprain	Participant applied KT with ankle eversion taping (AET) technique	No taping intervention		Functional dynamic balance was assessed using the Y-Balance Test (YBT)	No exact time between taping and testing. However, the tape was applied for 4 weeks (average, 15 hours per day)	KT with AET improved in functional dynamic balance, reduced ankle instability and pain

Lee and Lee, 2017	7 male and 8 female physically active individuals free of ankle injury; Randomized crossover trial design	5 participants, applied KT with ABT technique	5 participants, applied placebo taping 5 participants, received no tape	15 participants randomly assigned to KT, placebo taping and no-tape group, then switched after 1 week	Postural control was assessed using Balance Error Scoring System (BESS), and active ankle flexibility was assessed using ankle AROM	Taping, followed by testing immediately	No significant difference among the group for AROM and BESS scores of single-leg and tandem stances on a firm surface among the taping group. However, the BESS scores of the single-leg and tandem stances on a foam surface were significantly lower with ABT compared to no-tape group but did not have any significant difference from placebo taping group
Botsis et al., 2019	12 non-professional female ballet dancers free of ankle injury; Mixed-model, repeated measures design	12 participants, applied KT for prevention of a lateral ankle sprain	12 participants, applied ST for prevention of a lateral ankle sprain with no tension 12 participants, received no tape	12 participants randomly assigned for KT, ST and no-tape group, then switched	Ankle complex passive and active motions was assessed using portable ankle arthrometer and jump landing time-to-stabilization was assessed using force plate	No exact time between taping and testing	KT showed a significant difference in ankle complex passive and active motions. However, no significance differences among KT, ST, and no-tape for jump landing time-to-stabilization
Choi and Lee, 2020	16 male and 15 females free of ankle injury individuals; Single-blinded, randomized controlled trial design	16 participants, applied KT with ABT technique	15 participants, applied KT with APT technique	31 participants randomly assigned to intervention group and control group	Static and dynamic balance was assessed using BioRescue	Pre-test, then ankle muscle fatigue-inducing exercise, then test, followed by taping and testing immediately	KT with ABT technique decreased significantly when eyes open and closed in the static and dynamic conditions

Sample

A total of eight studies from an overall study involved individuals with ankle instability, which involved chronic ankle instability (CAI), functional ankle instability (FAI) and ankle sprain (Domingo et al., 2015; Kim et al., 2015; Lee & Lee, 2015; Lee & Lee, 2015; Jackson et al., 2016; Lee & Lee, 2016; Mohamed et al., 2016; Kim & Shin, 2017). Another seven studies involved individuals without ankle instability (Fayson et al., 2013; Kim & Cha, 2015; Bailey & Firth, 2017; Farquharson & Greig, 2017; Lee & Lee, 2017; Botsis et al., 2019; Choi & Lee, 2020).

Balance Abilities

From 15 studies, 13 studies recorded an improvement in balance abilities, including static balance, dynamic balance, muscle fatigue and ankle flexibility (Fayson et al., 2013; Kim et al., 2015; Kim & Cha, 2015; Lee & Lee, 2015; Lee & Lee, 2015; Jackson et al., 2016; Lee & Lee, 2016; Mohamed et al., 2016; Farquharson & Greig, 2017; Kim & Shin, 2017; Lee & Lee, 2017; Botsis et al., 2019; Choi & Lee, 2020). However, four studies did not record an improvement in balance, including in time-to-stabilization (TTS), balance parameters and proprioception (Fayson et al., 2013; Domingo et al., 2015; Bailey & Firth, 2017; Botsis et al., 2019).

Kinesiology Tape Application Technique

All the studies included an intervention with KT application, according to Kase's recommendation (Kase et al., 1998). Five studies involved ankle balance taping (ABT) (Kim et al., 2015; Lee & Lee, 2015; Kim & Shin, 2017; Lee & Lee, 2017; Choi & Lee, 2020). Two studies involved ankle inversion taping (AIT) and ankle eversion taping (AET) (Lee & Lee, 2015; Lee & Lee, 2016). Lastly, four studies targeted a specific muscle, such as the tibialis anterior, tibialis posterior, gastrocnemius, peroneus and sole (Kim & Cha, 2015; Jackson et al., 2016; Bailey & Firth, 2017; Farquharson & Greig, 2017).

Duration of Kinesiology Tape Application

Seven studies involved the immediate effect of KT application balance abilities (Kim & Cha, 2015; Lee & Lee, 2015; Bailey & Firth, 2017; Farquharson & Greig, 2017; Kim & Shin, 2017; Lee & Lee, 2017; Choi & Lee, 2020). In addition, another six studies involved more than 24 hours of KT application (Fayson et al., 2013; Domingo et al., 2015; Kim et al., 2015; Lee & Lee, 2015; Jackson et al., 2016; Lee & Lee, 2016). In contrast, two studies did not state the duration of KT application (Mohamed et al., 2016; Botsis et al., 2019).

Discussion

Kinesiology Tape Effect on Balance Abilities

The current review identified 15 studies investigating the effect of KT on ankle-improving balance abilities. This study specifically showed that KT application was observed to improve balance abilities in participants with or without ankle instability. From the balance abilities in the 15 included studies reported, seven studies showed a significant improvement in balance abilities involving individuals with ankle instability

(Kim et al., 2015; Lee & Lee, 2015; Lee & Lee, 2015; Jackson et al., 2016; Lee & Lee, 2016; Mohamed et al., 2016; Kim & Shin, 2017). Another four studies provide similar findings, which was that a significant improvement was recorded in individuals without ankle instability (Kim & Cha, 2015; Farquharson & Greig, 2017; Choi & Lee, 2020). In addition, three studies showed that two had outcomes with a significant effect and no significant effect on balance abilities in individuals without ankle instability (Fayson et al., 2013; Lee & Lee, 2017; Botsis et al., 2019). The studies showed an improvement in the performance recorded, which included static balance, dynamic balance, muscle fatigue, ankle flexibility and gait ability. From the previous result, it is indicated that KT application is preferable, compared to another kind of taping, in ensuring balance abilities in both healthy individuals and individuals with ankle instability.

Findings by Kim et al. (2015) concluded that KT may stimulate cutaneous mechanoreceptors, which inhibits the transmission of nociceptive signals. Hence, KT may increase the ankle AROM by increasing the threshold of pain transmitted by receptors in the ankle joint. Moreover, the stimulation of proprioceptors caused by using KT application over the ankle joint improved ankle joint position sense, allowing the ankle joint to remain in a neutral posture. Thus, increased ankle stability improved the Cumberland Ankle Instability Tool (CAIT) score by decreasing the error scores in the BESS test and increasing reach distances in the SEBT. Another similar finding offered by Lee and Lee (2017) that reported KT application had an improvement on the BESS performances of the single-leg and tandem stances on foam, without affecting ankle AROM. The finding was consistent with a previous study by Jackson et al. (2016) in which it was reported that the ankle proprioceptors may be affected after a lateral ankle sprain, resulting in dampened feedback. Therefore, the tactile stimulus from the KT application provides the feedback that the damaged proprioceptors have been lacking. In contrast, a study by Lee and Lee (2017) showed no significant difference in AROM when applying KT may be because of individuals without ankle instability. Additionally, Bailey and Firth (2017) concluded that there were no improvements in proprioception on KT application to the ankles in professional football players without ankle instability. It is stated that kinaesthesia was a more important contributor to proprioception since it relies more on cutaneous stimulation from skin stretch.

Apart from that, two studies showed a significant improvement in gait ability, which the application of KT stimulates various sensory receptors, improving the contraction ability of the muscle (Kim & Cha, 2015), and KT application on the injured side of the ankle may increase the stability of the ankle joint while preventing excessive posture that can cause pain, allowing movement within the elastic range (Kim & Shin, 2017).

In addition, Choi and Lee (2020) have conducted a study on the static and dynamic balance after muscle fatigue-inducing exercise. An improvement in both static balance and dynamic balance was recorded. It stated that muscle fatigue-inducing exercise may cause a significant increase in surface area ellipses due to impaired proprioception and kinaesthetic sense and reduced neuromuscular control. Hence, due to the elasticity of the KT that returns to its original length, it may support the joint to return to its original position. Additionally, Farquharson and Greig (2017) illustrated similar outcomes on semi-professional soccer players without ankle instability to mediate a fatigue impact on balance performance after both localized and soccer-specific exercise protocols. The underlying mechanism of KT application activated a positive thermal and tactile effect, as a result of both exercise protocols. A current study by Botsis et al. (2019) reported that KT support significantly improved ankle complex inversion stiffness in the low-loading range but not the high-loading range. Contrary to research conducted, Fayson et al. (2013) concluded that KT application may support mechanical stiffness of the ankle joint without altering peak motion in the ankle joint as higher loads were applied.

Three studies demonstrated different outcomes, as they reported there were no significant improvements in balance abilities (Fayson et al., 2013; Domingo et al., 2015; Botsis et al., 2019). From the previous outcomes, two studies illustrated similar outcomes, which no significant improvement between KT application and time-to-stabilization (TTS). These findings may also be attributed to the individuals as they may have been utilizing other neuromuscular balance strategies (Fayson et al., 2013; Botsis et al., 2019). Findings by Domingo et al. (2015) reported that no significant difference between groups in most balance measurements in individuals with ankle instability. The use of the KT application may act as a psychological reminder that reassured participants and improved their sense of stability and confidence, resulting in its effectiveness in preventing injury.

Based on the analyses, KT may stimulate proprioception and cutaneous mechanoreceptors to improve ankle joint sense and maintain the neutral position of the ankle joint. In addition, KT is an elastic tape that allows the ankle to move within the ROM without affecting ankle AROM, hence improving balance abilities. Lastly, the elasticity of KT is known to return to its original length, contributing to stabilising the ankle joint in its original position.

Application of Kinesiology Tape Technique and Balance Abilities

Based on the reviews, there were a few techniques of KT application used as an intervention in balance abilities improvement. The KT application in all studies was according to Kase's recommendations (Kase et al., 1998). Techniques of KT application used included ankle balance taping (ABT), ankle inversion taping (AIT), ankle eversion taping (AET) and lateral ankle sprain taping. Additionally, some studies targeted a specific muscle, including the tibialis anterior, tibialis posterior, gastrocnemius, peroneus and sole. The improvement in

balance abilities occurred due to the activation of proprioception and cutaneous mechanoreceptors that was triggered by the KT application, enabling the ankle joint to maintain its original position and increase the pain threshold, respectively, based on the application of KT.

Five studies demonstrated an improvement with the use of the ABT technique in balance abilities (Kim et al., 2015; Lee & Lee, 2015; Kim & Shin, 2017; Lee & Lee, 2017; Choi & Lee, 2020). The ABT technique provided the stability of the ankle joint through the adjustment of ankle movements, which included dorsiflexion, eversion, and inversion, which consisted of four strips without limiting ROM. In contrary to research conducted, Kim and Shin (2017) concluded the effectiveness of the ABT technique in gait ability. The ABT technique applied posterior gliding of the talus to enhance dorsiflexion of the ankle joint and applied inversion/external rotation of the calcaneus to increase inversion and eversion movement of the ankle joint. Due to KT application with its elasticity, it maintained ankle joint stability while allowing free mobility of the ankle, resulting in a significant improvement in gait ability (Lee & Lee, 2015). However, a study by Lee & Lee (2017) concluded that the ABT technique significantly lowers the BESS score on foam surfaces but no significant difference in AROM. In addition, Lee and Lee (2015) conducted a study on individuals with ankle instability using the AIT technique. The study showed an improvement in balance ability with the AIT technique. Additionally, Lee and Lee (2016) illustrated similar outcomes in individuals with ankle instability using the AET technique, resulting in enhanced balance abilities. KT application with the AIT technique protected the sprained ankle, from recurrence and prevent eversion that can cause pain due to the mechanical effect of inversion, which it is the same mechanism to AET technique that protects the ankle from reinjury through mechanical effects of AET application.

Another four studies involved the lateral ankle sprain taping technique as an intervention in improvement of balance abilities (Fayson et al., 2013; Domingo et al., 2015; Mohamed et al., 2016; Botsis et al., 2019). The current study by Mohamed et al. (2016) showed the lateral ankle sprain taping technique has a superior effect in individuals with ankle instability for improving ankle joint stability. Another two studies recorded a similar finding in which the lateral ankle sprain taping technique improved muscle stiffness; however, there were no significant differences in TTS in individuals without ankle instability (Fayson et al., 2013; Botsis et al., 2019). Additionally, the study by Domingo et al. (2015) illustrates that lateral ankle sprain taping techniques had no significant improvements on individuals with ankle instability in balance abilities. It is concluded that the improvements observed could be related to other factors that showed a significant improvement in perceptions of confidence, stability and reassurance during tape conditions.

Four studies were conducted about applying KT to the specific muscle (Kim & Cha, 2015; Jackson et al., 2016; Bailey & Firth, 2017; Farquharson & Greig, 2017). The findings by Farquharson and Greig (2017) showed an improvement in muscle fatigue while applying KT at the peroneal for muscle facilitation in which peroneal musculature involved in ankle eversion, assisting plantar flexion, hence stimulated a multiplanar cutaneous benefit. The recent study by Kim and Cha (2015) concluded that there was an improvement in gait and balance abilities by applying KT at the tibialis anterior and calf muscle among individuals without ankle instability. Another similar finding recorded by Jackson et al. (2016), which put the KT application at the anterior tibialis, posterior tibialis, peroneus longus muscle and over the transverse arch, has significant improvement in static balance. Findings by Bailey and Firth (2017) demonstrated different outcomes, as they reported there were no significant improvements in proprioception while applying KT at the peroneal, gastrocnemius and sole.

As a result, KT application may be beneficial to both individuals with and without ankle instability in improving balance abilities. It is suggested that the ABT technique and lateral ankle sprain taping technique can both provide stability to ankle joints and prevent ankle injury in individuals with and without ankle instability. The ABT technique provides the stability in dorsiflexion, inversion and eversion, while the lateral ankle sprain taping technique prevents excessive inversion and eversion movement, which can lead to ankle injuries.

Duration of Kinesiology Tape Application and Balance Abilities

From the analyses, four studies conducted involved in the immediate effect of KT application showed an improvement in balance abilities (Kim & Cha, 2015; Lee & Lee, 2015; Kim & Shin, 2017; Lee & Lee, 2017). Apart from that, two studies provided similar findings, in which there was a significant difference in the immediate effect of KT application after muscle fatigue in balance abilities (Farquharson & Greig, 2017; Choi & Lee, 2020). However, one study involved the immediate effect of KT application and showed no improvement in balance abilities (Bailey & Firth, 2017).

Another five studies involved more than 24 hours of KT application, and concluded that there was an improvement in balance abilities (Fayson et al., 2013; Kim et al., 2015; Lee & Lee, 2015; Jackson et al., 2016; Lee & Lee, 2016). Jackson et al. (2016) conducted a study after 72 hours of tape removal. As a result, static balance improvements were maintained for 72 hours even after the tape was removed after 48 hours of application, which occurred due to the constant stimulation of cutaneous receptors and mechanoreceptors. In contrast to previous studies, Domingo et al. (2015) showed no significant improvement in balance abilities in individuals with ankle instability, after seven days of KT application. However, another two studies did not state

the duration of KT application before testing, but showed an improvement in balance abilities (Mohamed et al., 2016; Botsis et al., 2019).

In conclusion, it is recommended for individuals with ankle instability to apply KT for more than one day for an average of 15 hours a day to stimulate proprioception and cutaneous mechanoreceptors to treat the injured part and prevent further injury, hence, improving balance abilities. Meanwhile, individuals without ankle instability should preferably apply KT immediately before performing sports or recreational activities to prevent ankle injuries in future.

Conclusions

This review aims to systematically investigate the effect of KT application on ankles to improve balance ability in individuals with and without ankle instability. Across 15 comparisons conducted, the ABT and lateral ankle sprain taping technique are both recommended for individuals with and without ankle instability to treat and prevent injuries, where the technique provides the stability in dorsiflexion, inversion and eversion movement. Additionally, individuals with ankle instability were recommended to apply KT for more than 24 hours to trigger the mechanism and treat the injured part. Meanwhile, individuals without ankle instability were recommended to immediately apply KT prior to performing any sports and recreational activities to prevent any ankle injuries. Finally, further research on comparing KT application, placebo taping, and outcome measures on ankles in improving balance abilities and the method to blind the control condition to prevent bias in the study are suggested.

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