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Effectiveness of Arch Support Taping is Subjects With Excessive Foot Pronation: A Meta-analysis

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Abstract

Background: An excessive pronated foot is defined as a flattening or complete loss of the medial longitudinal arch. Excessive foot pronation is considered to have high risk factors of overuse injuries in the lower limb. Various treatments have been investigated in attempts to control excessive pronation.

Objects: This meta-analysis identifies the effects of an anti-pronation taping technique using different materials.

Methods: The electronic databases used include MEDLINE, the Physiotherapy Evidence Database (PEDro), Science Direct, the Korean Studies Information Service System (KISS), the Research Information Sharing Service (RISS), the Korea National Library, and the Korean Medical Database (studies published up to July 31, 2019). The database search used the following keywords: "foot drop" OR "foot arch" OR "foot pronation" OR "flat foot (pes planus)" AND "taping" OR "support." Eight eligible studies were analyzed to determine the effectiveness of anti-pronation taping in study and control groups.

Results: The overall random effect size (Hedges' g) of the anti-pronation taping technique was 0.147 (95% confidence interval [CI]: -.214 to .509). When the effect (Hedges' g) was compared by the type of tape material, rigid tape (RT; Lowdye taping) was .213 (95% CI: -.278 to .704) and kinesiotape (KT; arch support taping) was -.014 (95% CI: -.270 to .242). Based on this meta-analysis, it was not possible to identify the extent to which anti-pronation taping was effective in preventing navicular drop, improving balance, or changing foot pressure. Only three of the eight eligible studies applied KT on excessive pronated feet, and the outcome measure areas were different to those of the RT studies. The KT studies used EMG data, overall foot posture index (FPI) scores, and rear foot FPI scores. In contrast, the RT studies measured navicular heights, various foot angles, and foot pressure.

Conclusion: This review could not find any conclusive evidence about the effectiveness of any taping method for patients with pronated feet. Future studies are needed to develop the anti-pronation taping technique based on the clinical scientific evidence.

Key Words: Kinesio taping; Meta-analysis; Rigid taping; Pronated foot.

Introduction

Pes planus has been defined as a loss or flattening of the medial longitudinal arch; it is also called excessive pronated foot (Kodithuwakku Arachchige et al, 2019). Foot pronation action is normally needed for shock absorption during the gait's intial stance phases (Lafortune et al, 1994). However abnormal foot pronation tends have other structural causes, such as tibial internal rotation or foot adduction, altering normal biomechanical mechanism. The flat foot population endures decreased postural stability, which is associated with higher incidence of lower extremity overuse injuries (Dahle et al, 1991; Levinger et al, 2010). Such problems typically include medial tibial stress syndrome, patellofemoral pain syndrome, metatarsal stress fracture, plantar fasciitis, Achilles tendinitis, and hallux ridius (Cheung and

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Table 1. The summary of included articles

Study	Types of tape	Taping methods	Sample Size(N)		Outcome	Age
			Experimental group	Control group		
Kim (2011)	Rigid tape	X-type	15	15	Navicular drop height, Medial midfoot (N/㎠), Lateral midfoot (N/㎠)	22.0
Eom (2014)	Rigid tape	Low-Dye taping	15	15	Navicular height, Overall stability index	21.2
Choi (2018)	Rigid tape	Low-Dye taping	10	10	Calcaneal inclination angle, Talocalcaneal angle, Antero-posterior talocalcaneal angle, Antero-posterior talometatarsal angle, Front plantar foot pressure (%), rear plantar foot pressure (%), Body sway surface (cm^2)	22.5
Luque-Suarez (2014)	Kinesiotape	Arch support	34	34	FPI[a] change scores, Rear foot FPI changes scores	25.0
Lee (2017)	Kinesiotape	Arch support	18	20	EMG (vastus medialis oblique, vastus lateralis, abductor hallucis)	24.7
Newell (2015)	Kinesiotape	Navicular sling	25	25	Navicular height	20.0
	Rigid tape	Low-Dye taping	25	25	Navicular height	20.0
Vicenzino (2000)	Rigid tape	[b]ALD	14	14	Navicular height	23.8
Vicenzino (2007)	Rigid tape	ALD	22	22	Foot pressure (rear foot-medial, rear foot-lateral, mid foot-medial, mid foot-lateral)	28.0

[a]foot posture index, [b]augmented low-Dye taping method.

Ng, 2007; Cheung and Ng, 2008; Moen et al, 2009; Weist et al, 2004).

Various mechanical factors affect the foot. The rearfoot and the midfoot are adducted during pes planus. The pes planus occurs multifactorial conditions, with congenital pes planus presenting since birth and acquired pes planus developing after birth. Its causative factors include age, ethnicity, gender, obesity, and the function of the intrinsic and extrinsic foot muscles (Pita-Fernandez et al, 2017). According previous research pes planus affects roughly 25% of the general population, and is more prevalent among female individuals, those with higher body mass indices, and those with larger feet (Pita-Fernandez et al, 2017).

Structurally pes planus can occur in one foot or both feet. Its most common difference with a normal foot is calcaneal varus, a principal cause of excessive foot pronation. Such structural alterations make the medial longitudinal arch (MLA) collapse lowering the navicular height (Power et al, 1995). Foot instability can also negatively affect to the maintenance ability of functional body balance stability causing the foot and leg to fatigue easily, produce pain, and increase the risk of lower extremity injury. These effects can alter the normal activities of daily living as weell as quality of life (Kodithuwakku Arachchige et al, 2019).

Different interventions have been developed and applied to control pronated foot, such a s foot orthoses, motor control footwear, insoles, ankle bracing, intrinsic foot muscle training, arch support taping, surgical correction, and rehabilitation strategies (Kodithuwakku Arachchige et al, 2019). Cheung et al's (2011) meta-analysis research of 29 studies

proved the effectiveness of 3 foot orthoses, motor control footwear, and therapeutic adhesive taping. All of the interventions were able to control foot pronation, but foot taping was the most effective for controlling calcaneal eversion (Cheung et al, 2011).

Various foot taping methods are applied to control pain, facilitate intrinsic foot muscles, and redistribute foot pressure by using different tape materials and various taping techniques (Whitaker et al, 2003). Tape materials can be divided by mechanical elasticity characteristics, traditional tape is rigid (non-elastic) while kinesiotape is elastic. In previous research, traditional tape shows effectiveness during structural corrections of the foot's arch, but kinesiotape facilitates the proprioceptive sense to correct the foot's arch neurophysiologically (Franettovich et al, 2012; Luque-Suarez et al, 2014).

Although some previous taping studies have shown the effectiveness of anti-pronation taping, there are various applicable tape materials and techniques, and reported results have use differ outcome measures-longitudinal arch height, pain, activities of intrinsic foot muscles, foot pressure, functional outcome measures of the foot-that have created conflicting findings. Therefore, the purpose of this meta-analysis is to identify and summate the effects of an anti-pronation taping technique using different materials to obtain scientific evidence.

Methods

Literature Search

A literature search was performed using the following electronic databases: MEDLINE, the Physiotherapy Evidence Database, Science Direct, Embase, the Korean Studies Information Service System, the Research Information Sharing Service, the National Assembly Research Service of the Republic of Korea, and the Korean Medical Database (studies published up to July 31, 2019). The search used the following keywords: "foot drop" OR "foot arch" OR "foot pronation" OR "flat foot (pes planus)" AND "taping" OR "support." The search keywords and phrases used in the online search was included using a flowing combination of the key words "flat foot", "pes planus", "foot drop", "foot arch", "foot pronation", "taping", "support", and "arch support". After the online search was completed the reference lists of published papers obtained from primary electronic searches were reviewed by hand. The primary database search produced, 538 articles published from 1991 to July 31, 2019. A screening process then took place to remove articles, before screening remaing article titles and abstracts against the search terms. The remaining articles were then reviewed as full texts.

Data Extraction, Primary Outcome and Synthesis of Results

After completing the primary searches and reviewing the full texts, eight articles remained. These eligible studies were analyzed to determine the effectiveness of anti-pronation taping. Among these studies, two had studied about effects of the rigid tape (RT), five studied the effects of kinesiotape (KT) and one had studied both of them. Data was extracted by author (published year), types of tape, taping method, sample size, sample age, and outcome measures (mean, and stand deviation). Table 1 provides a summary of this extracted data.

High heterogeneity between data sets was found in studies using different taping techniques and the I2 was 85.73 ($p<.05$), so the total effect size was estimated using randomized effect model in the Comprehensive Meta-analysis 2.0 program (Biostat, Englewood, NJ, USA) (Cooper and Hedges, 1994). The effect size was determined using Cohen's d (standardized mean difference).

Results

Characteristics of eight selected articles

The sample sizes of the selected articles ranged

from 20 to 68 participants. The experimental groups were treated using x-type taping (RT), low-Dye taping (RT), augmented low-Dye taping (ALD), and arch support taping (KT) techniques while the control groups received either sham treatment or none at all.

Overall random effect size of the various anti-pronation taping techniques

The overall random effect size (Hedges' g) of the anti-pronation taping technique was .147 (95% confidence interval [CI]: -.214 to .509). When the Hedges' g was compared to tape material types, rigid tape when used with low Dye taping, was .213 (95% CI: -.278 to .704) and KT when used with arch support taping, was -.014 (95% CI: -.270 to .242) (Figure 1). Based on this meta-analysis, it was not possible to identify the extent to which anti-pronation taping was effective in preventing navicular drop, improving balance, or changing foot pressure. Only three of the eight eligible studies applied KT on excessively pronated feet, and the outcome measure areas differed from the RT studies. Specifically, the KT studies used EMG data, overall foot posture index (FPI) scores, and rear foot FPI scores, while the RT studies measured navicular heights, various foot angles, and foot pressure.

Discussion

Taping techniques have been used to prevent sports injuries supporting joint structures and muscles, and facilitate rehabilitation processes in the field of sports rehabilitation (Thelen et al, 2008). The main effects of taping can be divided into neurophysiologic and biomechanical effects. Neurophysiologic effects that are achieved simply by appling tape to the body, facilitating the proprioceptive function to recover process after chronic injury, prevent acute injury, support injured muscles and joints, relieve pain by lifting the skin, and improve blood and lymph flow (Lephart, 1995; Williams et al, 2012). The biomechanical effects of taping are modifying the movement, correcting position, supporting structural function along with weakened muscles or tendons, and reducing the speed of motion.

Williams et al (2012) reviewed 10 studies on the effectiveness of KT. Their meta-analysis showed, applied outcome measures of pain scales, ranges of motion, muscle strength (specifically grip strength), proprioception, and the muscle activity of quadriceps and hamstrings (peak torque). The meta-analysis indicated KT showed little quality or a lack of consistent evidence to improve on muscle functions or range of motion, and sense of proprioception. Franettovich et al (2008) attempt to determine the biomechanical, physiological and psychological base for anti-pronation taping by using systematic review. The tape application methods reviewed low-Dye taping, and modified low-Dye taping (e.g., x-strip, reverse-8 stirrup, ALD). They proved the biomechanical taping effect achieved through anti-pronation taping reduced the calcaneal eversion angle of the standing leg alignment by 9~17% (static activities). Positive effects were also shown immediately after tape application on the height of navicular (8~16% increase), arch height ratio, tibial internal rotation, calcaneal eversion (reduction of 4.6 degrees), and plantar pressure during dynamic activities (e.g., walking or running). Despite these results , the effects were not maintained consistently depending on duration of dynamic exercise. Inconclusive evidence was also found regarding neurophysiologic and psycholgic effects (Franettovich et al, 2008).

Radford et al (2006) reported that the maintenance time of low-Dye taping was within 10-minutes, finding evidence of an effect that failed to support the maintenance of navicular height through the application RT and KT. Verbruggen et al's (2018) narrative reviewed five studies (four randomized controlled trials, and one controlled clinical trial) about the effectiveness of applying low-Dye taping to plantar fasciitis pain. All of the selected studies reported pain under the visual analogue scale, while

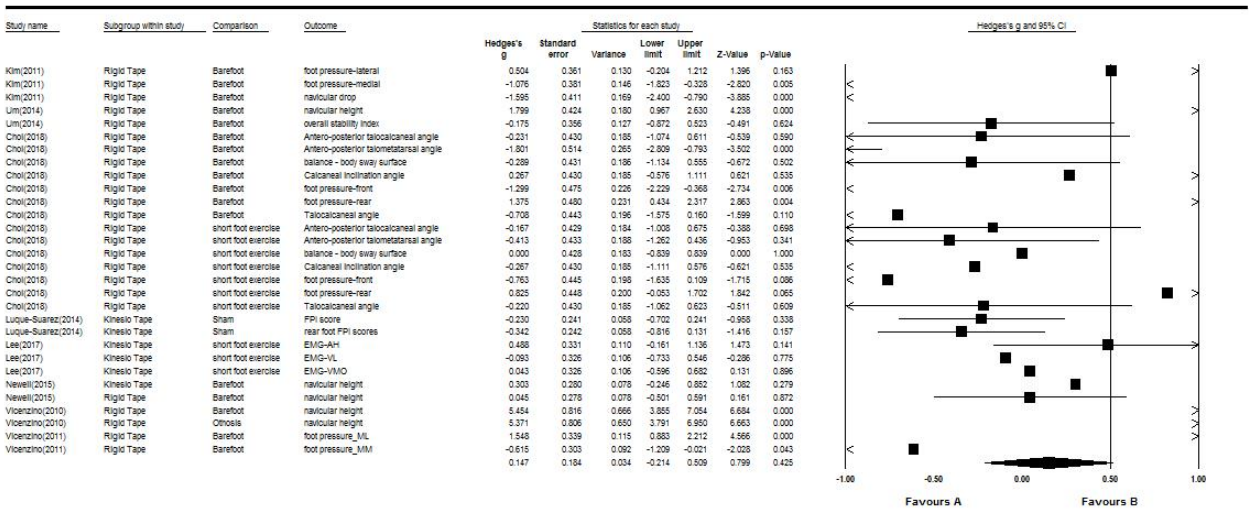

Figure 1. Forest plot of 8 studies (std diff: standard difference, CT: confidence interval).

other outcome measures were used indeterminately, such as the Foot Health Status Questionnaire (to check of foot function and health status), the Manchester Foot Pain and Disability Schedule (to measure pain related to foot disability), the transfer area of the center of gravity, and Functional Foot Index Questionnaire (to measure foot function). All of the result showed a significant reduction of visual analog scale scores statistically, along with comparison differences between group conditions, application periods, and maintaining time of effects.

While this study's meta-analysis suggests which anti-pronation taping techniques and tape materials are more effective scientifically, only 8 eligible studies (with 31 subgroups) were analyzed to compare the effectiveness of anti-pronation taping in experimental groups with controls. The overall effect of anti-pronation taping was not in evidence, and the each effect of RT and KT did not provide supportive scientific evidence. Based on this meta-analysis, it was not possible to identify the extent to which anti-pronation taping was effective in preventing navicular drop, improving balance, or changing foot pressure. As this study could not evaluate the quality of the study, the risk of bias, and data extraction independently, further studies are needed to make up for these limitations and obtain scientific results.

Conclusion

This meta-analysis identified the effects of anti-pronation taping technique using different materials. The database search used the following key words: "foot drop" OR "foot arch" OR "foot pronation" OR "flat foot (pes planus)" AND "taping" OR "support." Eight eligible studies were analyzed to determine the effectiveness of anti-pronation taping in study and control groups. Five of the eligible studies applied rigid tape (RT; low-Dye taping), and only three of the eight eligible studies applied kinesiotape (KT) on excessive pronated feet.

The overall random effect size of the anti-pronation taping technique was .147 (95% confidence interval [CI]: -.214 to .509). It means these taping techniques are not support conclusive evidence to prevent pronation of the foot scientifically. Future studies are needed to develop the anti-pronation taping technique based on the clinical scientific evidence.

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