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Research Article

The Effect of Different Taping on Balance and Strength in an Older Adult with Ankle Osteoarthritis

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Abstract

Background: Ankle Osteoarthritis represents an important limiter on different aspects of efficient functioning of the ankle joints. The purpose of this study was to examine if application of zinc white tape and Kinesiotape would have an immediate positive effect on balance and strength of an older adult with ankle osteoarthritis.

Methods: A 44 year old male diagnosed with osteoarthritis in his right ankle was recruited. The participant was 5'10" tall and weighted 178 lbs. He performed the Single-Leg Jump-Landing Test (SLJLT), the Star Excursion Balance Test (SEBT) and the Standing Heel Rise Test (SHRT) without tape, and then with Kinesio and white Zinc tape. The tests were implemented on different days to prevent fatigue.

Results: The results revealed that in comparison to no-tape conditions, both taping approaches coincided with enhanced static and dynamic balance control, as inferred from the Single-Leg Jump-Landing Test (SLJLT) and Star Excursion Balance Test (SEBT) respectively. The differences in strength, based on Standing Heel Rise Test (SHRT), were also evident but their clinical relevance is unclear.

Conclusion: Overall, the results showed that taping represents a potentially enhancing, and immediate aid for someone with ankle osteoarthritis. The differences between the two tapes, in line with previous literature, warrant further exploration. Nevertheless, from the clinical and

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practical standpoint it appears that the application of either tape may be beneficial when the individual may engage in exercise or even simple activities of daily living.

Keywords

Ankle Osteoarthritis; Static and Dynamic Balance Control; Strength, Kinesiotape; Zinc (White) Tape

Introduction

Ankle osteoarthritis is a degenerative disease that primarily affects older adults. It results in the breakdown of synovial joints due to long-term weight-bearing and joint overuse [1]. Past research showed that ankle osteoarthritis has a negative impact on balance, especially when a person is constrained to place the entire body weight on a single leg [2]. Control of balance is often dependent on strength, as effective activation of muscles surrounding the ankle is essential to the ability of a person to correct for the external or self-initiated disturbances to the Center of Mass (COM). In the case of patients with osteoarthritis, there is a need to derive a non-invasive easily applicable interventions to regain the functional strength and balance while minimizing pain and discomfort, which often limit their ability and willingness to exercise or perform even seemingly simple tasks of daily living (e.g., negotiating stairs) [3]. Many different treatments have been implemented in the past, which are vital to the delay of joint deterioration, reduction in symptoms, and improvement of strength, range of movement, and balance. Such approaches included low-impact exercises, hydrotherapy, soft tissue massage, dry needling and electrotherapy (e.g. ultrasound), among others [2]. However, the immediate effects of different type of taping on strength and balance control in these individuals has been rarely investigated, despite the fact that this approach was proven to be effective with patients exhibiting knee osteoarthritis [4,5].

In the clinical field a variety of taping approaches have been implemented. One of the treatments commonly used is strapping, which involves the implementation of Zinc oxide tape. Its primary purpose is to act as a rigid support by stabilizing weakened ligaments, tendons, and muscles. It can also inhibit or promote muscle activity depending on the method of application [6]. In this context ankle taping reduces the risk of injury, or the severity, by providing additional limitation to the ranges of motion that may overload connective tissues, for example by reducing the absolute inversion or the rate of ankle inversion. In contrast to the Zinc tape, another tape that has been used widely in the field is the Kinesiotape. In the 1970s, Kenzo Kase, a chiropractor and acupuncturist working in the US and Japan, developed specialized “Kinesiotape” (KT), with a texture and elasticity similar to that of human skin. Kinesiotape differs from white zinc oxide tape as it is less restrictive and it can be stretched to 40 to 60%

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of its original length [7]. It has been postulated that KT provides many physiological effects including improved muscle function, circulation of blood and lymphatic systems, while decreasing pain through neurological suppression, and repositioning of the subluxed joints by alleviating muscle tension [8]. In regards to balance control, it has been suggested that its implementation increases proprioception around a joint through increased stimulation to cutaneous mechano receptors [7]. This is due to the fact that the elasticity of the tape mimics the properties of the skin's epidermis creating a constant pull on the skin, subsequently providing constant proprioceptive information to the area of the body it covers [9]. Thus, while the zinc tape is primarily used to restrict the motion, the main objective behind the use of KT is to optimize the healing process while supporting and stabilizing muscles and joints without restricting the joint's range of motion.

A lot of literature examined the use of athletic taping to enhance balance and muscle strength in various populations. In regards to ankle joint specifically, Cortesi, Cattaneo and Jonsdottir showed that the application of KT on the back of the ankles helped reduce postural sway in the AP plane of motion for patients with multiple sclerosis [10]. Also, in another study, it was shown that individuals with chronic ankle instability reported an increase in confidence and dynamic balance when they were taped, as inferred from the Star Excursion Balance Test (SEBT) [11]. A similar pattern of results was evident in the studies across different sports. The positive effects of taping on balance and strength were reported in athletes with chronic ankle instability and basketball players with chronic inversion sprains among others [12-14]. However, there were also studies which showed contradictory effects in recreational athletes with sprained ankles and in volleyball players [15,16]. Also, no substantial effect was evident in research which examined the effect of KT on muscle activation of lower extremity and ankle kinesthesia in individuals with unilateral chronic ankle instability [13]. In these studies the results showed either no effect of KT or rigid typing, or the effects were deemed as too small to be clinically relevant.

As evident the use of taping represents an integral part of treatment of various conditions related to the ankle joint. Also, it appears that the effectiveness of these approaches is context specific as it may have the desired results in some circumstances, yet showed no evidence in others. Given that taping has not been used frequently with individuals with ankle osteoarthritis, the purpose of this research was to examine the possible effects of two popular types of taping on strength and static and dynamic balance in an individual with ankle osteoarthritis.

Material and Methods

Due to fact that homogeneous samples of individuals with ankle osteoarthritis are difficult to obtain given the variability in the symptoms, impact on balance and strength, and their

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functional capability, a single-subject approach was implemented. A 44 year old male diagnosed with osteoarthritis in his right ankle was recruited. The participant was 5'10" tall and weighed 178 lbs. He was involved in moderate intensity physical activity at least 3 times a week. He did not exhibit any additional sensory or musculoskeletal issues that would affect his balance control or strength.

In terms of procedures the participant completed no tape session first. A week later he carried out the same set of tasks when a white zinc oxide tape was applied using the closed basket weave technique, while the final session involved the application of the KT the following week (Fig. 1). The typing was carried out by a certified athletic therapist.

Figure 1: The white zinc oxide tape (left) and the KT (right) applied to the affected ankle.

In each session the participant completed a series of tasks in the same order. The Star Excursion Balance Test (SEBT) (Fig. 2) was performed first in order to infer the nature of dynamic balance. The SEBT required the participants to place his dominant foot in the center of the star while reaching his non-dominant foot as far as possible in eight different directions: Anterior (A), Anterolateral (AL), Anteromedial (AM), Posteromedial (PM), Posterior (P), Posterolateral (PL), Medial (M) and Lateral (L). Each direction extended from the centre at 45° increments. The objective of the test was to reach as far as possible with the non-dominant leg along the lines without staggering or falling. The participant was asked to touch his toes to the ground at the furthest distance reached, which was then recorded. The participant was allowed three practice trials. After the rest period the participant performed three test trials in each of the eight directions with a 60 seconds rest period between trials.

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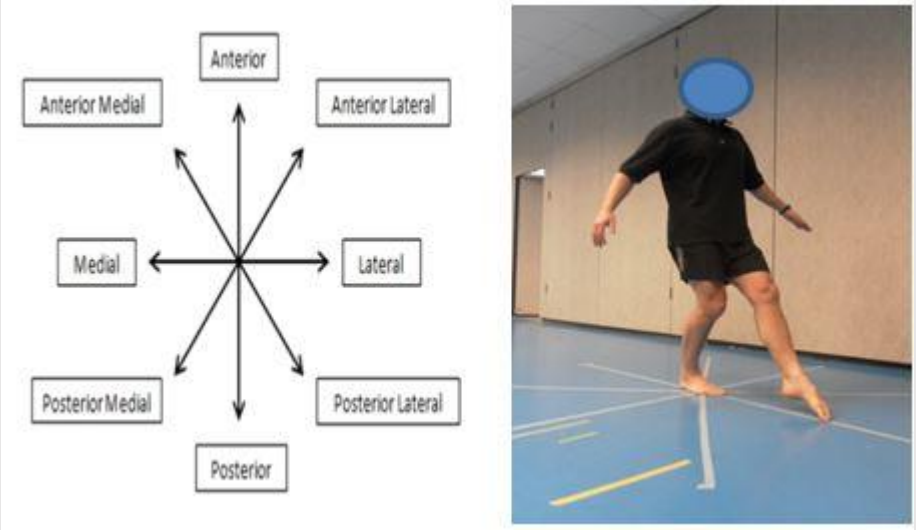

Figure 2: The set-up for the SEBT test.

The Single-Leg Jump-Landing Test (SLJLT), which was used in previous research to compare the differences between individuals with stable and unstable ankles, was carried out next to make inferences about static balance control [17]. The SLJLT required the participant to jump to a height of 50% of his maximum vertical jump height, and then land onto a force platform with only the affected foot. Prior to the commencement of the test, the participant was required to measure his maximum vertical jump height from a double leg stance. The participant began the maximum vertical jump test 70 cm away from the Vertec Vertical Jump Measuring Device (Fig. 3). The participant was allowed to utilize his arms as he jumped, but was required to maintain 180 degrees of shoulder flexion with one arm to touch the instrument in order to record their maximum jump height. The participant completed three trials, and the mean was used to determine 50% of his maximum vertical jump height. Once the vertical jump height was derived, the participant was asked to jump from a two-foot take off stance, and lend on the affected foot on the AMTI force plate (Fig. 3). The goal was to gain balance as quickly as possible, and then maintain this stance for 10 seconds with the hands placed on the hips and looking forward. The participant was allowed three practice trials with a 30 second rest period between trials.

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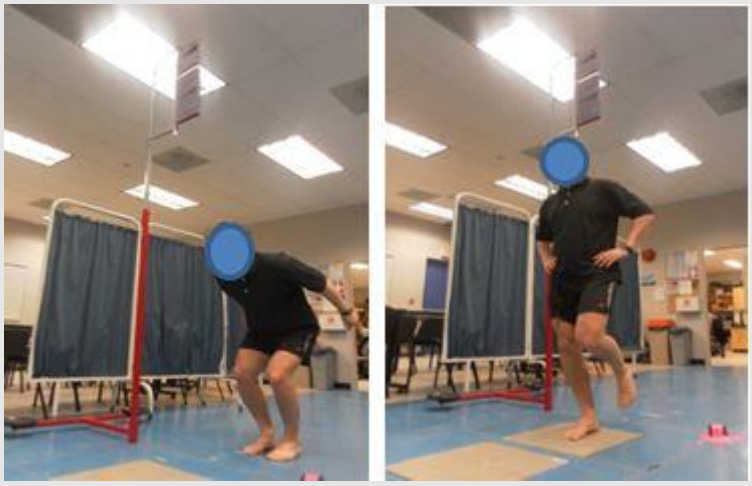

Figure 3: The set up for the Single-Leg Jump-Landing Test.

The last test involved measurement of ankle strength via a popular clinical tool known as Standing Heel Rise Test (SHRT) (Fig. 4). The examination of calf muscle performance is typically used in patients with lower extremity disorders, as a means of determining clinic status, progression through rehabilitation, and return to work/activity status [17]. The SHRT commenced with the participant standing approximately 70 cm away from the wall, while placing both hands on the wall for support. The participant began by lifting his non-dominant foot completely off the floor and raised the heel of the dominant foot through full plantar flexor range of motion. The participant then lowered the dominant foot back to the ground. The participant required to complete as many raises as possible till fatigue to the beat of a metronome, which was set at one heel raise every two seconds. The test ended when the participant fatigued and failed to complete the heel raises to the beat of the metronome. The participant completed one trial.

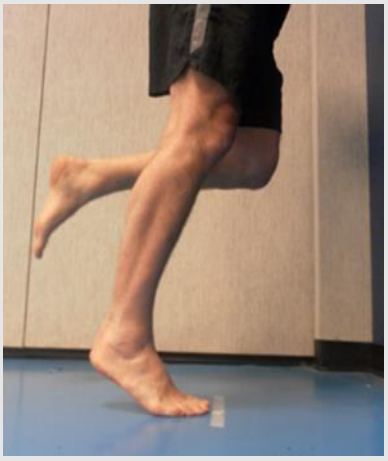

Figure 4: The set-up for the standing heel rise test.

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In regards to data reduction and analysis of the SLJLT, all testing was completed on an AMTI force plate with an amplifier gain set at 4000 times, and a low pass filter of 10.5 Hz. The force platform data were collected at a sampling rate of 100 Hz and stored offline for analysis. The AMTI BioDaq analysis package was used to compute balance measures. From the Center of Pressure (COP) measures, the mean for the three trials was derived for area of sway (cm^2) (Ao), which measures the overall area within which the COP was displaced during the trial, and path Length (L)(cm), which captures the overall amount of sway exhibited during the trial. In both measures smaller values represented more optimal postural control. In terms of SEBT, the derived measure of "excursion" represented the distance obtained in each of the 8 direction (cm), with larger values indicating more optimal performance. The SHRT was implemented in order to examine the strength of the ankle as inferred from the ability of calf muscles produced the maximum number of repetitions till fatigue, with larger values representing higher strength.

Results

The analysis of dynamic balance, via SEBT (Table 1), showed the two taping conditions resulted in larger values, hence indicating a better dynamic balance as opposed to NT condition. Across both taping conditions there was a consistent pattern showing the superiority of the KT over WT.

Directions	Conditions		
	NT	WT	KT
Anterior	71.9 (2.9)	78.3 (2.4)	81.3 (4.3)
Anterior Lateral	62.6 (3.0)	67.7 (2.8)	76.3 (3.1)
Lateral	61.3 (3.5)	68.5 (4.7)	70.7 (4.7)
Posterior Lateral	71.3 (4.5)	74.9 (3.4)	89.3 (5.2)
Posterior	71.7 (3.1)	78.6 (4.5)	85.7 (5.4)
Posterior Medial	72.0 (5.5)	76.0 (2.7)	86.5 (5.6)
Medial	65.0 (1.9)	77.8 (4.3)	84.7 (4.2)
Anterior Medial	70.1 (2.9)	78.4 (3.2)	92.0 (3.5)

Note: Larger values represent greater stability.

Table 1: Mean performance the three conditions (in cm), in 8 different directional conditions for the SEBT.

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The results pertaining to static balance, as derived from SLJLT, showed that the overall amount of postural sway as captured by path length (Fig. 5) was substantially smaller when the two taping conditions were compared to no-tape condition. Also, the KT appeared to be more beneficial to WT, however the magnitude of this difference was not as pronounced, when the NT and WT/KT were compared. The analysis of area of sway revealed a similar scenario, as the use of tape resulted in smaller excursions of the COP, implying better stability. As per path length, also this measure showed more positive effects of KT over WT.

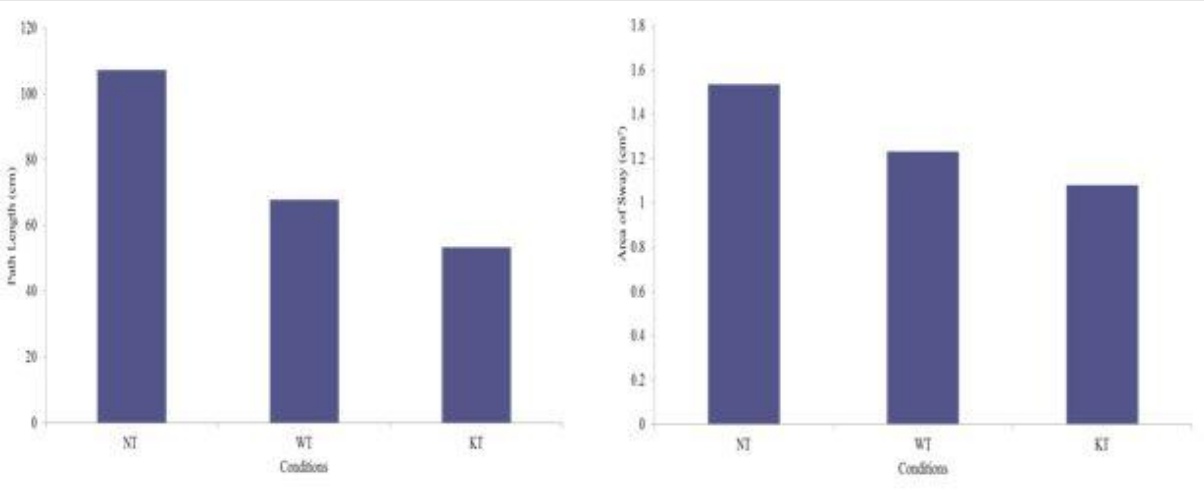

Figure 5: The amount of postural sway exhibited across the three conditions, as captured by path length (left) and area of sway (right). Smaller values represent more optimal performance.

The results pertaining to strength (Fig. 6) showed that the participant was able to perform more heel-rise repetitions in the taping conditions, as opposed to no tape. Also, in line with the previous data, the use of WT type coincided with best performance, however the differences between the two taping conditions were not pronounced.

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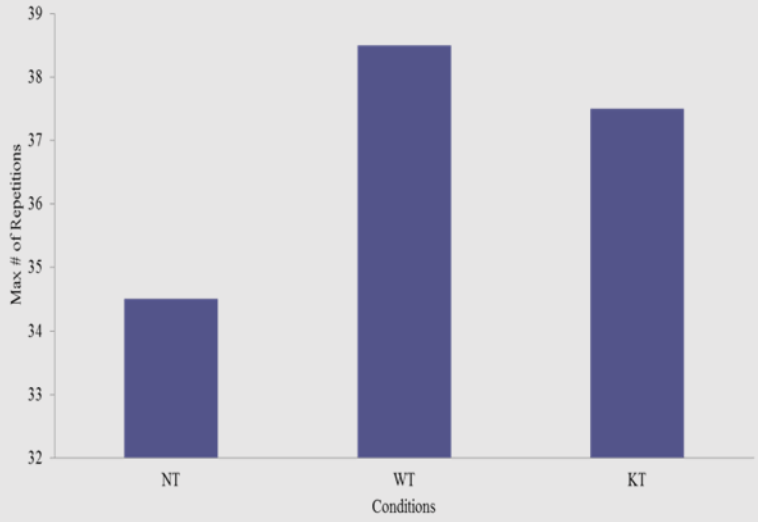

Figure 6: Number of repetitions across the conditions, with larger values representing better performance.

Discussion

Clinically, it has been well established that ankle osteoarthritis coincides with poor balance control as evident from changes in the COP measures across a variety of functional tasks [2]. The current analysis showed that the ability to maintain static balance was enhanced when either taping approach was implemented. As evident (Fig. 5), there was a substantial decrease in the overall amount of sway, as captured by path length, when the NT and both taping conditions were compared. In fact, the amount of sway exhibited in the NT condition was twice as pronounced as compared to the KT, which in itself had more stabilizing impact as compared to the WT condition. It should be noted that given the accuracy and precision of the force-platform methodology implemented here, a difference of 40 cm in the path length measure represents a robust clinical change. This pattern of results was also in line with inferences that were derived from the area of sway measure. Once again, the KT condition coincided with least pronounced excursions from the vertical. The implementation of the tape decreased the overall amount of sway (path length), as well it enhanced the degree to which the person was able to prevent the excursions of COP towards the perceived stability limits (area of sway). Thus, from the clinical perspective, this finding indicated that when the task demands constrained the participant to remain as still as possible, he was able to maintain the COM closer to the vertical position, when both tapes were applied with superior performance coinciding with the KT condition.

The previous research regarding ankle taping and balance control of individuals with ankle arthritis is very limited, and the results emerging from other populations remain equivocal. The

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present results were in line with studies which examined the impact of ankle taping on static and dynamic balance jeopardized due to fatigue [18]. Also, they confirmed data reported by Shin and Kim who investigated the effect of ankle taping on balance ability of soccer players with acute ankle sprains [19]. The application of KT tape improved static balance, as inferred from decreased path length and velocity when KT condition was compared to placebo and no taping conditions. Present results were also consistent with more recent inferences showing that athletes with chronic ankle problems exhibited improved balance control, as inferred from COP measures, across many different task constraints [20]. The authors attributed this positive effect to improved proprioception of the ankle region. It is likely that the pressure and compression produced by the KT stimulates cutaneous receptors which enhances the information transfer about joint position and movement, and therefore, enhances proprioception. In line with the KT tape, also the use of non-elastic ankle taping has been shown a beneficial effect on static and dynamic balance in patients with chronic stroke. It has been suggested that the use of the more rigid taping technique stabilizes the patients' ankle, as well as it builds their self-confidence. It is likely that its rigidity aids in limiting the excessive movement of the ankle joint, thus enhancing overall stability as evident from less sway.

However, these positive changes in static balance, associated with the use of KT and the more rigid tape, were not observed in other studies. Silva, Cruz, and Ganesan examined the effects of white athletic tape and KT on postural control in healthy individuals [21]. The results showed no significant differences in COP area and distance measures between no taping, athletic and KT either before or after running. Also, these inferences were confirmed in a study which examined the effect of KT taping of the ankle on postural balance in the elderly [22]. The analysis of COP displacement, AP and Lat sway, area of sway and COP velocity revealed no significant differences between the groups, across the different taping conditions. Collectively, it is evident that the impact of different taping techniques on static balance control varies. Some studies supported its effectiveness, although they failed to show the differences between the rigid and KT tape. However, other studies failed to show any positive impact of different taping approaches across varying populations.

Another aspect of balance that was examined focused on the dynamic aspect of this skill, as inferred from the scores on SEBT scores. This approach captured the ability of the person to perform self-perturbed tasks without jeopardizing their balance leading to falling or staggering. As per static balance control, also in this case the implementation of taping proved to be beneficial when compared to NT condition. The analysis of the scores also indicated that the SDCs, which is the smallest amount of change which falls outside the measurement error of the instrument, were large enough to be viewed as clinically significant. In practice, a change that is at or above 6.4, 7.1 and 8.8 cm, for ANT, PM and PL directions respectively, is considered as clinically relevant [23]. As evident from Table 1, these differences were evident in the conditions which involved the implementation of both tapes, but even more so when the NT and KT conditions were compared. These findings were in line with previous results

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pertaining to static balance, as the performance with the KT was superior to that exhibited when WT was implemented. As it was the case with the static balance control, little is known about the performance of individuals with ankle osteoarthritis, with or without taping, using BEST protocol. Thus, common patterns were sought with other populations. As an example, a study investigated the effects of KT on balance control of soccer players who had functional ankle instability [24]. The findings showed that the athletes who used KT had significant improvement in the balance as inferred from larger SEBT scores. This was also consistent with the results put forward by Kim, Lee and Kim who examined the effect of KT applied for a 33 years old patient [25]. Following two months of application, the changes in different directions were clinically meaningful, especially in anterior (56 to 68 cm), posteromedial (64 to 90 cm) and posterolateral (63.5 cm to 88.5 cm) directions. The changes evident in the present study were in line with those findings. However, similar to static balance control, also here there has been contradicting evidence regarding the application of different taping techniques and SEBT scores. For example, Bicci and colleagues showed that SEBT scores did not change when KT and athletic taping were applied to young basketball players [14]. The same was true when young adults with chronic ankle instability were examined as the application of KT did not impact reached distance in any of the directions examined [12].

The effect of either taping approach on the isotonic strength (endurance) of the ankle joint plantar flexor muscles was measured by heel-rise test. Strengthening of the ankle muscles can improve Range of Motion (ROM) and ADL performance. Also, when the ankle is exposed to prolonged activity, it is hoped that taping can prevent or delay the onset of fatigue, which in itself may lead to joints becoming unstable, potentially increasing the risk of ankle sprain injury. The current results showed that there was a difference between the no tape condition, and the KT and WT applications, with only subtle differences between the latter. Hence, the extra support that the taping provided delayed the onset of fatigue, nevertheless it remains unclear from the clinical perspective if the changes of 4 to 5 attempts are clinically relevant. Non-elastic (white) tape has been shown to be effective not only in restricting maximum inversion range of motion, but also in reducing the response time of peroneal muscles in subjects with previous injuries. However, some evidence suggested that the efficiency of the tape declined by 12-50% after 10 min of exercise, not offering support during situations of instability after 30 min of use. In this case the KT tape appeared to be more effective after a prolonged period of time, as it does not totally immobilize the joint which can actually make it a bit stiffer and uncomfortable. It is plausible that since the muscles around the ankle joint, which are affected by arthritis, typically have to work harder the application of the tape allows those muscles to relax thus prolonging their ability to support the joint via more efficient activation of the respective muscular synergies. The amount of previous research in this domain is limited. When rigid tape, comparable to one used here, was applied to basketball players with chronic inversion sprains, the results showed that actually the use of this tape reduced the number of heel raises performed as compared to Non tape, placebo taping and KT conditions

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[14]. Hence, instead of delaying the onset of fatigue, it resulted in faster deterioration in strength, as compared to the other conditions. The authors postulated that the cause of this decrease could be attributed to the limitation of plantar flexion ROM of ankle, which may occur when this kind of tape is applied. In addition, the researchers reported that there were no statistically significant differences in heel rises between KT and no-tape and KT and placebo. Hence, the previous results suggested that the application of any tape while performing this task does not improve the ankle's strength or delay in the onset of fatigue. As evident more research in this domain is warranted as the degree to which taping enhances strength, as measured here, may be context (population) specific.

Conclusion

The key consideration in managing osteoarthritis is that prolonged rest and coinciding decrease in the activities in a long run may have even more detrimental effects on the joints, leading to decreased strength and issues in balance. Thus, remaining active is an important goal for these individuals and the respective health professionals. In this research it was examined if different types of taping may improve functional performance of an individual with ankle arthritis in balance and strength domains. Overall, the results showed that taping the ankle had a positive effect on all of the aspects of the functioning being examined. The measures of static and dynamic balance showed that implementation of either tape resulted in less sway, as compared to no tape condition. Also, both types afforded the participant to performed more effectively dynamic postural tasks, as evident from the SEBT test. In regards to strength the differences although not as pronounced as compared to balance domain, showed a positive impact of taping on performance. However, in this context the inferences should be treated with caution as the clinical implications of the emerging differences is unclear. Due to lack of previous research involving the use of this approach with individuals with ankle osteoarthritis, more research is warranted in order replicate the current finings, as well to enhance the external validity of these results. Also, as evident from the previous research studies reported here, the results remain equivocal in terms of the effectiveness of different taping on balance and strength. It is likely that the differences in the samples examined, different methodologies, as well as variability in the kind of tapes used, as well as varying application protocols led to such inconsistent results. In terms of the differences between the two tapes, more research is also required. It is plausible that the choice of either approach may depend on the constraints of the activity and the desired goal of the implementation. When restriction is the goal than white zinc tape may be desired. However, in more dynamic situations (e.g., sports) likely the use of KT may be more beneficial from the standpoint of comfort and overall ability to move in different planes of motion.

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Conflict of Interest

The author declares no conflicts of interest.

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