THE EFFECTS OF KNEE BRACING ON REACTIVE AGILITY PERFORMANCE AND EMG ACTIVITY IN HEALTHY SOCCER PLAYERS – A PILOT STUDY

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This pilot study examined differences between braced and non-braced soccer players on measures of reactive agility time and electromyographic (EMG) activity of the gluteus medius (GM), biceps femoris (BF), and vastus lateralis (VL) muscles during the acceleration and change of direction phases of the Y-shaped reactive agility test. Twenty-four participants completed a Y-shaped reactive agility test under two conditions including wearing no knee brace and wearing a Playmaker II knee brace (DonJoy®, Lewisville, Texas) on their dominant leg. Although higher muscle activation was found in the GM and BF muscles during the change of direction phase compared to the acceleration phase, bracing did not statistically significantly affect agility time and EMG muscle activity. This outcome suggests that preventative bracing does not seem to hinder an athlete's performance.

KEYWORDS: Time, electromyography, Y-shaped test, acceleration, change of direction.

INTRODUCTION: Soccer is the most popular sport in the world. The increase in the sport's popularity has been paralleled with an increased prevalence of knee injuries. Knee braces are commonly worn in healthy athletic populations to prevent knee injuries prophylactically or some worn following knee injury (Yeung et al., 2011). One concern with wearing knee braces, however, has been the possible effect on sports performance and the research examining this topic has been confounding. Some studies have shown that agility time improved during an agility T-test, while others have shown no change in agility time (Albright et al., 2000). To date, no studies have examined the effects of knee bracing on reactive agility performance. Electromyography (EMG) is also another area of interest with regards to sport performance. To date, there is limited research on the effect of the application of a knee brace on the EMG activity of various lower extremity muscles during cutting maneuvers. More specifically, limited studies have explored the effect that knee braces may have on the peak muscular activation of the gluteus medius (GM) muscle during an agility task (Muyor et al., 2020). Therefore, the purpose of this pilot study was to examine differences between braced and non-braced soccer players on measures of reactive agility time and EMG activity of the GM, biceps femoris (BF), and vastus lateralis (VL) muscles during the acceleration and change of direction phases of the Y-shaped reactive agility test.

METHODS: Twenty-four healthy soccer players (14 male and10 female) completed the pilot study. Participants completed a Y-shaped reactive agility test under two conditions including wearing no knee brace and wearing a Playmaker II knee brace (DonJoy®, Lewisville, Texas) on their dominant kicking leg. After a familiarization and practice trial, the participant initiated the test by accelerating forward from the starting line. After passing the first timing gate, the participant then sprinted for 5 m from the first timing gate (Brower©, Draper, Utah) to the second set of cones, where the researcher visually indicated using hand signals and verbally indicated which direction the participant cut towards (left or right). To ensure consistency when the participants made the directional change to either direction, a visual cue in the form of a set of cones was placed at the 5 m mark. When a participant reached the second set of cones, the student researcher then visually (e.g., by lifting the arm of student researcher on the side the participant cut towards) and verbally indicated the direction the participant had to cut towards. The participant then reacted to the direction the researcher gave and cut at a 45° angle in that direction. The participant then sprinted for 5 m and crossed the last Brower© timing gate. Agility test time (s) and peak EMG muscle activity as a percent of the participant's maximal voluntary contraction (%MVC) of the GM, BF, and VL muscles of the braced leg was measured (Delsys® Trigno, Natick, Massachusetts; peak EMG data was based on the rectified, filtered, and sampled data at 1000 samples per second). The Y-shaped reactive agility test was separated into the acceleration phase and the change of direction phase (see Figure 1). A three-way repeated measures ANOVA was conducted to compare the independent variables (brace condition, phase, and muscle type) on the dependent variable EMG activity. Since no three-way interaction effect was found among the independent variables, then two-way interactions of brace condition, agility phase, and muscle type were examined. A paired samples t-test was also conducted to compare the type of brace conditions on measures of reactive agility time. The alpha level was set at $p<.05$ for both statistical analyses.

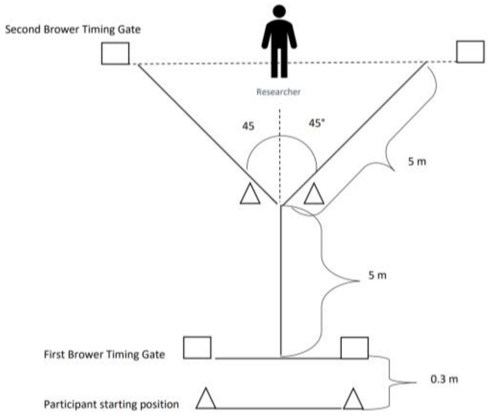

Figure 1. Y-shaped reactive agility test diagram.

RESULTS: The three-way repeated measures ANOVA revealed no statistically significant interaction effect among the three independent variables (brace condition, phase, and muscle type) on peak EMG activity during the Y-shaped reactive agility test, $F(2,46)=2.296$, $p=.124$, $\eta^2=.173$.
A two-way ANOVA comparing phase and muscle type revealed a statistically significant difference in peak EMG activity during the Y-shaped reactive agility test with a large effect size, $F(2,22)=6.565$, $p=.006$, η2=.374. Bonferroni pairwise comparisons analysis revealed a statistically significant increase in peak EMG activity in the GM muscle in the change of direction phase compared to the acceleration phase with a large effect size, $F(1,23)=21.59$, $p=.0001$, η2=.484 (see Figure 2).
A two-way ANOVA examining brace condition and muscle type did not reveal a statistically significant interaction in peak EMG activity during the Y-shaped reactive agility test, $F(2,22)=1.451$, $p=.256$, $\eta^2=.117$ and no significant main effects.
There was also no statistically significant difference in the Y-shaped reactive agility test time between the no brace condition and knee brace condition, $t(23)=-1.149$, $p=.262$ (two-tailed), $d=.235$, 95% CI[-638, .174] (see Figure 3).

DISCUSSION: Based on the data obtained in the current pilot study, healthy individuals who choose to wear a prophylactic hinged knee brace can expect to experience no significant changes or deleterious effects in reactive agility performance while reacting to a stimulus requiring a 45° change of direction. These results can serve to benefit future researchers, coaches, and soccer players as the literature evolves around the topic of reactive agility performance with the application of a knee brace (Greene et al., 2000) with current findings

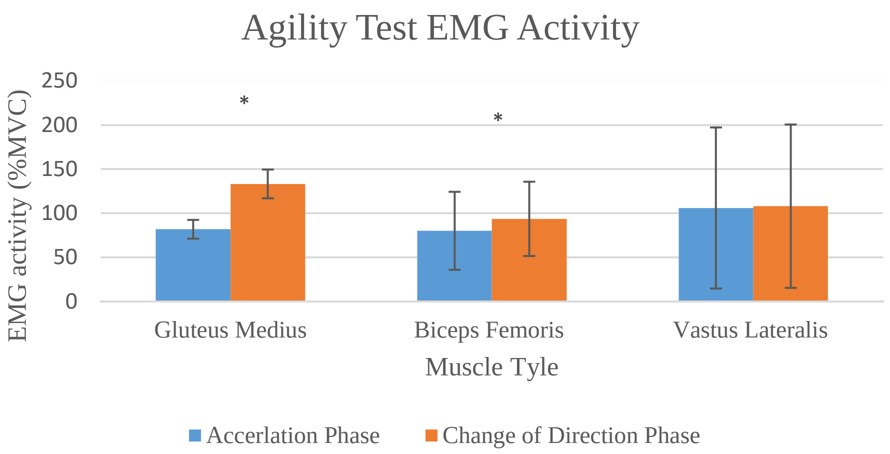

Figure 2. Y-shaped reactive agility test EMG activity by phase and muscle. * denotes statistically significant differences during the acceleration phase ($p<.05$).

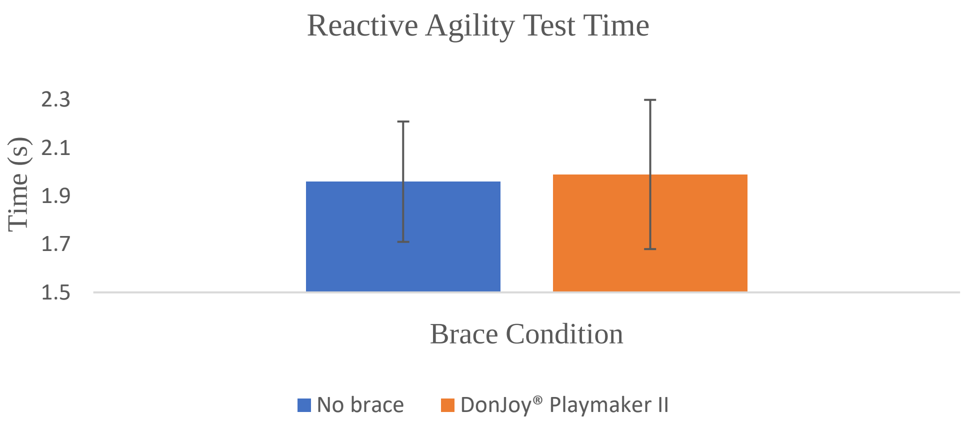

Figure 3. Y-shaped reactive agility test time results. This graph displays the mean and standard deviations of Y-shaped reactive agility test time for both the non-braced and braced (DonJoy® Playmaker II) condition.

demonstrating that individuals who are prescribed or choose to wear a knee brace prophylactically should not have a negative effect in performance measures related to agility and cutting. The non-significant results in the present pilot study were expected due to the relatively small moment and 45º angular change of direction where the participants were required to change directions to either the left or right compared to the rest of the agility test. Based on the results obtained from the current pilot study, the application of a knee brace did not significantly affect the agility time during a reactive agility test. Healthy soccer players should not expect significant changes in agility performance while wearing a hinged prophylactic knee brace but future research should explore this in pathological conditions and use a greater angular change in reactive agility (e.g., 90º or 180º change of direction) to explore any effects on other sport specific cutting movements (Bodendorfer et al., 2019). There was also no statistically significant three-way interaction between bracing condition, muscle type, and phase for measures of EMG muscle activity during the Y-shaped reactive agility test. Compared to the no brace control, there was no statistically significant differences in EMG activity in any of the three muscles tested regardless of the phase. These results may indicate that healthy individuals wearing a prophylactic hinged knee brace may experience no alternations in EMG activity for the GM, BF, and VL muscles while reacting to a stimulus requiring a 45° change of direction. There were, however, statistically significant differences in the two-way interaction between the phase and muscle type, with the GM muscle showing increased EMG muscle activity during the change of direction phase that support the research findings of Muyor et al. (2020). This outcome may be due to increases in GM EMG muscle activity during a cutting or change of direction movement compared to straight line running. Furthermore, the GM muscle is responsible for hip abduction which occurs in the planting leg during a cutting task (Muyor et al., 2020).

There was a statistically significant increase in BF EMG muscle activity in the change of direction phase compared to the acceleration phase. This statistically significant increase may be because the BF muscle is primarily responsible for hip extension, which occurs during the push off phase of a directional change. The need for increased BF muscle activity may be because the change of direction movements involved more explosive movements. Increased BF muscle activity is also needed to position the hip into extension during the moment of a directional change in more of a straight line rather than an oblique angle (Muyor et al., 2020) and, therefore, the demonstrated EMG activity in this muscle may be specific to the phase of the task.

During the change of direction phase, the EMG activity in the BF muscle decreased in the braced condition compared to the non-braced condition, yet the outcome was not statistically significant. These results contradict the previous notion that the application of a knee brace increases BF EMG muscle activity that may reduce anterior shear forces in the knee. In some ligament deficient knee conditions, any reduction in activity in the hamstring muscle may be detrimental and may impact on stability and increased anterior shear forces (Albright et al., 1994; Yeung et al., 2011). As a result, further research is required in this area to see how EMG changes, more specifically, in pathological knee conditions as bracing does not appear to impact healthy soccer players.

CONCLUSION: The current pilot study identified that higher muscle activation was found in the GM and BF muscles during the change of direction phase compared to the acceleration phase. The application of a hinged prophylactic knee brace, however, did not significantly affect agility time and the muscle activity in the GM, BF, and VL muscles during a Y-shaped reactive agility test. As no significant differences were found from a performance perspective, coaches and healthy soccer players who choose to suggest and/or use preventative bracing can be confident that performance may not be hindered. Future researchers can also build on the results from the current pilot study and incorporate different movements soccer players regularly perform with a larger sample size to determine the utility and both positive or negative effects of bracing from a biomechanical perspective. Also, exploring reactive agility and EMG muscle activity in a pathological knee population can further clarify the utility of bracing post injury or prophylactically.

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