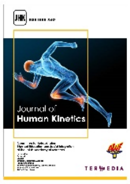

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Section I – Kinesiology

Proprioceptive and Biomechanical Responses to Ankle Bracing in Elite Basketball Players: A 3D Motion Capture and Sensor-Based Approach

by

Boran Eroglu [1], Begum Yalcin [2], Hande Argunsah [1,2,]*

This study investigated the effects of ankle bracing on proprioception, agility, and lower-extremity biomechanics in 12 professional male basketball players. Ankle proprioception was assessed using the joint position reproduction (JPR) test, and kinematic data were captured using a 3D wearable motion capture system (Xsens MVN Awinda) during the change of direction (COD) agility T-Test. Tests were performed under braced and non-braced conditions (W bracing and WO bracing conditions, respectively). No statistically significant differences were found in proprioceptive accuracy between conditions ($p = 0.975$ and $p = 0.995$ for performed vs. reference angle errors in WO bracing and W bracing conditions, respectively). Similarly, no significant differences were observed in average velocity or time during COD movements ($p > 0.05$). However, the brace significantly restricted ankle range of motion, with the absolute angular error (AAE) in internal/external rotation reaching 3.03. Knee kinematics showed increased flexion restriction (AAE = 4.86) and moderate changes in abduction/adduction (AAE = 1.36). At the hip, internal rotation increased under the braced condition, though differences were not statistically significant (AAE = 2.80). Despite these biomechanical alterations and a non-significant reduction in proprioceptive feedback, agility performance was maintained ($p > 0.05$). These results suggest that while ankle bracing alters joint kinematics and limits ROM—especially at the ankle and knee—it does not significantly compromise agility performance. Prolonged use, however, may increase reliance on external stabilization, emphasizing the need for concurrent proprioceptive training in injury prevention protocols.

Keywords: *proprioception; basketball; kinematics; agility; ankle bracing*

Introduction

Ankle sprains are among the most common injuries in team sports. The primary cause of recurrent sprains is chronic ankle instability, often related to factors such as peroneal muscle weakness, proprioceptive deficits, or mechanical instability. These injuries frequently occur during high-risk movements, such as cutting maneuvers, landings, jumps, and contact with other players. Recent evidence highlights that asymmetrical landing mechanics and task-specific variations in landing strategies—particularly during single- and double-leg tasks—are strongly associated with increased ACL injury risk, especially in female athletes (Chen et al., 2026; Jamkrajang et al., 2026). Acute ankle sprains are prevalent not only among physically active individuals (Herzog et al., 2019), but also among basketball players at all levels of competition (Tummala et al., 2018). Ankle sprains typically occur when the ankle is rolled, twisted, or turned beyond its physiological range of motion, causing the ligaments to stretch or tear. Between 2013 and 2017, the risk of an ankle sprain during an NBA season was 25.8%. Of the 796 total sprains, 71% occurred during games, and 71.2% were

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[1] *Department of Biomedical Engineering, Faculty of Engineering and Natural Sciences, Acibadem Mehmet Ali Aydinlar University, Istanbul, Turkey.*

[2] *Department of Biomedical Engineering, Graduate School of Natural and Applied Sciences, Acibadem Mehmet Ali Aydinlar University, Istanbul, Turkey.*

* Correspondence: hande.argunsah@acibadem.edu.tr

related to player contact. Additionally, 80% of these injuries happened in the inversion/eversion plane. According to a systematic review on basketball injuries, 21.9% of the total 12,960 injuries were ankle related (Andreoli et al., 2018). Not only are ankle sprains common, but they are also among the most frequent recurrent lower extremity injuries, with nearly 40% leading to chronic symptoms (Doherty et al., 2016; Miklovic et al., 2018).

To reduce the occurrence of ankle sprains, various external support systems, such as athletic tapes, orthoses, and high-top shoes, have been developed and widely used. Ankle braces are among the most common of these systems, providing stability by restricting motion during inversion and plantarflexion. Braces help reduce ankle inversion speed, prevent injuries, and, when combined with strength and balance training, serve as an effective injury prevention strategy (Gross and Liu, 2003; Kaminski et al., 2019). While the mechanical support provided by bracing is well-documented, it alone does not fully prevent ankle injuries. Other predictive factors—such as body height, body mass, sex, muscle strength, reaction time, postural sway, joint laxity, anatomical alignment, and range of motion (ROM) of the ankle-foot complex—also contribute to the ankle injury risk (Beynnon et al., 2002).

Joint proprioception plays a significant role in preventing injuries, as it is responsible for relaying feedback about the joint position and enabling rapid adjustments to avoid harm. The effectiveness of proprioceptive training in reducing ankle sprains, both for athletes with and without a history of ankle injuries, has been well established (Rivera et al., 2017). Agility, defined as an athlete’s ability to quickly accelerate, decelerate, and change direction while maintaining control, is another crucial factor in injury prevention (Sheppard and Young, 2006). In addition, recent studies have demonstrated that sensorimotor factors, including proprioception, neuromuscular coordination, and muscle activation patterns, are strongly linked to sport-specific performance and agility outcomes in young athletes (Zemkova et al., 2025). Moreover, change of direction (COD) ability refers specifically to pre-planned movements without a reactive element. Research shows that injury prevention programs incorporating neuromuscular training and COD exercises reduce the risk of lower extremity injuries by approximately 39%, with even higher effectiveness rates for acute knee (54%) and ankle sprains (50%) (Bel et al., 2021).

Both proprioception and COD performance are vital components of an athlete's overall ability to prevent injuries and maintain high-level competitive function. Accordingly, an ideal ankle brace should provide sufficient joint stability to mitigate the risk of ankle sprains without adversely affecting athletic performance or agility. Although previous research has examined the effects of ankle bracing on proprioception and movement mechanics, these investigations have often been limited to recreational athletes or isolated clinical settings, lacking integration of dynamic performance tasks and advanced motion analysis. The current study addresses this gap by focusing specifically on elite male basketball players—a population at high risk for ankle injuries and performance-related biomechanical alterations. By combining the joint position reproduction (JPR) test for proprioceptive accuracy, the COD agility T-Test for functional performance, and a wireless wearable motion capture system to assess lower-limb kinematics, this study offers a comprehensive and ecologically valid approach to understanding the multifaceted impact of ankle bracing. This integrated methodology allows for the simultaneous evaluation of neuromuscular control, movement efficiency, and joint mechanics in sport-specific contexts, representing a novel and necessary contribution to the field of sports biomechanics and injury prevention.

Methods

Participants

The study involved twelve male elite basketball players (body height: 186.41 ± 8.24 cm, body mass: 85.25 ± 13.36 kg, age: 21.58 ± 1.83 years). Participants had no history of lower extremity surgery or significant injury within the past six months. A priori power analysis was conducted using G*Power (version 3.2.1, Universität Düsseldorf) to determine the minimum sample size required for a two-tailed paired t-test (within-subjects design), assuming $\alpha = 0.05$, power $(1–\beta) = 0.95$, and a moderate-to-large effect size of $d = 0.75$. This effect size was selected because prior studies on ankle bracing in athletic populations commonly report moderate-to-large effects on proprioceptive accuracy and lower-limb kinematics (Hadadi et al., 2014; Willems et al., 2002). Additionally, for our within-subject and homogenous sample, this effect size represented a conservative compromise between literature-based expectations and the feasibility of recruiting a small elite cohort. The analysis indicated that a minimum of 12 participants would be sufficient to detect statistically significant within-subject differences under these assumptions. Ethical approval was granted by the Institutional Review Board of the Acibadem Mehmet Ali Aydinlar University, Istanbul, Turkey (protocol code: 2020-01/04; approval date: 02 January 2020).

Measures

Twelve participants completed the joint position reproduction (JPR) test to assess proprioceptive ability and the COD agility T-Test to evaluate agility. A repeated-measures design was employed. Each participant completed all testing procedures under two conditions: with ankle braces and without ankle braces. To control for potential order effects, the sequence of testing (braced first vs. unbraced first) was randomized across participants using a computer-generated randomization schedule. A rest interval of 5 min was provided between conditions to minimize fatigue and carryover effects. Prior to formal testing, all participants completed a standardized familiarization session. This involved verbal explanations, visual demonstrations, and two supervised practice trials for both the JPR test and the COD agility T-Test. The familiarization was designed to reduce potential learning effects and ensure consistent task comprehension and execution across both WO bracing and W bracing conditions. The Össur Formfit® Ankle Brace (Össur hf., Iceland), a lace-up ankle brace, was worn on the participant's dominant ankle. The JPR test was conducted using the HUMAC NORM Isokinetic Testing and Exercise System (Computer Sports Medicine, Inc., Stoughton, MA, USA), while kinematic data were collected using the Xsens MVN Awinda system (Movella North America Inc., Henderson, NV, USA), a 3D wearable motion capture system. The Xsens system includes 17 trackers (MTw), which are attached to specific body landmarks, operate on batteries, and communicate wirelessly. It records body positions at a frequency of 60 Hz.

Proprioceptive accuracy was assessed using the active JPR protocol, in which participants attempted to replicate a target ankle angle without visual input. This method has been shown to be a valid and reliable measure of joint proprioception, particularly in athletic populations (Docherty et al., 1998; Han et al., 2015). The JPR test took place at a FIFA-accredited athletic performance center. Ankle proprioception was assessed in the inversion/eversion plane using the HUMAC NORM system, with device settings adjusted to standard procedures for ankle measurements. The test consisted of two parts: in the first, the participant's ankle was passively or actively positioned at reference angles, which they then matched actively or passively. The JPR test was conducted under both braced and non-braced conditions. Reference angles of 12°, 14°, 16°, 18°, and 25° inversion were selected based on existing literature (Brockett and Chapman, 2016), with these angles chosen to approach the maximum ROM for ankle inversion. Participants were positioned according to their body proportions, ensuring that their body posture did not restrict ankle ROM. They were instructed to actively position their ankles at each reference angle, holding the position for 5 s, repeating this process three times for each angle while under the non-braced condition. Participants were expected to learn and remember each angle. Vision was blocked with an eyepatch during testing.

The COD agility T-Test was used to evaluate pre-planned change of direction performance. The test requires the athlete to sprint forward, shuffle laterally, and backpedal along a T-shaped course, with all movements performed in a predetermined sequence. As no reactive or perceptual stimuli are involved, the task reflects COD performance rather than agility in the reactive sense (Pauole et al., 2000; Sassi et al., 2009). The T-Test has demonstrated high reliability and construct validity in athletic populations. The COD Agility T-Test was performed on a basketball court (Figure 1A). Kinematic data for lower-extremity joint ROM were recorded using the Xsens MVN Awinda system. The test involved positioning four cones in a T-shape as shown in Figure 1B. On an auditory signal, the participant sprinted forward from cone 1 (start) to cone 2, touching cone 2 with the right hand. Next, maintaining a forward-facing position without crossing feet, the participant shuffled left for 5 yards (4.57 m) to touch cone 3 with the left hand. Then, they shuffled right for 10 yards (9.1 m) to touch cone 4 with the right hand, shuffled left for 5 yards to touch cone 2 with the left hand, and finally ran backward to the starting point, stopping the timer when they crossed the start line. A trial was disqualified if the participant failed to touch the base of any cone, crossed their feet instead of shuffling, or failed to maintain a forward-facing position during the test.

Design and Procedures

A randomized dataset of angles was created using five reference positions, each of which was repeated ten times. Participants were instructed to say "done" when they believed they had reached the desired reference angle, and the angle value displayed on the isokinetic device screen at that moment was recorded. After completing the initial WO brace test, participants were fitted with the Össur Formfit® Ankle brace, and the W brace test was performed following the same procedure. The standard errors for both tests were calculated by subtracting the performed angle values from the reference angle values. The average standard errors for the WO brace and W brace conditions were then compared with the reference values to assess the impact of the brace on joint proprioception. The COD movements occur when the athlete contacts the ground. Therefore, the first and last frames of the COD were defined as the initial contact of the last flight phase of the approach and the last toe-off of the first flight phase after the COD. The distinctive events for each COD are represented in Figure 1B.

The average velocity for each phase was calculated in meters per second (m/s) by multiplying the number of frames in each phase by 1/60 (since Xsens records data at 60 fps) and dividing the distance traveled (in m) by the time value (in s). This calculation was performed for both the WO and W bracing conditions. Additionally, the time spent during each COD movement was calculated for each participant under both conditions. Kinematic data for the ankle, knee, and hip joints were collected during each COD movement for both conditions. Following the marker acquisition process, data preparation and analysis began. The same calculation for average velocity and time spent during each COD movement was applied for both the WO and W bracing conditions. Kinematic data for the ankle, knee, and hip joints were also analyzed for both conditions.

Each trial of the COD agility T-Test was segmented into distinct movement phases (forward sprint, lateral shuffle, and backpedal) using synchronized event markers. Within each phase, joint angle trajectories (ankle, knee, hip) were interpolated and time-normalized to a common scale of 0–100% of the movement duration, allowing for consistent temporal alignment across participants and conditions. To assess the change in proprioceptive accuracy between the braced and unbraced conditions, AAE was calculated for each trial of the JPR test. The AAE was defined as the absolute difference between the reproduced angle and the target angle. To quantify the relative change in proprioceptive performance, we computed the following difference:

$$\Delta \text{ Error} = \mu \text{ AAE W bracing} - \mu \text{ AAE WO bracing}$$

where μ AAE W bracing was the average absolute angular error across all braced trials, and μ AAE WO bracing was the average error across all unbraced trials.

Statistical Analysis

All analyses were performed in IBM SPSS Statistics (version 29, IBM Corp., Armonk, NY, USA). Data normality was verified with the Shapiro-Wilk test, and descriptive results are reported as means ± standard deviations. Given the within-subject design, comparisons between brace and no-brace conditions were conducted using paired-samples *t*-tests. To assess practical relevance, Cohen’s *d* effect sizes with 95% confidence intervals were calculated and interpreted as small (0.20–0.49), medium (0.50–0.79), or large (≥0.80). Statistical significance was accepted at $p < 0.05$ and 95% confidence intervals (CIs) were calculated for mean differences.

Results

Twelve participants completed the study, and no significant differences were observed in age, height, or body mass among the participants. The results of the JPR test, COD agility T-Test, and kinematic analysis were compared between the WO bracing and W bracing conditions.

JPR Test Results

The angles performed by each participant, repeated 10 times for each reference angle, were averaged for each condition. Results from the paired *t*-test are presented in Table 1. Across all tested angles, mean JPR scores were consistently higher under the WO bracing condition, all demonstrating medium effect sizes, indicating meaningful practical benefits of ankle bracing (Figure 2). Significant improvements were observed at 12° and 16° trials. At 18° and 25° trials differences did not reach statistical significance, however, both showed medium effect sizes, suggesting potential practical relevance. The consistent direction and magnitude of effects across all angles support the interpretation that ankle bracing enhances proprioceptive performance, particularly at smaller joint angles, and that non-significant results in some cases may reflect limited statistical power rather than absence of an effect. This pattern suggests that the brace's proprioceptive benefits may be more pronounced at smaller joint displacements, additionally CIs confirm reliable benefits of bracing at smaller angles, while indicating uncertainty at larger displacements.

COD Agility T-Test Results

The COD Agility T-Test results were analyzed considering two aspects: performance and kinematics. The performance assessment included velocity analysis, and the time spent during lateral COD movements, which are associated with a higher risk of injury. Additionally, since COD2 and COD3 involved identical movement patterns regardless of the participant's dominant foot, data from the dominant limb were analyzed. The performance measures for the WO bracing and W bracing conditions were compared to evaluate the brace's effect on performance. The kinematic assessment focused on ankle, knee, and hip joint movements in specific planes. The average velocity for each phase was compared between the WO bracing and W bracing conditions. The results from the phase-based paired samples T-Test showed that only phase A demonstrated a statistically significant difference ($p < 0.05$), indicating that average velocity without a brace was higher than with a brace. For all other phases (B–E), and for the overall average velocity, no significant differences were observed between WO bracing and W bracing conditions (Table 2).

Similarly, the average times spent at each phase for the WO bracing and W bracing conditions were compared. The paired *t*-test results indicated that among the five phases, only phase A showed a statistically significant difference, with a large effect size, demonstrating that ankle bracing meaningfully reduced velocity in the initial movement phase. Specifically, phase A exhibited a significant reduction in velocity with brace use (t (11) = 2.89, $p = 0.015$, Cohen's $d = 0.833$, large effect), suggesting that ankle bracing may hinder explosive acceleration or initial movement execution. Phases B–E showed no statistically significant differences, with effect sizes ranging from negligible to small-to-moderate ($p = 0.568$, $d = 0.17$, small effect; $p = 0.703$, $d = –0.113$, negligible effect; $p = 0.670$, $d = 0.126$, small effect; $p = 0.384$, $d = –0.262$, small-to-moderate effect), indicating minimal practical impact and, in some cases, a trivial tendency toward higher velocity with the brace. Overall, only phase A demonstrated a statistically significant and practically meaningful difference. Across the other phases, ankle bracing had minimal influence on velocity, suggesting its primary effect occurs during early acceleration or initial directional changes, with little impact on later movement stages.

The paired samples *t*-test was conducted to compare athletes' performance in four COD phases under two conditions. The descriptive statistics showed that the mean times across phases were highly comparable between conditions, with mean differences ranging from −0.08 to +0.03 s. Standard deviations were similar, indicating consistent variability across both testing conditions. The results revealed no statistically significant differences across any of the COD phases (all *p*-values > 0.05). Effect size calculations (Cohen's *d*) indicated that the magnitude of differences was trivial to small in all cases, suggesting that ankle bracing had a negligible impact on the time spent in COD movements and the CIs indicated that bracing affected only the initial acceleration phase without impairing overall agility or COD efficiency (Table 3).

Kinematic data for the lower extremities were collected at 60 Hz using the Xsens MVN Awinda system. All continuous variables were presented as mean ± SD. The absolute angular error (AAE) was calculated to assess the differences between the

WO bracing and W bracing conditions. Larger AAE values indicated poor regression fit and greater divergence in movement trajectories, while smaller AAE values suggested strong regression fit and more similar movement patterns (Figure 3).

The brace demonstrated a significant ROM restriction effect on the ankle, confirming its stabilizing role. The beginning and the end of the movement patterns showed similar trends, but the middle section of the lateral COD movement differed notably across the intervals. Additionally, the brace restricted knee flexion, with the highest error rate observed in this movement pattern (AAE = 4.86). The most substantial change in knee kinematics occurred between the mid-stance and terminal swing phases. Knee adduction-abduction movements showed relatively low variation (AAE = 1.36).

For the hip joint kinematics, the W bracing condition exhibited a noticeable increase in ROM, particularly in internal rotation, compared to the more stable pattern seen in the WO bracing condition. Although the AAE (2.80) did not reveal a significant difference between the two conditions, the increase in internal rotation under the W bracing condition is noteworthy. The lowest AAE was observed in the hip joint abduction-adduction pattern (AAE = 1.35), indicating a symmetrical movement pattern regardless of brace use. The hip joint flexion-extension pattern also showed relatively low error rates (AAE = 2.01).

Table 1. Paired *t*-test results comparing joint position reproduction accuracy with and without ankle bracing across test angles.

Angle (°)	WO Bracing (μ ± SD)	W Bracing (μ ± SD)	t	*p*-value	Cohen's *d*	95% CI [lower, upper]
12	10.8 ± 3.8	13.1 ± 3.9	−2.75	0.019	−0.794	[−1.531, −0.057]
14	12.8 ± 3.9	15.3 ± 4.1	−2.5	0.029	−0.722	[−1.442, −0.002]
16	15.4 ± 4.2	18.1 ± 4.2	−2.24	0.047	−0.647	[−1.351, 0.057]
18	17.3 ± 3.9	19.9 ± 4.8	−2.08	0.061	−0.6	[−1.295, 0.095]
25	23.8 ± 4.6	26.9 ± 4.8	−1.92	0.082	−0.554	[−1.24, 0.132]

Negative t-values indicate higher mean error under the WO Bracing compared to the W Bracing condition. Interpretation thresholds: negligible (<0.2), small (0.2–0.5), medium (0.5–0.8), large (>0.8)

Table 2. Phase-specific and overall velocity comparisons between the WO Bracing and W Bracing conditions.

Phase	μ WO Bracing (s)	μ W Bracing (s)	μ Diff	t	*p*-value	Cohen's *d*	95% CI [lower, upper]
A	4.08	3.99	0.096	2.885	0.014	0.83	[0.0229, 0.17]
B	3.40	3.37	0.031	0.589	0.567	0.17	[−0.087, 0.1507]
C	3.53	3.55	−0.017	−0.392	0.702	−0.11	[−0.1132, 0.079]
D	3.27	3.23	0.0391	0.437	0.670	0.12	[−0.1579, 0.2363]
E	3.62	3.68	−0.058	−0.906	0.384	−0.26	[−0.1999, 0.0833]
Average	3.58	3.56	0.018	0.448	0.662	0.13	[−0.072, 0.1088]

Table 3. Paired samples *t*-test results with descriptive statistics for change-of-direction (COD) phases under W Bracing and WO Bracing conditions.

Phase	μ WO Bracing (s)	μ W Bracing (s)	μ Diff	t	*p*-value	Cohen's *d*	95% CI [lower, upper]
COD 1	0.485	0.482	0.003	0.35	0.732	0.10	[−0.015, 0.020]
COD 2	0.743	0.826	−0.083	−1.04	0.323	−0.30	[−0.261, 0.094]
COD 3	0.863	0.835	0.028	0.54	0.602	0.16	[−0.086, 0.142]
COD 4	0.532	0.531	0.001	0.05	0.963	0.01	[−0.063, 0.066]

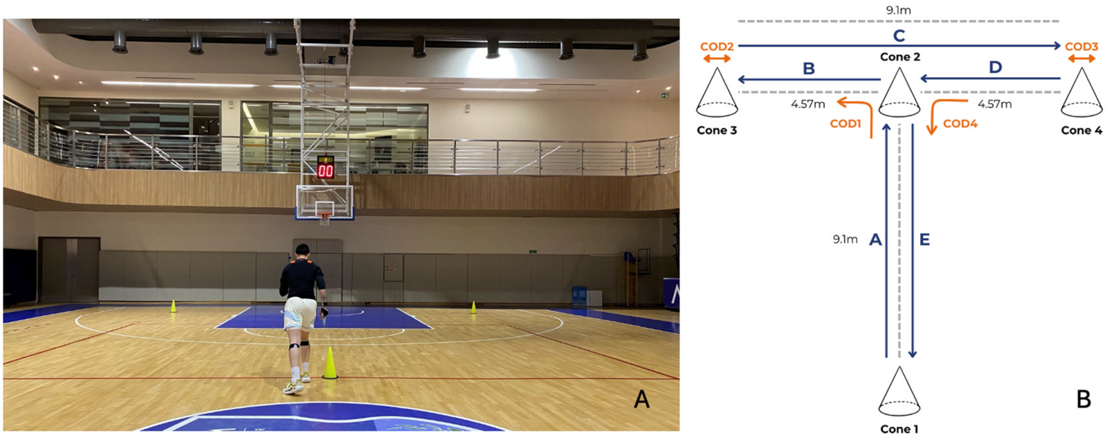

Figure 1. A. Test set-up; B. The schematic design of the agility T-Test (A: Forward run from Cone 1 to Cone 2; COD1: 90° COD, from forward run to sideways movement in the left direction; B: First left shuffle which is sideways movement from Cone 2 to Cone 3; COD2: 180° lateral COD, from left shuffle to sideways movement in the right direction; C: Right shuffle which is sideways movement from Cone 3 to Cone 4; COD3: 180° lateral COD, from right shuffle to sideways movement in the left direction; D: Second left shuffle which is sideways movement from Cone 4 to Cone 2; COD4: 90° COD, from left shuffle to backward sprint; E: Backward sprint from Cone 2 to Cone 1).

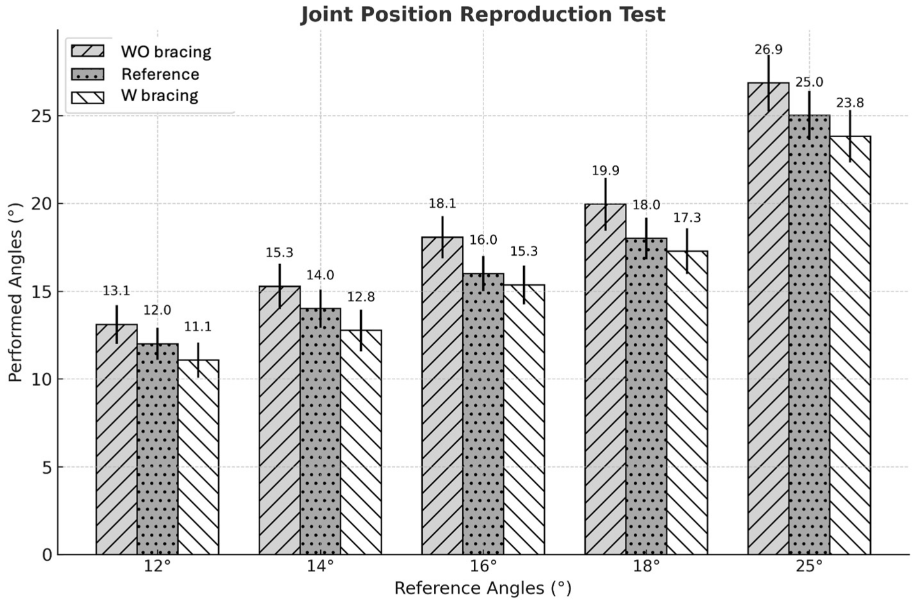

Figure 2. Average performed angle values of WO bracing and W bracing conditions at reference angle trials.

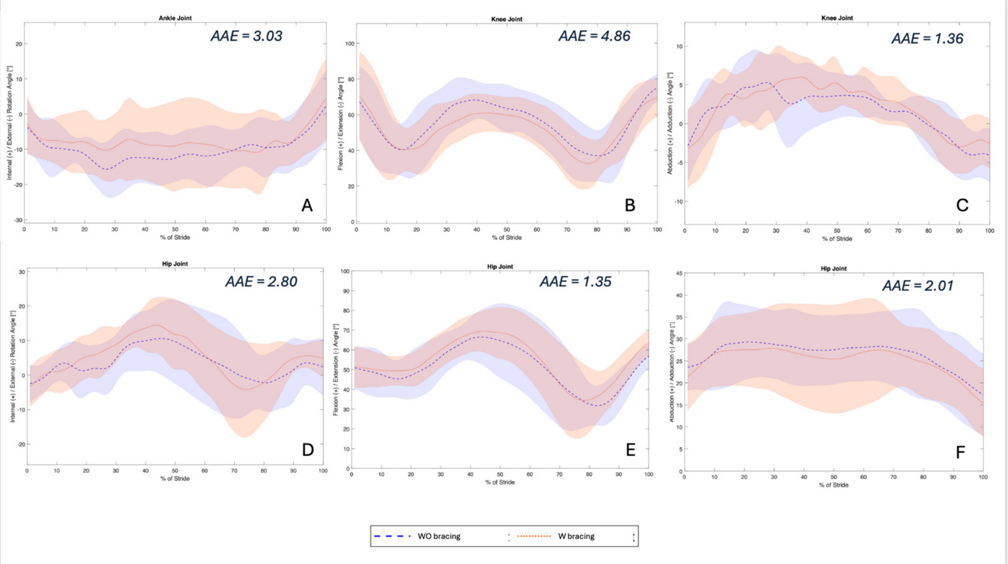

Figure 3. Lower extremity joints kinematics during lateral COD movement under WO bracing and W bracing conditions (A. Ankle Internal (+)/External (−) Rotation Angle, AAE: 3.03; B. Knee Flexion (+)/Extension (−) Angle, AAE: 4.86; C. Knee Abduction (+)/Adduction (−) Angle, AAE: 1.36; D. Hip Internal (+)/External (−) Rotation, AAE: 2.80; E. Hip Abduction (+)/Adduction (−) Angle, AAE: 1.35; F. Hip Flexion (+)/Extension (−) Angle, AAE: 2.01).

Discussion

This study explored the impact of ankle bracing on performance, proprioceptive awareness, and lower-limb kinematics in professional male basketball players. Proprioceptive function was assessed using the JPR test, which provides an objective measure of sensorimotor accuracy and is widely used to detect deficits that may predispose athletes to injury. In parallel, the COD agility T-Test was employed as a sport-specific functional measure, as it reflects the ability to rapidly accelerate, decelerate, and change direction, which are the skills that are fundamental to basketball performance and strongly linked to injury prevention. Together, these tests enabled the evaluation of both sensorimotor control and applied performance under braced and unbraced conditions.

Our findings indicate that ankle bracing has a nuanced influence on proprioception and performance. Although bracing restricted ankle ROM and altered lower-limb kinematics, agility performance was largely preserved. The results of the COD agility T-Test revealed significant differences only in the initial phase of movement, where bracing appeared to reduce early acceleration. In later phases of the agility task and in overall time and velocity, differences were small or negligible. These results suggest that while bracing may transiently influence early directional change, athletes are able to functionally compensate, thereby maintaining performance throughout the task.

Kinematic variables were selected with direct reference to mechanisms underlying common lower-extremity injuries such as ankle sprains and anterior cruciate ligament (ACL) ruptures, both of which are closely linked to specific joint positions and movement patterns. These injuries often occur in planes of motion that elevate injury risk, which guided our focus on ankle kinematics in the transverse plane and knee and hip movements across the frontal, sagittal, and transverse planes (Di Paolo et al., 2021). In a recent study in NBA players have highlighted associations between knee injuries and increased knee flexion, hip abduction, and dynamic knee valgus (Gill et al., 2023). Dynamic knee valgus, defined as the combined presentation of hip adduction, medial rotation, knee abduction, and lateral knee rotation (Scholtes and Salsich, 2020), has been further substantiated through video analyses of ACL injuries in male basketball players (Tosarelli et al., 2024). The present study's kinematic findings, brace-induced reductions in ankle mobility alongside increases in knee abduction and hip internal rotation, align with these established high-risk movement patterns, emphasizing the clinical importance of monitoring whole-limb coordination when athletes use braces.

From a proprioceptive standpoint, JPR errors were slightly higher under the W bracing condition, indicating reduced proprioceptive sensitivity. Nevertheless, the mechanical stability afforded by the brace appeared to compensate for this deficit during dynamic agility tasks, which is consistent with prior evidence that proprioception is critical for agility, balance, and reaction time (Brockett and Chapman, 2016; Deshpande et al., 2003). This finding highlights the complex trade-off between mechanical stabilization and sensory input: braces may dampen proprioceptive feedback yet still permit functional performance in the short term. However, prolonged use could foster dependency on external stabilization and limit the development of intrinsic sensorimotor control, underscoring the importance of integrating proprioceptive and neuromuscular training alongside brace use.

The practical implications are highly relevant for basketball training and injury prevention. Coaches and athletic trainers should ensure that proprioceptive and agility training are systematically incorporated into athlete preparation. When braces are prescribed, their use should be balanced with unbraced training to preserve proprioceptive function and avoid over-reliance on external support. Individual factors such as injury history, playing style, and positional demands should guide decisions about brace use.

Limitations of this study should also be acknowledged. Although the sample size was determined using a priori power analysis, the relatively small between-condition differences suggest that the true effect sizes may be smaller than expected, raising the possibility of insufficient statistical power to detect subtle but meaningful effects. The sample was limited to professional male basketball players, reducing generalizability to other populations. In addition, testing sessions were not counterbalanced across conditions, outcomes were restricted to short-term performance, and injury-related endpoints were not included.

Conclusions

This study emphasizes the combined importance of proprioceptive measures in evaluating the effects of ankle bracing. Bracing stabilizes the joint and alters kinematic strategies, but does not substantially impair agility performance beyond the initial phase of movement. These findings suggest that, with appropriate proprioceptive and agility training, athletes may benefit from the protective effects of ankle bracing while minimizing potential drawbacks. Future research should include larger and more diverse cohorts, apply counterbalanced designs, and adopt longitudinal follow-up to clarify the long-term implications of brace use for proprioception, agility, and injury risk.

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ORCID iD:

Hande Argunsah: https://orcid.org/0000-0002-5776-1797

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