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COMPARISON OF ANKLE DORSIFLEXION IN CLOSED KINEMATIC CHAIN OF FOOTBALL PLAYERS AND ICE HOCKEY PLAYERS

PRIMERJAVA DORZALNE FLEKSIJE GLEŽNJA V ZAPRTI KINEMATIČNI VERIGI NOGOMETAŠEV IN HOKEJISTOV

ABSTRACT

Limitation in ankle dorsiflexion is associated with the development of injury to the musculoskeletal system. However, little is known about the impact of different sports disciplines on the dorsiflexion range of motion in the ankle joint. Therefore, the aim of the study is to compare the dorsiflexion range of motion of ice hockey players and football players. The sample included 26 professional football players with an average age of 22.46 (± 3.75). The control group included 37 professional ice hockey players with an average age of 24.62 (± 4.34). The range of motion of ankle dorsiflexion in closed kinematic chain was tested using a mobile phone application. The mean ankle dorsiflexion range of motion in football players was 41.40° (± 5.36) at the right ankle joint and 45° (± 5.91) at the left ankle joint. The mean ankle dorsiflexion range of motion in football players was 42.49° (± 6.92) in the right ankle joint and 45.92° (± 5.45) in the left ankle joint. The ranges of motion of the dorsiflexion of the right ankle ($p < 0.016$) and the dorsiflexion of the left ankle ($p - 0.031$) ranges of motion in ice hockey players were significantly higher compared to football players. The average ankle dorsiflexion range of motion in the closed kinematic chain of ice hockey players was significantly higher compared to football players.

Keywords: ankle joint range of motion, dorsiflexion, ice hockey, football

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IZVLEČEK

Omejitev dorzalne fleksije gležnja je povezana z razvojem poškodb mišično-skeletnega sistema. Malo je znanega o vplivu različnih športnih disciplin na obseg dorzalne fleksije v skočnem sklepu. Namen naše študije je primerjati obseg dorzalne fleksije hokejistov in nogometašev. V vzorec je bilo vključenih 26 profesionalnih nogometašev s povprečno starostjo 22,46 let (± 3,75). V kontrolni skupini je bilo 37 profesionalnih hokejistov s povprečno starostjo 24,62 let (± 4,34). Obseg dorzalne fleksije gležnja v zaprti kinematični verigi smo testirali s pomočjo mobilne aplikacije. Povprečni obseg dorzalne fleksije gležnja pri nogometaših je bil 41,40° (± 5,36) v desnem gleženjskem sklepu in 45° (± 5,91) v levem sklepu. Povprečni obseg dorzalne fleksije gležnja pri nogometaših je bil 42,49° (± 6,92) v desnem gleženjskem sklepu in 45,92° (± 5,45) v levem gleženjskem sklepu. Obseg dorzalne fleksije desnega gležnja ($p < 0,016$) in dorzalne fleksije levega gležnja ($p - 0,031$) je bil pri hokejistih bistveno večji kot pri nogometaših. Povprečni obseg dorzalne fleksije gležnja v zaprti kinematični verigi hokejistov je bil bistveno večji kot pri nogometaših.

Ključne besede: gibljivost gležnja, dorzalna fleksija, hokej na ledu, nogomet

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INTRODUCTION

Football is a popular sport, characterised by repetitive activities such as acceleration, deceleration, and change of direction (Thompson et al., 2017). To master individual football components, quick decision-making and game skills are required (Robinson & White, 2005). Football is a contact sport and requires a high level of physical capacity and tolerance to high-intensity loads (Di Salvo et al., 2009). High intensity and frequent contact with an opposing player lead to a higher level of prevalence and incidence of injuries. Dorsiflexion of the ankle joint has an important effect on the movement of football players, and limited range of motion can increase the risk of injury.

Ice hockey is a popular team sport and ice skating is a new type of human movement (Formenti, 2014). It is characteristic of ice hockey and is also important for ice hockey skills. Excellent ice skating ability is one of the main skills of any elite ice hockey player (Buckeridge et al., 2015). Ice hockey players rely primarily on the reactive force caused primarily by a perpendicular force applied to the ice skate (Bond et al., 2018). During ice skating, the ankle is fixed by the ice skate (Mavor et al., 2018). Greater ankle joint dorsiflexion in a closed kinematic chain in ice hockey players is caused by pushing the knee forward, allowing greater dorsiflexion when axial load is applied.

Different injuries are known to be associated with limitation of ankle dorsiflexion. Dorsiflexion limitation is associated with the development of Achilles tendinopathy, patellar tendinopathy, anterior cruciate ligament injury, and ankle injury (Backman & Danielson, 2011; Costa et al., 2006; Fong et al., 2011; Malliaras et al., 2006; Malloy et al., 2015; Rabin et al., 2014; Wahlstedt & Rasmussen-Barr, 2015).

However, there is little information about the impact of individual sports disciplines on the ankle dorsiflexion range of motion. The aim of this pilot study is to compare the dorsiflexion range of motion in a closed kinematic chain of ice hockey players compared to football players.

METHODS

The sample

Two groups of athletes were included in this study. The first group consisted of ice hockey players and the control group consisted of football players. Only athletes who have been practicing sports for more than seven years were included in the study. Athletes who practice more than one sport discipline and athletes who suffer acute ankle injury and infectious diseases

were included. The athlete testing took place in Banská Bystrica. Testing was not carried out during and after training to ensure that the training process did not affect the range of motion of the ankle.

The sample consisted of 26 professional football players from the First Slovak Football League with an average age of 22.46 (±3.75). The youngest player was 18 years old and the oldest player was 30 years old. The mean weight of the football players was 76.14 kg (± 6.81). The mean height of the football players was 181.11 cm (± 5.43).

Table 1. Football players baseline data (n-26).

Age		Weight	kg	Height	cm
mean	22.46 (±3.75)	mean	76.14 (±6.81)	Mean	181.11 (±5.43)
SE	0.73	SE	1.33	SE	1.06
minimum	18	minimum	60	Minimum	172
maximum	30	maximum	90	Maximum	190

*SE – standard error, n- number

The control group included 37 professional ice hockey players with a mean age of 24.62 (± 4.34). The youngest player was 18 years old and the oldest player was 34 years old. The mean weight of the ice hockey players was 87.25 kg (± 7.72). The mean height of the ice hockey players was 185.40 cm (± 6.66).

Table 2. Ice hockey player's baseline data (n-34).

Age		Height	cm	Weight	kg
mean	24.62 (±4.34)	mean	185.40 (±6.66)	mean	87.25 (±7.72)
SE	0.71	SE	1.09	SE	1.27
median	24	median	185	median	86
minimum	18	minimum	170	minimum	71
maximum	34	maximum	198	maximum	103

*SE – standard error, n- number

The weight bearing lunge test

The weight bearing lunge test is used to measure the dorsiflexion range of motion of the ankle joint under axial load in a closed kinematic chain. A goniometer is needed for this test. The participant moves in a lunge position and lunges forward. The subject lunges forward without swinging their knee to the side. The subject must not lift their heel off the mat. If the subject lifts the heel off the mat and valgotization or varotization of the knee occurs, the attempt is

invalid. The physician ensures that the ankle reaches maximum dorsiflexion. The other ankle stays on the mat. The examiner records the angle of dorsiflexion of the ankle. The testing was carried out using a Dorsiflex iPhone application mobile application (15, 16).

Statistical analysis

Data were collected, put into an Excel spreadsheet, and subjected to statistical analysis using SAS® Enterprise Guide® software (SAS Institute Inc., USA). Each sample was subjected to a normality test with p-values < 0.05. An *F test* was used to test homoscedasticity. Based on this, a parametric t-test (two-sample assuming the same variances) was used to compare the mean values of the right ankle joint (left) between the two groups of hockey and football players. The alternative hypothesis was set as one-sided with respect to the sample mean (the sample mean value for ice hockey players was higher than for football players).

RESULTS

The mean dorsiflexion range of motion of the right ankle joint in football players was 41.40° (± 5.36). The minimum recorded range of motion was 28° and the maximal recorded range of motion was 53.40°. The mean range of motion of dorsiflexion of the left ankle joint in ice hockey players was 45° (± 5.91). The minimal recorded range of motion was 32° and the maximum recorded range of motion was 60°. It was found that a statistically significant difference was found between ice hockey players and football players (p <0.016). The results are shown in Table 3.

Table 3. Mean values of right ankle dorsiflexion in ice hockey players and football players.

Methods	*N*	Mean	*SD*	*SE*	Minimum	Maximum
Football Group	26	41.40°	5.36	1.05	28.00°	53.40°
Ice hockey Group	37	45.00°	5.91	0.97	32.00°	60.00°

**SD* – standard deviation, SE – standard error, N- number

Table 4. Mean values of left ankle dorsiflexion in ice hockey players and football players.

Sport	Methods	*N*	Mean	*SD*	*SE*	Minimum	Maximum
Football Group		26	42.49	6.92	1.35	29.80	59.60
Ice hockey Group		37	45.93	5.44	0.89	35.00	60.00

**SD* – standard deviation, SE – standard error, N- number

The mean dorsiflexion range of motion of the left ankle joint in football players was 42.49° (± 6.92). The minimum recorded range of motion was 29.80° and the maximum recorded range of motion was 59.60°. The mean dorsiflexion range of motion of the left ankle joint in ice hockey players was 45.93° (± 5.44). The minimal recorded range of motion was 35° and the maximum recorded range of motion was 60°. A statistically significant difference was observed between ice hockey players and football players (p – 0.031) was observed. The results are demonstrated in Table 4.

DISCUSSION

Optimal ankle joint mobility is essential for efficient and safe movement in sports. Despite differences between sports disciplines, professional athletes need to have a sufficient ankle range of motion to be able to move to the proper position in the given sport and perform the following movements safely and efficiently.

Both football and ice hockey are demanding sport disciplines and to perform successfully, versatility of movement is required. The ankles are fixed with footwear in both these sports disciplines. Football players wear football boots and hockey players wear ice skates.

This study focused on the impact of football and ice hockey on the dorsiflexion range of motion in a closed kinematic chain. It was assumed that the impact of sports activities influence the ankle dorsiflexion range of motion. Significantly higher levels of ankle dorsiflexion range of motion were identified in ice hockey players, because their knees are pushed forward, allowing greater ankle mobility in the closed kinematic chain, and, by extension, greater ankle dorsiflexion under axial load.

Weight-bearing lunge tests were used to test ice hockey players and football players. The

validity of the test using the weight-bearing lunge test was verified in a systematic review by Powden *et al*. (2019). Twelve studies were included. High interclinician reliability (ICC = 0.80-0.99) and intraclinician reliability (ICC = 0.65-0.99) have been verified.

However, the range of motion of dorsiflexion can change during the season, as Moreno-Peréz et al. (2020). The sample consisted of 45 football players, tested to identify the acute effect on movement activities before and after a game. Long-term effects have also been tested during the season. The greatest ankle dorsiflexion range of motion was recorded before the season. Ankle dorsiflexion was greater in the preseason compared to the middle of the season. Reduced ankle dorsiflexion has been recorded after the season compared to the preseason (13.8% dominant, 12.5% non-dominant). This reduced dorsiflexion has been observed in almost 30% of football players. The acute effect after a football match has been recorded in terms of increased dorsiflexion; however, this increase in the dorsiflexion range of motion decreased again over the next 48 hours.

Due to the size of the sample, no retests were performed before and after the season. The focus was on the long-term effect of football and ice hockey on the ankle dorsiflexion range of motion in football players and ice hockey players.

A limited ankle dorsiflexion range of motion increases the risk of multiple injuries and increases the risk of patellar tendinopathy, Achilles tendinopathy, anterior cruciate ligament rupture, and ankle injury (Backman & Danielson, 2011; Costa et al., 2006; Fong et al., 2011; Malliaras et al., 2006; Rabin et al., 2014; Wahlstedt & Rasmussen-Barr, 2015).

Limited ankle dorsiflexion leads to compensatory alternating movement mechanisms. Limited dorsiflexion of the ankle joint leads to changes in the kinematic motion in the frontal and sagittal planes of the knee biomechanics. Lima *et al*. (2018) have shown a connection between ankle dorsiflexion and dynamic knee valgus and concluded that limited ankle dorsiflexion motion may be related to the potential risk of lower extremity injury.

The potential negative effect of limited dorsiflexion motion can also cause pathophysiology in terms of patellofemoral syndrome and can also lead to patellar tendinopathy. Patellar tendon injuries are common in sports that require jumping, such as basketball and volleyball. Malliaras *et al.* (2006) have tested the connection between plantar flexor strength, jump height, and ankle joint mobility among 113 volleyball players. Ankle mobility has been measured using the weight-bearing lunge test in the closed kinematic chain. However, the only confirmed association has been limited ankle joint dorsiflexion ($p < 0.05$). According to Malliaras *et al* ., the limited range of motion of the ankle during the eccentric phase of movement can lead to tendon overuse.

The connection between the limited ankle dorsiflexion range of motion and injuries has also been tested in research by Backman and Danielson (2011). The sample included 75 professional basketball players who have been monitored for one entire basketball season. Twelve of them have suffered patellar tendinopathy during the season. In these basketball players, a reduced ankle dorsiflexion range of motion ($p = 0.038$) has been observed in the dominant limb and in the nondominant limbs ($p = 0.024$). Another important report has shown that players with dorsiflexion less than 36.5 ° had a higher probability of developing patellar tendinopathy in one year from 18.5% to 29.4% compared to players with dorsiflexion greater than 36.5°, and a probability of developing patellar tendinopathy in one year from 1.8% to 2.1%.

Kosik *et al*. (2019) tested dynamic stability and mobility of the ankle in axial load among patients with and without chronic ankle instability. Reduced dynamic stability and dorsiflexion have been found in patients with chronic ankle instability.

CONCLUSION

The level of mean dorsiflexion range of motion in the closed kinematic chain was significantly higher in ice hockey players compared to football players. One of the main reasons may be the higher range of mobility during ice skating.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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