Influence of kinematic and kinetic inter-limb asymmetry on injuries

Critically review the biomechanics literature to design a suitable protocol for assessing kinematic and kinetic inter-limb asymmetry and its influence on either performance or injury

‘ Kinetic and kinematic inter-limb asymmetry analysis of the knee joint during countermovement jumps in female football players with and without previous ACL injuries’

Rationale: previous research looks at cause and prevention of ACL injuries (authors names) and mainly focuses on male athletes (authors names). This study looks at whether previous ACL injuries have an effect on kinetic and kinematic inter-limb asymmetry of the knee. Also is focused on female athletes because female athletes are more prone to ACL injuries, due to the Q angle (authors names)

Introduction

Inter-limb asymmetry compares how well one limb performs in relation to the other and has been extensively researched in the literature (Keeley, Plummer & Oliver, 2011). Inter-limb asymmetry is of interest because it allows you to assess the relationship between both limbs. This study looked at inter-limb asymmetry with reference to kinetic and kinematic aspects. Kinematics looks at motion characteristics and particularly temporal and spatial motion, whereas kinetic analysis looks at how the movement is produced and maintained throughout performance (Hamill & Knutzen, 1995). This study looked at the kinetic and kinematic inter-limb asymmetry of the knee joint in female football players with and without previous ACL injuries. Countermovement jumps were used to assess the kinematic and kinetic inter-limb asymmetry of the knee joint. Countermovement jumps were used to assess the knee joint because it has previously been found that the magnitude of the forces at the patellofemoral joint and tibiofemoral joint (during jumping) are higher than everyday activities and less vigorous movements (Cleather, Goodwin & Bull, 2013). Countermovement jumps involve firstly, eccentric effort, and then quickly followed by a concentric action. It is also well-known from previous research, that a participant can jump higher in a countermovement jump compared to a squat jump. It has been found that the knee joint contributes to half of the work completed during a countermovement jump (Hubley & Wells, 1983) which highlights the importance of the knee joint in power-based exercises and also identifies the impact that knee injuries (ACL) can have on inter-limb asymmetry. Jump height (kinematic) and ground reaction force (kinetic) were the variables which were measured in this study, following a countermovement jump. Previous research from Moran and Wallace (2007) has also found that by increasing the range of motion of the knee would increase the height at which a participant is able to jump, following a countermovement jump. Pupo et al (2012) found that the height a participant is able to jump, following a countermovement jump, relies on the power that the muscles are able to produce during the concentric phase of the jump. Research from Ferraro and Fabrica (2017) used Volleyball players (without injury) in order to measure jump height following a countermovement jump. The height reached following a countermovement jump were 0. 334m ± 0. 015m (mean ± SD). Ground reaction force is the force delivered by the surface when a participant is moving. Ground reaction force is closely linked to Newtons third law, where every action has an equal and opposite reaction. So, when a participant applies force to the ground, an equal force is applied in the opposite direction, which can then be measured and analysed (Hamill & Knutzen, 1995). Hori (2006), found that using a number of different methodologies, directly calculated from ground reaction force data, were the most accurate way of measuring strength from a countermovement jump. Different approaches including, displacement-time data from a position transducer (Wilson et al, 1993) and ground reaction force from a force platform (Young et al, 2005). This study looked at the inter-limb asymmetry in female football players with previous ACL injuries and also without previous ACL injuries. It's important to study how jump height and ground reaction force differs in athletes with and without previous ACL injuries, in order to highlight potential areas of the knee to strengthen. The anterior cruciate ligament joint is a main part of the knee and is the ligament most involved in injuries (Lesci & Bumbasirevic, 1999). Evidence in the literature explains that when football players return to play after an ACL injury, there is differences in the strength of their limbs during jumping activities (Myer et al, 2012). In relation to female football players, McAlindon (1999) discovered that female competitors are up to 10 times more likely to suffer an ACL related injury compared to men. The majority of the research into female athletes and ACL injury suggests that the Q angle is the main reason as to why female athletes suffer more knee injuries as opposed to men. Previous studies suggest that the Q angle is larger in females, thus leading to more ACL related injuries than men. Horton and Hall (1989) researched the Q angle in relation to ACL injuries and discovered a mean ± SD Q angle of 15. 8 ± 4. 5 degrees in female athletes and 11. 2 ± 3 degrees in males. A larger Q angle may lead to an increase in the interaction of force which affects the patellofemoral joint (Li, DeFrate & Zayontz, 2004). There is very little evidence in the literature of research between countermovement jumps and kinetic and kinematic factors. There are enormous amounts of research in the area of ACL prevention and rehabilitation (Boling, Marshall, Guskiewicz & Beutler, 2009; Hewett, Ford, Hoogenboom & Myer, 2010; Huang et al, 2017; Drapsin et al, 2016; Kizilgoz et al, 2018). However, there is very little research into how previous ACL injuries can have an effect on kinetic and kinematic inter-limb asymmetry. There is little research in the area of female athletes with previous ACL injury, even though it is an interesting and important area of concern due to evidence that the Q angle has such an influence on ACL injuries. Due to the lack of research in the areas stated above, this study also looks at whether previous ACL injuries have an effect on kinetic and kinematic inter-limb asymmetry. This study is also directed about female athletes because they are more prone to ACL injuries (because of the Q angle). The main aim of the present study was to identify whether there was a difference in inter-limb asymmetry of female football players with and without previous ACL injuries. The study aimed to find out whether previous ACL injuries have an impact on countermovement jumps, and in particular, jump height (kinematic data) and ground reaction force (kinetic data). By using reflective markers on each limb, the study also aimed to discover the inter-limb asymmetry of the limbs, by using the ground reaction force data following a counter-movement jump. It was hypothesised that those female football players without a previous ACL injury would produce a greater jump height and also be able to produce a superior ground reaction force compared to the football players with a previous ACL injury.

Methods

Participants

20 female football players were collected from 14 professional women's football clubs in England. 10 of the 20 participants (50%) used in this study had suffered an ACL injury within the last 12 months, in align with King et al (2018), who used participants that had undergone ACL reconstruction on average 8. 8 months (0. 7) prior to participating in the study. And the other 10 footballers had not suffered from an ACL injury within the last year. The female football players recruited into the study had a mean age of 22. 6 (3. 42), height 160. 5cm (10. 24) and mass 63. 8kg (5. 58).

Experimental design and protocol

The study opted for a cross-sectional approach because it measures kinetic and kinematic inter-limb asymmetry at a specific point in time. The study also took an independent groups design style because of the fact that two different groups are completing the same trial. Meaning that there are no order effects and there is a lower risk of demand characteristics. The procedure of the test was explained to the participants, and informed consent was gained. A health screen questionnaire was also completed by each participant prior to beginning the trial. The trials took place in a Biomechanics laboratory and all participants visited the lab on two separate occasions. The same procedure was carried out on both visits, and then results were averaged out. The participants were required to complete the trial on two separate occasions in order to increase the accuracy and reliability of the study and its results. Before each session, it was compulsory that the participants had not participated in vigorous physical activity for at least 36 hours prior to attending the laboratory sessions (Mcerlain-Naylor, King & Pain, 2014). Before starting to collect data, all 20 participants completed a warm-up, which consisted of a 2-minute jog, 5 squats and 4 countermovement jumps (King et al, 2018). The same warm-up was completed by each participant prior to beginning the trial on both visits to the Biomechanics laboratory.

Measurements – Ten cameras (functioning at 200Hz) were placed around the laboratory in order to measure kinematic inter-limb asymmetry data (Ferraro & Fabrica, 2017). The change in distance between the height of the participants body's centre of mass at the peak point of the jump and at the beginning of the jump and the duration of the jump were used to calculate the height of the jump, in accordance with Bobbert et al (2008).

Data analysis – Countermovement jumps on the force platforms allowed for vertical, anterior posterior and medio-lateral force data to be collected.

Statistics –

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