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ORIGINAL ARTICLE

Gender difference in lower limb muscle activity during landing and rapid change of direction

L'activité musculaire des membres inférieurs selon les sexes est différente lors de la réception au sol et lors d'un changement rapide de direction

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KEYWORDS
Muscle activity;
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Summary
Objectives. — The purpose of the study was to examine gender differences in lower limb muscle activity during jump landing and rapid change of direction.
Equipment and methods. — Surface electromyography (EMG) of the rectus femoris, biceps femoris and gluteus maximus were recorded for 10 male and 10 female basketball, volleyball or netball players performing five repetitions each of two tasks; (1) landing from a maximal height vertical jump and, (2) 45° rapid change of direction on their dominant leg. Independent sample *t*-tests were conducted to determine sex differences and paired samples *t*-tests were conducted to determine task differences in peak EMG muscle activity.
Results. — Rectus femoris muscle activity was significantly greater in females compared to males during jump landings and rapid change of direction. Biceps femoris muscle activity was significantly greater in males compared to females during jump landing. No significant gender differences in gluteus maximus muscle activity were found during jump landings or rapid change of direction. These findings suggest that significant differences in muscle activity of the quadriceps and hamstrings exist between males and females when performing jump landing and change of direction movements, which may place females at greater risk of ACL injury compared to males, for example.

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MOTS CLÉS
Activité musculaire ;
Ligament croisé antérieur ;
Électromyographie

Résumé
Objectifs. — Le but de cette étude était d'examiner les différences entre les sexes dans l'activité musculaire des membres inférieurs à la suite d'une réception au sol après un saut et un changement rapide de direction.
Matériel et méthodes. — Une électromyographie de surface (EMG) du fémur droit, biceps et fessiers a été enregistrée pour 10 hommes et 10 femmes jouant au basket-ball, volley-ball ou netball. Tous ont répété cinq fois de suite chacune des deux tâches suivantes : (1) réception après un saut vertical à la hauteur maximale et (2) changement rapide de direction à 45° sur leur jambe dominante. Des échantillons de tests-*t* indépendants ont été menés pour déterminer ces différences et des échantillons de tests-*t* faits en parallèle ont aussi été utilisés pour déterminer la différence des tâches dans une activité optimale musculaire EMG.
Résultats. — L'activité musculaire du fémur droit était significativement plus élevée chez les femmes que chez les hommes au cours de la réception après un saut et un changement rapide de direction. L'activité musculaire du biceps fémoral était significativement plus élevée chez les hommes que chez les femmes au cours de la réception après un saut. Il n'y a eu aucune différence significative entre les sexes concernant l'activité du grand muscle fessier lors de la réception après un saut ou un changement rapide de direction. Ces résultats suggèrent qu'il existe des différences significatives dans l'activité musculaire des quadriceps et des ischio-jambiers entre les hommes et les femmes quand ils sautent et changent leurs mouvements de direction ce qui pourrait entraîner un risque plus accru de blessures ACL chez les femmes que chez les hommes.

1. Introduction

Between 70% and 90% of anterior cruciate ligament (ACL) injuries have been reported to occur in non-contact situations (no direct contact with the knee) [1]. Most non-contact ACL injuries appear to occur in situations involving one or more of the following manoeuvres: at foot strike with knee close to full extension during rapid change of direction, landing and deceleration [1,2]. The incidence of ACL injury is therefore relatively high in sports such as basketball (0.06 per 1000 person days) [3] and volleyball (0.45 per 1000 person days) [3] that are characterised by a high frequency of landing [4], deceleration [5] or rapid change of direction [6]. The incidence of non-contact ACL injury in females has been reported to be 6 to 8 times greater than in males competing in the same sports [7,8]. Various risk factors have been reported to be associated with the apparent increased incidence of ACL injuries in females These include intercondylar notch width [9], Q angle [10], patella tendon tibia shaft angle [11], ACL cross sectional area [12], joint laxity [13], hormonal influences [14], muscle strength [15], muscle stiffness [16], muscle activity patterns [17] and biomechanics of landing [15,18—21]. However, the risk factors for which there appears to be strong empirical evidence are those factors related to structures providing dynamic stability (i.e. stability provided by the muscles that cross the tibiofemoral joint) to the knee joint. In particular, landing biomechanics, muscle activity pattern, muscle strength and muscle stiffness [2,22].

When providing dynamic stability of the knee, co-contraction of the knee flexors and extensors should, ideally, result in a zero shear load on the proximal tibia and, therefore, minimal strain on the knee ligaments [23]. However, if the shear load exerted by the quadriceps is greater than the shear load exerted by the hamstrings, a resultant anteriorly directed shear force may be exerted on the proximal end of the tibia, which will potentially cause anterior tibial translation and therefore is likely to increase ACL strain [24,25]. This is known as quadriceps dominance, defined as a preferential activation of the quadriceps compared to the hamstrings when providing dynamic stability of the knee joint [26], which a number of studies have found to be greater in females than males during activities associated with ACL injury [17,27—31]. Previous research has examined muscle activity of the quadriceps and hamstrings muscles during cutting [27,30—32], single-limb landings [28,33], double limb stop/drop jump landings [34,35] and squats [17]. The results of these studies tend to show that females exhibit greater activation of the quadriceps muscles compared to males [27—30,32]. However, for the hamstrings, the findings are somewhat conflicting since some studies report no significant difference between males and females [29,30,33] whereas other studies report males to exhibit significantly greater muscle activity of the hamstrings compared to females [34,36]. The differences in the findings of these studies may be partly due to differences in the tasks examined, however there is little research investigating muscle activity of the same cohort of subjects during both landing and change of direction manoeuvres therefore it has not yet been established in the same group of subjects whether gender differences in lower limb muscle activity associated with ACL injury are consistent between both change of direction and landing tasks. Also, there is limited research examining muscle activity of the gluteus maximus during both landing and change of direction tasks which may also be associated with ACL injury since the gluteus maximus controls the alignment of the femur and the pelvis in all planes of motion during weight-bearing activities [37]. Recent research has begun to examine gender differences in gluteus maximus muscle activity during dynamic tasks and