



ORIGINAL ARTICLE

Comparison of selected muscular activity of trunk and lower extremities in young women's walking on supinated, pronated and normal foot



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Abstract Changes in anatomical structure of the foot reduce the foot ability for normal performance. This study aimed to compare selected muscles of trunk and lower extremities during walking in individuals with different foot types. Forty-five female students were categorized into three groups depending on their foot structures namely, pronated, supinated and normal feet. Foot types defined by foot posture index and X-ray under the specialist physician. Electromyography activities were recorded from muscles of tibialis anterior, peroneus longus, medial gastrocnemius, biceps femoris, gluteus medius, external oblique and erector spinae in three groups while walking in determined path with self-selected gait speed. Each effort simultaneous with electromyography registration was recorded with camera. One-way ANOVA test was used to compare the groups at significance level of 0.05. The activity of muscle of tibialis anterior and medial gastrocnemius was greater in pronated foot group than that in supinated and normal groups during heel contact phase of gait ($p = 0.001$). Supinated foot group exhibited a greater peroneus longus activation than the other groups ($p = 0.001$). No significant differences were observed for remaining four muscles ($p > 0.05$). During midstance phase, peroneus longus, supinated foot group exhibited a greater activity compared to other groups while pronated foot group exhibited a greater muscle activity for gluteus medius than others ($p = 0.001$). There was a significant difference between normal and pronated foot groups for external oblique ($p = 0.001$). Regarding the findings of this study, the muscular performance changes in pronated and supinated foot groups are more noticeable than that in normal foot type.

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PALABRAS CLAVE

Músculos de las extremidades inferiores;
Marcha;
Pie neutro;
Pie pronador;
Pie supinador

Comparación de la actividad muscular seleccionada del tronco y las extremidades inferiores en la forma de caminar de las mujeres jóvenes con pies supinadores, pronadores y neutros

Resumen Los cambios en la estructura anatómica del pie reducen su capacidad de rendimiento normal. Este estudio trató de comparar los músculos seleccionados del tronco y las extremidades inferiores al caminar, en personas con diferentes tipos de pie. Se clasificó a 45 estudiantes femeninas en tres grupos, dependiendo de la estructura de sus pies, es decir, pronadora, supinadora y neutra. El médico especialista definió los tipos de pie mediante el índice postural del pie y rayos X. Se registraron las actividades electromiográficas de los músculos tibial anterior, peroneo lateral largo, gemelo interno, bíceps femoral, glúteo medio, externo oblicuo y erector de la columna en los tres grupos, al realizar un recorrido determinado, con una velocidad de marcha auto-seleccionada. Se grabó con una cámara cada esfuerzo simultáneo al registro electromiográfico. Se utilizó el test ANOVA con un factor para comparar los grupos, con un nivel de significación de 0,05. La actividad de los músculos tibial anterior y gemelo interno fue superior en el grupo de pie pronador que en los grupos de pie supinador y neutro, durante la fase de contacto del talón de la marcha ($p=0,001$). El grupo de pie supinador reflejó una activación superior del músculo peroneo lateral largo que el resto de los grupos ($p=0,001$). No se observaron diferencias significativas en los cuatro músculos restantes ($p > 0,05$). Durante la fase de media distancia, para el peroneo lateral largo, el grupo de pie supinador reflejó una mayor actividad en comparación a los demás grupos, mientras que el grupo de pie pronador reflejó una mayor actividad muscular para el glúteo medio que los demás grupos ($p=0,001$). Se produjo una diferencia significativa entre los grupos de pie pronador y pie neutro para el externo oblicuo ($p=0,001$). Con arreglo a los hallazgos de este estudio, los cambios en el desempeño muscular en los grupos de pies pronadores y supinadores son más notorios que en el grupo de pie neutro.

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Introduction

In walking foot bears the performance of absorbing contact forces with the ground, balancing, and adaptation to ground surfaces and transmission of forces efficiently, which are obtained through mutual activities of foot joints.¹

The important movements occur at the talocrural, subtalar, talonavicular, calcaneocuboid and navicular-cuboid joints during walking.² The recent studies point out individual differences and high complexity of tarsal movements which can be summarized into pronation and supination movements. Pronation occurs in the midstance which helps to increase the available motion of the forefoot, shock absorption and adaptation to ground. Toward the end of stance, foot supination increases and leads to decrease available motion of the forefoot resulting in stability to the front.¹

Unnatural biomechanics of foot reduces the foot ability to do normal performance.³ Pronated foot is one of the most common reasons of people's referring to orthopedics and clinics as seen in a wide range of deformities such as reduction of medial longitudinal arch height, heel external rotation and anterior foot abduction.⁴ It is generally believed that pronated foot acts as a facilitator in bringing about overtraining damages and pathologic conditions such as plantar fasciitis, Achilles tendon shortening, stress fracture, shin splint and pain in heel, knee and back.⁵

Heel internal rotation concomitant with medial longitudinal arch height is called supinated foot contributing to a wide range of lower extremity deformities such as forefoot adduction, finger forking, genu varum and other symptoms.⁶ It was structurally determined that for people with this deformity. During walking, time and area of contact with ground become less and they have weak shock absorption due to locking of midtarsal joints.⁷ Foot pronation and supination are abnormalities when contribute to structural and performance deficiencies in standing and walking with changes in lower-extremity, lumbar-pelvic area and lower extremity muscles.⁸ In contrast to disturbance in proximal muscle performance, it is effective on distal muscle performance.⁹ Over pronation and over supination of subtalar joint can change the position of hip, pelvis and trunk and upper extremities.⁸ Over pronation is concomitant with tibia internal rotation, femur¹⁰ and knee valgus^{11,12} and pelvis anterior tilt.^{13,14} Supinated foot is accompanied by external rotation of the tibia¹⁵ consequently, the femur rotates in the same direction as the tibia, and the femoral neck angle influences knee angle and position. Thus, supinated foot may contribute to lower limbs dysfunction. It is reasonable to assume that close chain activity in lower limb may alter the mechanical alignment and dynamic function in proximal joint. Hansen¹⁵ noted that an overpowering posterior tibialis muscle is an apparent feature in subjects with supinated foot. This muscle inverts and internally rotates

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