

ASSOCIATION OF THE KNEE DYNAMIC VALGUS IN THE STAIR DESCENT TEST WITH THE HIP RANGE OF MOTION OF MEDIAL ROTATION



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ABSTRACT

Introduction: The knee is a widely studied joint due to its high incidence of injuries. Most studies correlate these lesions with the valgus during flexion of the knee (dynamic), which is attributed mainly to the poor performance of the gluteus medius muscle. **Objective:** This study had the aim to evaluate the association between the hip medial rotation and the valgus angle (in two dimensions) during the stair descent test obtained through photogrammetry (SAPO software). **Methods:** 104 female volunteer athletes were evaluated in the measurement of the hip internal rotation (Craig's test) and the angle value of knee valgus during the descending of a step; the analyses were submitted to inter-rater reliability assessment observed with the Bland and Altman plot. The data were analyzed through multiple linear regression in order to adjust the results to the age of the evaluatees. **Results:** The angle generated in the medial rotation of the hip presented average of 45.3 degrees, with the increase of the knee valgus, while the valgus during the descent movement presented average of 8.6 degrees. Significant inverse relation in the association of the medial rotation and knee valgus was found. **Conclusion:** The presented data show a possible association between the reduction of the medial rotation of the hip with the increase of the knee valgus; however, the data are not conclusive since the evaluation was bidimensional. The obtained results suggest the need of more conclusive studies.

Keywords: medial rotation, valgus, hip, knee.

INTRODUCTION

The knee is the intermediate joint of the lower limb, located between the hip and the ankle¹. According to Hall², the dynamic stabilization of the knee is guaranteed by the musculature which surrounds the joint. The hip indirectly influences on the kinematics of the knee as well as other adjacent joints^{3,4}.

The theory proposed by Pauwels⁵⁻⁸ (balance of Pauwels) highlights the importance of the gluteus medius for the hip stabilization; however, it analyzed the biomechanics only in one movement plane rather than in three as suggested by Frain⁶ in his investigation. Mascal⁹ and Russell¹⁰ also show the importance of the gluteus medius (GM) for the pelvis stabilization and consequent maintenance of the knee kinematics.

Weakness in that muscle leads to drop in the contralateral pelvis, increase in the internal rotation and ipsilateral femoral adduction (dynamic valgus¹¹) during functional movements such as descending steps. Schmitz⁴ suggests that the dynamic valgus is probably related to strength, coordination, ability, anatomic alignment and subjacent arthrokinematic function.

The gluteus medius is an important hip abductor; the greater the hip flexion, the greater the activation of that muscle¹⁰. The GM strengthening is described¹² in the treatment of the patellofemoral dysfunction and shows decrease of the excess of dynamic valgus.

Excessive valgus is a dangerous condition for knee injuries^{1,4,9,10,11,13}, the literature highlights the correlation between the ACL injuries and increase of the valgus by the increase of the tension in the ligament.

The female morphology is characterized by a wider pelvis and

more remarkable valgus than in the male gender. Studies explain greater movement in valgus during jumping activities in women through physiological factors such as delay in the activation of the knee medial musculature^{3,13-19}, lower articular stiffness^{11,20-22} and body mass¹⁰.

Russell¹⁰ showed during unipodal jump, higher level of valgus in women compared to the male gender, corroborating the previous study by Schmitz¹¹ where he evidences that in low torques women present greater knee laxity; however, when the torques are increased, this laxity is not observed, which he explains by the difference of the material property (histological) and by the anatomy of the tibiofemoral junction.

Men in advanced stages of maturation demonstrate bad alignment of the dynamic valgus while women demonstrate this bad alignment during the whole maturation phase⁴.

The femoral anteversion angle is one of the factors related in the literature to the increase of the dynamics valgus. Nyland³ when correlated the hip muscular activation with the femoral anteversion angle, found lower electromyographic activation both in the vastus medialis and in the gluteus medius in the hips with greater femoral anteversion.

The evaluation of the femoral anteversion can be radiologically or clinically done (Craig's test)^{3,12,23,24}. The clinical evaluation reliability is still controversive. Canto²³ did not find correlation between the clinical evaluation and the radiological exam, while Staheli²⁴ and Kozic¹² found this correlation.

The Craig's test presents as advantages the low cost and easiness of performance. However, the literature does not reach to a consensus concerning its reliability.

OBJECTIVES

To perform an association analysis of the knee dynamic valgus during a step descend together with the hip internal rotation (Craig's test) in young female athletes.

MATERIALS AND METHODS

All procedures described here followed the Ethical Principles and were approved by the Ethics Committee of the Medicine School of São Paulo – EPM/Unifesp.

It was an observational and transversal study with a closed sample composed of 104 female volunteers, practitioners of sport at competitive level (judo, basketball, soccer, Olympic wrestling, swimming, track and field, handball and artistic gymnastics) aged between 11 and 18 years, and members of the Olympic Center of Training and Research (COTP) of the São Paulo State Government.

All athletes were submitted to a questionnaire including weight, height, age, sports modality, training frequency and previous injuries. The collected data enabled that the Body Mass Index (BMI) of the athletes could be performed with the equation of the weight divided by the height to the square. The athletes were subsequently evaluated concerning their hip medial rotation (Craig's test), knee dynamic valgus when descending a step and bilateral Trendelenburg test.

The hip medial rotation evaluations were initially performed placing a plumb line at the site of analysis in order to obtain the absolute vertical line. Blue adhesive markers were also placed on the tibial tuberosities as well as calcaneus tuberosities of the participants, which were positioned at ventral decubitus, one of the limbs flexed at 90 degrees and contralateral hip being stabilized by the evaluator and passive movement of the complete hip medial rotation always being done by the same evaluator. After such procedure, a photo was taken with a digital camera stabilized on a tripod at a pre-set distance, on the horizontal plane, with a one-meter border on each side up to the markers.

The evaluation of the dynamic valgus was performed placing Styrofoam markers colored in blue on the anatomic correspondence of the lateral malleolus, knee lateral interline, and half distance between the trochanter major and the knee lateral interline with the aid of an elastic band with Velcro. Participants placed on a 15-centimeter white box performed tests previous to the exam to learn the exercise. After the preparation phase, they were told to perform 10 consecutive repetitions of the step descent movement at unipodal rest without removing the calcaneus rested on the box during the repetitions. The tests were filmed with a digital camera stabilized on a tripod at a pre-set distance, on the horizontal plane, with a one-meter border on each side up to the markers.

The Trendelenburg is a clinical test which consists in the evaluation of the strength of the gluteus medius through the observation of the individual at unipodal rest, with his/her back to the evaluator for a pre-set period of 30 seconds. The evaluator will observe the drop of the contralateral pelvis which indicates positiveness for the test and consequent fatigue of the gluteus medius.

The images were analyzed by biophotogrametry, with the SAPO software. Four participants were excluded from the research due to flaw in the data collected, where the software analysis was not possible.

The data were exposed on the tabular plane and statistically analyzed in the SPSS Statistics 17.0 software for *Windows* (SPSS, Inc.); data normality was verified with the Kolmogorov-Smirnov

test. The descriptive statistics was composed of the calculation of mean and standard deviation for all continuous and semi-continuous data with normal distribution. Value of $\alpha \leq 5\%$ was accepted as statistically significant.

In order to have the knee valgus inter-observer reliability tested, the Bland and Altman concordance test was used, while the analysis between angle values of the dynamics valgus and the measurements of the hip medial rotation angles were performed by multiple linear regression to adjust the results by the age of the evaluated subjects.

RESULTS

Athletes aged between 11 and 18 years with mean of 15 years and 1.5 of standard deviation were evaluated. The mean of the Body Mass Index (BMI) of the evaluated athletes was 21.2 with 2.3 of standard deviation.

The angle given in the hip medial rotation presented 71.2 degrees as maximum value, 23.5 degrees as minimum value, 45.3 degrees as mean and 8.6 of standard deviation. The knee valgus during step descent presented maximum value of 22 degrees, minimum value of six degrees of knee varization, 8.6 degrees of mean and standard deviation of six degrees.

There was reverse significance between the hip medial rotation with the knee dynamic valgus without the age confusion factor, that is to say, the smaller the hip medial rotation, the greater the homolateral knee valgus during the step descent movement.

DISCUSSION

Many authors^{4,9,10,11,13,16} study about the dynamic valgus, a condition which indirectly influences on the knee. The female sex presents a more remarkable valgus than the male sex due to its anatomy, delay in the muscular activation, smaller articular stiffness and body mass.

Activation of the medial musculature is described^{13-19,25} as a factor which predisposes to greater knee dynamic valgus in women. Lower articular stiffness was found in the female sex^{11,20-22} and correlated with the increase of the dynamic valgus (above 14 degrees) as well as body mass¹⁷.

In the present study correlation between the increase of body mass and increase of the dynamic valgus was not found, since all the athletes with overweight did not present abnormal valgus values.

Pauwels, Kummer and Verne⁵ were pioneers in introducing the strength vectors representing the muscles. The Pauwels theory⁵⁻⁸ illustrates the importance of the gluteus medius for the pelvic stabilization and consequent knee kinesia; however, only 14.2% of our sample obtained relation between the increase of the dynamic valgus (above 14 degrees) and the positiveness of the Trendelenburg test on the left lower limb and 15.6% on the right lower limb.

The theory is questioned by Frain⁵ and Kummer⁷ when it approaches only one plane of the movement and attributes all the importance of stabilization to the gluteus medius without including other muscles. Both Mascal⁹ and Schmitz¹¹ in studies directly related to the gluteus medius also present the importance of this muscle in the hip stabilization.

A study carried out by Nyland³ in female athletes with the aid of electromyography demonstrated that hip medial rotation angle higher than 42 degrees caused decrease in the activation of the gluteus medius (34%) and the vastus medialis (27%) during isometric contraction of abduction and external rotation. We observed that the female athletes presented excessive valgus (above 14 degrees), 78.5% presented hip medial rotation angle higher than 42 degrees; however, from all the athletes who presented medial rotation higher than 42 degrees, only 16.1% performed valgus above 14 degrees.

Willson and Davis²⁶ compared the bidimensional and the tridimensional evaluations of the knee valgus and concluded that a study in three dimensions was more reliable. The methodology applied in the collection was not the most reliable since it was bidimensional; nevertheless, a study in two dimensions performed by these authors justifies its application in the clinical practice due to its low cost, practicality of the method and capacity to produce values equivalent to the tridimensional examination.

Another factor which influences on the dynamic valgus is the femoral anteversion angle²⁷. During childhood and adolescence this angle decreases with age progression²⁸.

The most reliable measurement of femoral anteversion is performed by the image exam^{12,23,24}. The clinical evaluation is performed with the passive hip medial rotation (Craig's test). In our study it

was observed that decrease in the hip medial rotation significantly influenced on the increase of the knee valgus, which clashes with our initial hypothesis that the increase of the medial rotation would influence on the knee valgus. The literature is controversial about the reliability of the clinical evaluation; Canto²³ did not find correlation between the clinical evaluation and the radiological exam, while Staheli²⁴ and Kozic¹² found this correlation.

CONCLUSION

The data presented evidence a possible association between decrease of the hip medial rotation and increase of the knee valgus. The reason for such fact is not clear, since it may have been masked by the bidimensional evaluation which is not able to quantify the rotation existing in the femur during squatting, or by the fact that there was not association between femoral anteversion through the radiological evaluation and the hip medial rotation by the Craig's test.

These facts make us emphasize the need for further conclusive studies on the knee valgus and the clinical evaluations performed in this study.

All authors have declared there is not any potential conflict of interests concerning this article.

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