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Analysis of the rotational degree of hip of classic dancers

Abstract

Introduction: Among the various possible movements in the hip joint one of them is the external rotation of the femur in the socket of the acetabulum. A high degree of range of motion is required for the perfection of classical ballet lines, and this is one of the principles outlined in the technique that is specifically described in the dancer's vocabulary: the en dehors' hip skill is an important fundamental physical attribute in classical ballet.

Objective: to evaluate the degree of external and internal rotation of the hip region in classical dancers and to determine if they have a greater range of internal and external rotational movement in this region, compared to normality parameters in a control group.

Method: 60 female volunteers aged 12 to 25 years, divided into two groups: A - group practitioners: 30 young people who practiced classical ballet for at least 2 years and B - control group: 30 young sedentary women. It was used to measure the degree of amplitude of the internal and external hip joint of groups A and B, a universal 360 degrees' goniometer, metallic, in a total circle.

Results: According to the data collected, there was no significant difference between the groups, however we can observe angular differences in both groups. In the comparison between the degrees of external rotation of both lower limbs (LL), group A presented a mean of 34.6° in the lower right limb (LRL) and 32.8° in the lower left limb (LLL). While group B presented an average of 31.3° of rotation in LRL and 31.3° of rotation in LLL. In the internal hip rotation of both LL, group A presented an average of 36.6° in LRL and 41° in LLL. While group B, presented an average of 36° rotation in LRL and 37.4° rotation in LLL.

Keywords: hip rotation, classical ballet, range of motion

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Introduction

From the struggle for survival, going through the religious, folkloric, and artistic aspects to the present day, one can clearly perceive the presence of dance[1] becoming an immortal art.[2] This theory can be fostered by citing that " Aesthetically, dance can be considered as the oldest of the arts, the most capable of expressing both the strong and the simple emotions without the aid of words, because this, being able to express everything, proves insufficient at these moments".[3]

From primitive dance to the development of classical dance there was the transformation formed by different steps, gestures and figures previously elaborated. The technique of ballet itself has undergone evolutions, aiming to improve the mastery and placement of the body, principles of posture and balance, in search of the lightness and agility of the dancer.[4–7] Classical ballet requires a biomechanical aptitude and among many physical attributes required, external rotation of the hip joint is the most important, being predetermined by the bone and ligament structure,[8] i.e., the external rotation of the femur in the socket of the acetabulum.[9] It is historically important to note that this biomechanical change of dance occurred in the 17th century when the ballet began to appear on high stages with the audience ahead of them.[11] In this way, the external rotation of the whole lower portion began to be more evident, cause without the scenic spaces in sand format[12] and with the change of the angle of vision, it could leave the horizontality and seek the verticality, characteristic of the classical ballet that remains until today.[7] The en dehors, which in French means the external rotation of the femur in the socket of the acetabulum,[9] should be performed only at the hip joint and be completed by the feet abduction.[13,14] The normal degree, adding up both sides is from 80 to 100 degrees. In dancers with their feet in 1st position en dehors (heels united and feet slightly turned outwards) they reach 180 degrees.[9] This is one of the principles emphasized in the classic technique that is in the vocabulary of dancers: "The hip dehors' ability is an important fundamental physical attribute in classical ballet.[10]

The pelvitrocanterian muscles were responsible for the en dehors, aided by the sartorius, psoa major and gluteus maximus. Working in this way, the dancers had muscular hypertrophy in the quadriceps and lumbar, and hypotrophy in the adductors. With the discovery of the need to work the en dehors also using the long portion of the femoral biceps along with the gluteus, the hip was more secure in the center of the body and enabled the force of the movement en dehors to the pelvitrocanterians muscles. The dancer gained more balance and elasticity with less effort as the muscles began to play their roles correctly.[9] To achieve the ideal external rotation of 180 degrees (90 degrees per limb) required for professional dancers, it would be 60 to 70 degrees of external rotation in the hip joint bilaterally, and 20 to 30 degrees distributed between the knees and the feet.[15] It is seen that the external rotation of the hip is graded between 0 to 45 degrees, implanting the same measure for the internal rotation.[16] For some authors, the degree of internal hip rotation may have altered its graduation considerations being between 0 to 30degrees/60.[14] In

addition, usually the dancers measure their external rotation observing the position of the feet on the ground. [...] "Often they will try to increase this rotation". Errors in technique and training can cause injury. The most frequent is the forced rotation. Forcing the foot to rotate out on the ground using knees, hips and back, causes a predictable pattern of injuries, including tendinitis of the hip flexor, irritation of the facet joints, among others.[17] The bone shape that can present variations directly influencing the amplitude of the movements.[18]

Differences in the anatomy of the pelvis can be observed between genders and influence the range of motion. The female pelvis is shallower and smaller, the bones lighter and smoother, the coccyx more mobile, and the angle of the subpubic arch more obtuse. Being broader and nearly cylindrical, femoral bone heads are more widely separated in females and have a greater potential for range of motion than males.[14] In order to adequately measure the joint range of hip movement, it is necessary to follow adequate protocols and use the reference standards presented in the scientific literature. In addition, it is paramount to choose an equipment and/or technique that meets the needs of these protocols and is used correctly. A variety of instruments are used to measure joint movement, ranging from simple paper strokes, metric tapes, to electronic goniometers and motion analysis systems. The examiner should be clear on the purpose of the measurement: clinical or research, and consider the availability, the cost, easiness of use and size.

The universal goniometer is considered the most used instrument for this type of measurement. There are already several studies that prove its validity.[19,20] The measurements obtained with the goniometer are more accurate and reliable than the visual estimates, even when the latter are performed by a qualified examiner, since they provide only subjective information.[21,22] It is basically a protractor, to the center of which two arms or levers are attached. Normally only one arm is movable.[22] The examiner obtains these measurements by placing the mediating instrument part between the proximal and distal portion along the bones of the joint to be evaluated and may demarcate the anatomical points with a dermatographic pencil or adhesive label. Goniometry can be used to determine both the position of a particular joint and the total amount of movement available in this joint.[21]To perform the goniometry, it is recommended to use the passive method, that is, the individual performs the movement; In the final degrees, he can receive the aid of the examiner. Active movement can also be used, but it is important to emphasize that the same methodology must always be used: active or passive movement.[22]It can be emphasized that ballet, like any physical activity that requires repeated contractions of certain muscle groups, has its own set of associated injuries. Its practice implies physical-motor requests, integrating gestural and positional requirements considered anti-anatomical, frequently affecting joint and postural loads resulting from the training itself.[2] In the physical aspect, classical ballet practice requires continuity, specificity, individuality, precision, high psychomotor coordination, flexibility, laterality, spatial notion, physical conditioning and body expression.[23] Classical ballet promotes the specialization of the dancers to perform the specific functions and the muscular request is selective, i.e., some muscle groups are more exercised than others, being able to generate imbalances between the muscular groups agonists/antagonists. Unbalance of the forces acting on the joints can cause postural or biomechanical joint changes and predispose to injury or poor performance.

The hypothesis of the study is that dancers have a higher degree of external rotation of the hip due to training. Thus, the objective of this study was to evaluate the degree of external and internal rotation of the hip region in classical dancers and to determine if they have a greater range of internal and external rotational movement in this region, compared to normality parameters in a control group.

Method

This is an observational study, performed in two dance schools in São Caetano do Sul (SP), at the Dance School of the Foundation of the Arts of São Caetano do Sul (FASCS) and Ballet Ágilis. This project was submitted to the Research Ethics Committee of the Faculty of Medicine of ABC and approved under issue number 394.014 - CAAE 17359913.3.0000.0082

Inclusion criteria

A total of 60 young female volunteers aged 12 to 25 years old, that did not present pain and/or lesions in lower limbs, were divided into two groups:

Ballet group

30 young ballet dancers who have been practicing classical ballet for at least 2 years in FASCS and Ballet Ágilis schools.

Control group

30 sedentary young people who do not practice classical ballet and no other physical activity.

Procedures

Initially the volunteers were informed about the development of the research and if they agreed to participate, they signed the Informed Consent Term and the Term of Assent for minors. The work started from the screening of participants according to inclusion criteria. They were separated into two groups: Ballet and Control.

All were evaluated individually, placed in good posture alignment and oriented to perform the internal and external hip rotation movements for data collection, following the protocol of standardization of the passive method of movement .[22] In the final degree, the assessed dancers received help from the evaluator to complete the measurement. The range of motion was measured in the two groups by the same evaluator, using a goniometer, which is a measuring instrument of angles in semicircular or circular form graduated in 180 or 360 degrees.

Statistical analysis

The variables were presented by mean and respective 95% confidence interval, since the variables presented normal distribution (Shapiro-Wilk test, $p>0.05$). To analyze if there was an association between the degrees of hip rotation between the groups, the t student test was used. The confidence level adopted was 95%. Statistical analysis was performed by statistical software Stata version 11.0.

Results

Sixty volunteers aged 12 to 25 years old participated in the study, in which the rotational degree of the hip of 30 dancers was evaluated and compared with the values presented by a control group composed of 30 participants who did not practice the activity. According to the data collected, there was no statistical significance, however we can observe angular differences in both groups.

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Figure 1 shows that, in comparison between the degrees of external rotation of both lower limbs (LL) of the classical dancers, it presented, on average, 34.6 degrees in the lower right limb (LRL) and 32.8 degrees in the lower left limb (LLL). While for the control group they presented a mean of 31.3 degrees of rotation in LRL and 31.3 degrees of rotation in LLL.

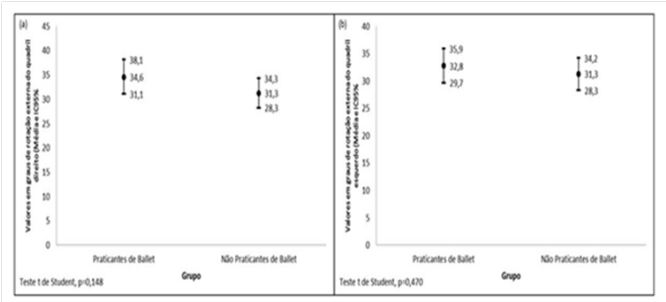

Figure 1 Point estimate and interval estimation of the degrees of external rotation of the right (a) and left (b) hip according to groups.

95% CI: 95% confidence interval.

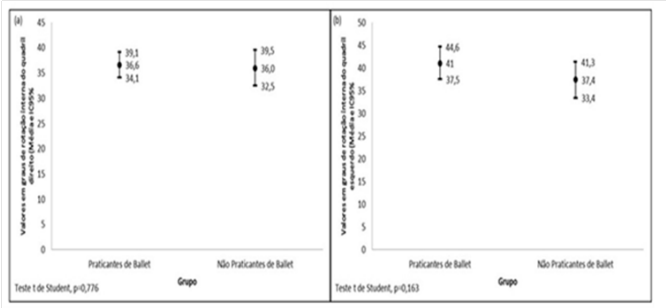

Figure 2 Point estimate and interval estimation of the internal rotation degrees of the right (a) and left (b) hip according to groups.

When analyzing the internal hip rotation of both LL represented by Figure 2, the results show that classical ballet practitioners have an average of 36.6 degrees in LRL and 41 degrees in LLL. While for non-ballet practitioners they present an average of 36 degrees of rotation in LRL and 37,4 degrees and rotation in LLL, with no statistical difference.

Discussion

In the present study, the data collected showed that there were no significant differences between the groups of rotational degrees of hip. However, the dancers were closer to the maximum range of motion that is 45 degrees.[14,22] On the other hand, there are authors who report that the internal rotation of the hip has its degree between 0 - 30/60 degrees.[24]

The Classic Ballet is characterized by the constant search for aesthetic movement's patterns, i.e., movements of great joint amplitude that go beyond the anatomical limits.[25] This theory, which is highlighted in the present study by the difference between the rotational degrees of the hip, since in both rotations (internal and external), the rotational averages were found to be smaller in non-practitioners, from 3.3 degrees to Less than external rotation in LRL and 1.5 degrees less than external rotation in LLL, which can also be seen when comparing the internal rotational degree, being 0.6 degree less than internal rotation in LRL and 3.6 degrees less rotation in LLL, both compared to the dancers' averages of rotation (group A).

There are quotations that point out the existence of some dancers with above-average joint mobility.[26] Complemented by the fact that classical dance leads to excessive overload on the lower limbs, causing imbalance and compromising biomechanics and its function.[27] Thus, it should not neglect the question of the injuries of young dancers who are usually self-induced with the extreme pursuit of external rotation.[24] In a study performed by Grego et al.[27] to point out the main dance injuries with 122 dancers in the age group of 8 to 30 years old in dance academies, the trend of increasing injuries over the years was observed: dancers of the age group of 8 to 11 years presented 4.2 injuries per person, while those of 18 or more, 8.17; i.e., almost twice as much evidencing the time spent in training. It was also observed that the main injuries occurred in the lower limbs (97.48%).

Ditullio et al.,[28] in their study with a group of 30 classical dancers and another with 30 non-dancing subjects, aged 14 to 18 years old, indicated an increase in external hip rotation and decrease in internal rotation in dancers and lower external rotation compared to internal rotation in non-ballet practitioners. The same author has an equal number of members and the same inclusion age range of this study. When comparing the data of this study with the aforementioned it is possible to affirm that there was a greater rotation angulation in both lower limbs of classical dancers. Klassen[11]in another comparative study verified the influence of ballet practice on hips rotations in a group of 6 to 17 years old, demonstrating a significant increase in external rotation and reduction of internal rotation, considered as progressive. It is also possible to highlight according to the current research the fact that none of the classical ballet dancers participating obtained an external rotational degree equal to 15 degrees, different from what was shown by the group of non-classical ballet practitioners who presented this low rotational index, being 3.33% of the members in LRL and 6.67% in LLL.

However, in a study on en dehors, it is emphasized that external rotation of the hip should not be used in the functional prediction, because there are individual differences in movements of the pelvis, hip, knee and foot,[13] and can corroborate with the current study, observing the difference between the internal and external rotation degrees of hip, as well as the difference between LRL and LLL during the execution of a same rotational movement, being it internal or external. Allowing to consider that each LL and proximal/distal joints belonging to them, have their individualities and particularities. Flexibility is one of the crucial factors for a favorable performance in various sports modalities, and this accentuates and favors the learning, practice and performance of a skillful movement.[14] For the excellence in the performance also great amplitudes in the accomplishment of the movements are necessary.[19] By means of the correct postural positioning, the desired stretching will naturally occur and, with the adoption of daily training practice, unnecessary efforts will be dispensed with. An evaluation in professional dancers by Soares et al.[11] done by an angular test performed by a goniometer, showed marked flexibility indexes, reinforcing that this is one of the most important physical qualities in dance.

The characteristics of the hip joint responsible for the greater or lesser extent of the external rotation movement are the size of the femoral neck (region between the femoral head and the greater trochanter), the size between the neck and the neck size anteversion (the hip slope forward). The degree of external rotation can not be significantly altered after eight or ten years of age. However, in the ballet, there is an apparent improvement in en dehors with the training, due to the progressive strengthening of the muscles responsible for the rotation in the hip joint.[9]

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Cigarro et al.[29] evaluated the influence of weekly practice of flexibility exercises for performance improvement in 10 classical dancers divided into two groups: A - classic ballet drills and flexibility; B - Classical ballet training only. In the results presented, a significant increase in the degree of range of motion in the hip joint was observed in all the movements tested (flexion extended and flexed, extension and abduction) in the dancers group, which did not happen with the control group. The group of ballet practitioners presented a significant increase in the range of motion of the hip flexion movement in all movements, except for the flexed left leg movement, where there was an increase in articular amplitude of 6.9%, but not significant (p=0,1393). It is noted that this difference between the groups shows that the group that participated in the flexibility training obtained a significant increase in the range of motion, compared to the control group.

In order to compare the current research, comparing the ages of the participants, and also having as a criterion of inclusion 2 years of dance practice, one is quoted by Steiberg et al.[23] between 1998 and 2004 in order to compare if the Range of 1320 classical dancers from different Israeli dance schools (mean 13.3 years) increased with age, and declined in a group of 226 girls of similar age group who did not practice dance, only sports school. It was found that the range of motion of the dancers did not improve or decrease with age, but was preserved. The ability of dancers to maintain flexibility of joints with age is probably because of their exposure to extensive exercise, as well as the range of motion in non-dancers tends to deteriorate with age. The natural tendency of soft tissue flexibility to decrease with age is probably delayed in dancers because the frequent and extensive stretches of these structures are well stimulated. This idea was already expressed by other authors who affirm that "affluence" (external rotation of the hip) is more difficult to obtain when the dancer begins to train after the age of 10 years old.[30]

There are many considerations about femoral anteversion and what almost all of them say is that changes in angulation occur from birth to eight years, the process being almost complete at 10 years and completely defined at 16. This means that the en dehors cannot be significantly altered between 8 and 10 years, but that some improvement can be obtained by stretching of articular structures at the expense of microscopic ruptures of fibers of articular ligaments that are not elastic. What we notice with the practice of ballet, however, is that often an improvement of the degree of en dehors is achieved through the progressive strengthening of the responsible musculature.[31] This theory can be proven with the results obtained in the current research, where there was no statistical significance, pointing out that the age group surveyed may have influenced the results.

As a proposal for improvement or treatment of the range of joint movement and increase of the external and internal rotational degrees of the dancers, it can be suggested that the flexibility training,[31] combined with the classic ballet classes, may help in the performance and maintenance of the Lines for the implementation of the broader and more advanced steps.

Another factor to be considered is the limitation of the dancers in what concerns the personal articular constitution. Turning forced to increase en dehors degree by means of excess in exercises of specific trainings for this region, can cause overstretching in your muscles and ligaments. It is suggested that the classes follow a pedagogical sequence and their exercises should be promoted by a conscious teacher, respecting the natural axes and segments of the joints of the body.

In the course of the study, it can be observed that the right-handed and left-handed factors can lead to changes in movement and flexibility, but the same was not considered for the moment. In view of the greater scope and depth of this theme, both in flexibility training and in the right-handed and left-handed factor, this can be an initial point of extension for further detailing of the research.

Conclusion

As the main observation and conclusion of the study, it was verified that the degrees of external and internal rotation of the dancers, are greater in comparison with the group of non-practitioners of classic ballet. In addition, the lowest external rotational index was observed in the group of non-dancers. Our data suggest that non-classical ballet practitioners are exposed to lesser load compared to classical dancers.

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Conflict of interest

The author declares no conflict of interest.

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