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Research Article / Araştırma Makalesi

Comparison of hip abductor strength in pre-professional ballet dancers with and without snapping hip

Atlayan kalça sendromu olan ve olmayan yarı-profesyonel bale dansçılarında kalça abduktor kas kuvvetlerinin karşılaştırılması

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ABSTRACT

Objective: To compare hip abductor muscle strength in ballet dancers with and without snapping hip syndrome and to evaluate the correlation between Hip and Groin Outcome Score (HAGOS) sub-scores and snapping intensity

Material and Methods: A cross-sectional study was conducted in randomly selected dancers, allocated to 3 groups according to their assessment by anterior hip pain or snapping in physical examination. The subjects completed the HAGOS survey. Subsequently, hip abductor strength was measured using a hand-held dynamometer.

The study was carried out on a total of 70 pre-professional ballet dancers (140 hips, aged 16-20). Participants classified into three groups based on medical history and physical examination (G1: pain (-) snapping (-); G2: pain (-), snapping (+); G3: snapping (+) and pain (+)). Secondly, all hips were classified into three groups (H1: pain (-), snapping (-), H2: pain (-), snapping (+), H3: pain (+), snapping (+). Snapping intensity in participants rated by the frequency of snapping (between level 0-4) according to their self-report. Differences were assessed between dancers and hips with snapping hip and without snapping hip.

Results: There was no difference in hip abductor strength levels between three hip groups (p=0.446). However, significant differences were observed in mHAGOS, pHAGOS, sHAGOS mean values between the three (G1, G2, G3) groups (p<0,001; p<0,001; p<0,001, respectively). sHAGOS, pHAGOS and mHAGOS mean values were significantly higher in G1 and G2 when compared to G3. Besides, there were negative correlation between snapping intensity and mHAGOS (p=0.002, rho=-0.37), pHAGOS (p=0.001, rho=-0.39) and sHAGOS (p=<0.001, rho=-0.55).

Conclusion: Hip abductor strength levels were not significantly affected by the presence of snapping in dancers; further investigation is needed in this regard. However, the results revealed that HAGOS sub-scores and snapping intensity is related. HAGOS questionnaire might be implemented to the dancers as a preseason screening method for snapping hip.

Keywords: *Snapping hip, hip abductor strength, HAGOS, ballet dancer*

ÖZ

Amaç: Atlayan (snapping hip) kalça sendromu olan ve olmayan bale dansçılarında abduktör kas kuvvet değerlerini karşılaştırmak ve Kalça ve/veya Kasık Problemlerine İlişkin Anket (HAGOS) alt skorları ile atlama yoğunluğu (frekansı) arasındaki korelasyonu değerlendirmek.

Gereç ve Yöntemler: Çalışmaya 16-20 yaş aralığında, 70 yarı-profesyonel bale dansçısı (kalça sayısı:140) katıldı. Katılımcılar öncelikle fizik muayenede kalça önü ağrısı ve/veya kalçada atlama hissi olup olmamasına göre 3 kategoriye ayrıldı. (Grup 1: ağrı (-), atlama (-); Grup 2: ağrı (-), atlama (+); Grup 3: ağrı(+), atlama (+)). Ardından tekrar toplam kalça sayısı üzerinden başka bir gruplama yapıldı. (H1: ağrı (-), atlama (-); H2: ağrı (-), atlama (+); H3: ağrı(+), atlama (+)). Katılımcıların beyanına göre atlama yoğunluğu 0-4 arasında derecelendirildi. Bütün katılımcılar çalışmanın başında HAGOS anketini doldurdu. Ardından bilateral kalça abduktor kas kuvvetleri el dinamometresi ile ölçüldü.

Bulgular: Çalışmaya katılan bale dansçılarının %92,86'sında atlayan kalça sendromu, %58,57'sinde kasık ağrısı tespit edildi. H1, H2, H3 grupları arasında kalça abduktor kuvveti açısından fark bulunmadı (p=0.446). Bununla birlikte G1,G2,G3 arasında mHAGOS, pHAGOS, sHAGOS ortalama değerlerinde anlamlı fark vardı (sırasıyla; p<0,001; p<0,001; p<0,001). İkişerli kıyaslamalarda ise mHAGOS, pHAGOS, sHAGOS değerleri G3'e göre G1 ve G2'de daha yüksekti. Atlama yoğunluğu ve mHAGOS (p=0.002, rho=-0.37), pHAGOS (p=0.001, rho=-0.39) ve sHAGOS (p=<0.001, rho=-0.55) arasında negatif korelasyon vardı.

Sonuç: Kalça abduktor kuvvetinin atlayan kalça sendromu varlığında etkilenmediğini ancak HAGOS alt skorları ile atlayan kalça sendromu arasında ilişki olduğu saptandı. Bu bağlamda, ileri çalışmalara ihtiyaç olmakla birlikte HAGOS anketinin atlayan kalça sendromu olan bale dansçılarının sezon öncesi değerlendirmelerinde kullanılabileceği düşünülmüştür.

Anahtar Sözcükler: *Atlayan kalça, kalça abduktor kuvveti, HAGOS, bale dansçısı*

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INTRODUCTION

The major hip abductor (HA) muscle is the gluteus medius, it also helps hip flexion, internal rotation, extension, and external rotation due to its different directional fibers (1-3).

During the gait and other various movements, it yields frontal plane stability of the pelvis (3,4).

Snapping hip is defined as an audible or palpable movement of the hip (5-7), particularly during flexion or extension. Some of the cases can be symptomatic such as hip pain (5). Snapping hip can occur due to external, internal, and intra-articular etiology. External reasons are possibly due to posterior iliotibial band, gluteus medius (GM) tendon, trochanteric bursitis, proximal hamstring tendon; internal reasons are related to iliopsoas tendon interaction over the anterior capsule of the femoral head; intra-articular causes are labral tear, loose bodies, synovial chondromatosis, capsular instability, and displaced fractures (5,8-10). Internal snapping hip can emerge from the flipping of iliopsoas tendon over the iliopectineal eminence, lesser trochanter, and femoral head (9,11,12). External snapping hip localized at the hip joint's lateral aspect and comes up due to gluteus maximus (abductor fibers), tensor fascia lata, or iliotibial band gliding over the greater trochanter of the femur (7,9,12,13). Recently, snapping hips with intra-articular etiology tend to be classified separately (7,13).

The reported prevalence of snapping hip appears to be quite different. A prevalence of 5.26% was reported in a study on 14 professional ballet dancers (14), while in another controlled study conducted amongst 30 professional ballet dancers it was 53.3% (15). Two studies that involved 87 student & company ballet dancers (16) and 204 pre-professional ballet dancers (17) reported the prevalence of 90.8% and 75.5%, respectively. It is stated that snapping hip prevalence is higher in dancers than in the average population (15).

Some repetitive dance movements may predispose to snapping hip. Generally, the repeated hip flexion movements are related to the fascia lata thickness and tenderness, which can create a weakness on the abductor and external rotator hip muscles, lack of core stability, or overpronation (6). In dancers, snapping hip related with iliopsoas tendon is the most common form (6,16). It is suggested that iliopsoas syndrome can develop due to repeated hip flexion and abduction in dancers. The weakness of hip flexors in abduction position is a diagnostic tool. Grand battement and *passé developpe'* ballet movements are accomplished by repeated flexion of the externally rotated hip, which causes internal snapping hip (5). Charbonnier et al. suggested that overtraining and overuse could precipitate internal snapping through the hip joint using the motion analysis method during the classic ballet positions: *developpe' the grand e'cart facial the grand e'cart late'ral, and the grand plie'* (18) Also, dancers who try to attain more turn-out without a proper technique form a hyperlordotic pelvic posture, which leads to the femoral head to move forward and the tendon of the iliopsoas to slide over it (19).

Although snapping hip may be a common performance-limiting factor for dancers, the reason-result relationship between hip adductor (HA) strength or any other lumbopelvic kinematics parameter and snapping hip has not been investigated. Besides, data on HA strength in ballet dancers is limited. The hip abduction/adduction muscle strength ratio was in favor of abduction in ballet dancers, but it was emphasized that measuring muscle strength in the standard position may not be appropriate for dancers performing in the turn-out pose (20). In another study, female ballet students aged 8-11 were found to have HA strength similar to that of the control group with the same bodyweight, although the control group had stronger hip flexion, internal/external rotation, and adduction significantly (21).

This study aims to investigate snapping hip prevalence in a cohort of pre-professional ballet dancers and compare the HA strength levels in dancers with and without snapping hip. The null hypothesis is: There is no significant difference between HA strength levels between dancers with and without snapping hip in a cohort of pre-professional male and female ballet dancers. Additionally, we investigated the correlation between Hip and Groin Outcome Score (HAGOS) sub-scores and snapping intensity.

MATERIALS AND METHODS

Subjects

A total of 72 pre-professional ballet dancers between 16 and 20 years of age were included according to inclusion and exclusion criteria (Table 1). Two participants were withdrawn from the groups due to incompatibility between their anamnesis, clinical assessment. A total of 31 female (mean age: 18.06, SD: 0.90) and 39 male dancers (mean age: 18.17, SD: 0.91) from a dance institution voluntarily attended to the study. 67 dancers fully completed the HAGOS questionnaire, therefore only 67 of them were included in HAGOS assessments. Hip abductor strength measurements were performed on both hips of 70 subjects (140 hips). Two clinicians with similar experience at The Royal Ballet School facilities conducted all the tests.

Informed consent was obtained in accordance with the Helsinki Declaration from all participants. The study was approved by the Research Ethics Committee, the Queen Marry

University of London (QMREC2014/24./123.). All participants were informed about the study.

Table 1. Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
Being between 16 to 20 years old	Previous surgical operation due to scoliosis, low back, hip, abdomen, groin and other lower extremity pathologies
Male and female dancers	Symptomatic or asymptomatic scoliosis
Dancers at a company, institute or ballet school	Recent low back, hip, abdomen, groin and other lower extremity pathologies (last 2 years)[24]
Dancing at least 3 hours per day for minimum 2 years	Previous low back, hip, abdomen, groin and other lower extremity surgeries
Volunteer to be involved in the project	Pregnancy
	Participating to other sports

Study design and testing procedures

Participants' anamneses were taken, and they filled the HAGOS questionnaire. General musculoskeletal assessment was performed. Afterward, clicking, snapping and pain in the anterior hip were evaluated during external hip rotation and resisted hip flexion in abduction. Snapping intensity in participants rated by the frequency of snapping according to their self-report. No snapping assigned as 'level 0', 'rarely' snapping assigned as 'level 1', 'sometimes' snapping assigned as 'level 2', 'often' snapping assigned as 'level 3', 'constantly' snapping assigned as 'level 4'. During the examination, subjects whose examination results were conflicted were evaluated by both examiners and concluded. Subsequently, HA strength of participants were measured by hand-held dynamometer.

HAGOS is a self-reported valid and reliable hip and groin outcome score that includes six subscales: symptoms-stiffness, pain, physical function in daily living, function in sports and recreational activities, physical activity attendance, hip and groin related life quality (22,23). As recommended in the HAGOS user manual, each category's total score was calculated and accounted for the maximum possible score. 100 stands for no problem, while 0 value represents severe problem. We only analyzed symptom and pain subscales of HAGOS besides mean HAGOS, since all other subscales are expected to get full points in ballet dancers.

The Lafayette Manuel Muscle Tester (Model 01163), Lafayette Instrument Company, Lafayette, IN, USA, was used for the HA strength assessment. This digital dynamometer can measure peak force, peak force time, and torque. According to manufacturer reports, the maximum force measurement capability is a plus 136.1 kg (300Ibs). The accuracy and reliability of this compact portable device were confirmed by previous studies (24,25).

The HA strength measurements of hips were performed in a lying-down position on the opposite side of the body (24,26). A minimal flexion position has been given to the knee and hip; also, the pelvis was slightly deviated to the forward position by the examiner during the pelvis stabilization by doing an anterior and posterior rotation. The leg was tested in 40-degree abduction, extension, and external rotation of the hip. To stabilize the subjects while they were lying on their side, non-stretching hangers were used to stabilize the subjects from their opposite side lower thigh and waist area to the examination table. The dynamometer was positioned to the leg's lateral side above the ankle; it was approximately 5 cm proximal to the lateral malleolus. The tester pressed down directly against the active abduction of the participants. First, the test was explained to the subjects, and a trial test was performed as a submaximal voluntary isometric contraction. The maximum HA force was performed in a brake test (24,25,27). The test was repeated three times with 5 minutes break between them, and the maximum value was recorded. Maximum force results were recorded measured from the both sides of participants.

Following the completion of all procedures, subjects were classified according to their snapping, pain, and physical examination findings, in one of the three following groups: The first group (G1) consisted of subjects who were snapping and hip/groin pain (-); the second group (G2) were snapping (+), pain (-), while the third group (G3) included snapping (+) and pain (+) participants. Furthermore, all hips were classified into 3 groups: Hip 1 (H1): pain (-), snapping (-); Hip 2 (H2): pain (-), snapping (+); Hip 3 (H3): pain (+), snapping (+).

Statistical analysis

Shapiro-Wilks test was employed to assess the normal distribution of numeric variables. Descriptive data were used to report median (M) and interquartile range (IQR) of the following values: HA strength; mean HAGOS (mHAGOS), symptom subcale HAGOS (sHAGOS) and pain subscale HAGOS (pHAGOS) according to the normality of the distribution test. Non-parametric Kruskal Wallis tests were employed to detect significant differences in HA strength levels between H1, H2, and H3, and HAGOS values between the three G1, G2, G3 groups. Spearman correlation coefficient test was used to assess correlations between snapping intensity and HAGOS subscales. Numbers between 0.00-0.30 were considered as poor or no correlation, 0.30-0.50 were considered as fair correlations, 0.50-0.70 were considered as moderate correlations, 0.75 to 1.00 were considered as strong correlation (28). Data were analyzed on SPSS version 24, IBM sta–

tistics program. The alpha level of significance was set at P-value <0.05.

RESULTS

Demographic data were given in Table 2. There were no significant differences between the means of age, height, weight variables (p>0.05). Snapping frequencies reported by subjects were varied from no snapping to constantly snapping. Bilateral snapping was positive in 19 dancers. Table 3. depicts the snapping hip profile, according to their snapping hip presence and locations, observed in male and female participants. The profile was categorized as follows: lateral snapping, anterior and lateral snapping, anterior snapping, hip and groin pain. The profile was determined based on the history of self-reported anterior/lateral hip pain, clicking or snapping, and physical examination findings with hip external rotation and resisted hip flexion in abduction positions. The results were checked for compatibility with the subjects' answers to the HAGOS subgroup questions.

Table 2. Demographics of participants, mean (SD)

	Group 1 (n=5)	Group 2 (n=24)	Group 3(n=41)	p
Age (year)	17.8 (0.83)	18(1.1)	18.2(0.79)	0.485
Height (cm)	174.3(9.84)	174.6(7.94)	172.6(7.17)	0.605
Weight (kg)	62.1(14.30)	61.9(8.67)	60.1(9.4)	0.860

n: Number of participants SD: Standard deviation

Table 3. Snapping hip profile

	male participants (n=39)	female participants (n=31)	Total participants (n=70)
Lateral snapping	2	1	3
Anterior+lateral snapping	1	0	1
Anterior snapping	33	29	62
Snapping + hip/groin pain	19	22	41
Snapping without hip/groin pain	16	8	24
Total snapping	35	30	65

Table 4. Comparison of HAGOS and HA strength values of hips

HAGOS COMPARISON	**Group 1**	**Group 2**	**Group 3**	**p value**
Number of participants	5	22	40	
mHAGOS (M (IQR)	95.7 (7.68)	95.8 (2.68)	87.21 (5.97)	0,000
sHAGOS (M (IQR))	98.57 (3.57)	87.55 (9.80)	71.78 (13.39)	0,000
pHAGOS (M (IQR))	99.5 (1.3)	98.86 (2.5)	91.75 (6.9)	0,000
HIP COMPARISON	**H1**	**H2**	**H3**	**p value**
Number of hips	57	33	50	
HA strength (M (IQR))	29.4 (7.5)	29.2 (3.8)	28.2 (4.3)	0.446

M: Median; (IQR): Interquartile range; HAGOS: Hip and Groin Outcome Score; mHAGOS: mean HAGOS; sHAGOS: HAGOS symptom subscale score; pHAGOS: HAGOS pain subscale score; HA: hip abductors

Table 5. Pairwise comparisons of G1, G2, G3 groups in terms of HAGOS sub-scores

	p values		
	mHAGOS	pHAGOS	sHAGOS
Group 1-Group 2	1.000	1.000	0.311
Group 2-Group 3	**0.000**	**0.000**	**0.000**
Group 3-Group 1	**0.020**	**0.001**	**0.000**

HAGOS: Hip and Groin Outcome Score; mHAGOS: Mean HAGOS; sHAGOS: HAGOS symptom subscale score; pHAGOS: HAGOS pain subscale score

Snapping hip was found in 92.86% of dancers, and 58.57% of the participants reported hip-groin pain in this study. The test results revealed no significant HA strength differences between the H1, H2, and H3 (p= 0.446) (Table 4). However, significant differences were observed in mHAGOS, pHAGOS, sHAGOS mean values between the three (G1, G2,G3) groups (p<0,001; p<0,001; p<0,001, respectively) (Table 4). mHAGOS, pHAGOS and sHAGOS mean values are significantly higher in G1 and G2 when compared to G3. Significant values of pairwise comparisons of G1, G2, G3 groups in terms of HAGOS sub-scores are given in Table 5. Negative correlation was found between snapping intensity and mHAGOS (p=0.002, rho=-0.37), pHAGOS (p=0.001, rho=-0.39) and sHAGOS (p=<0.001, rho=-0.55).

DISCUSSION

Even though snapping is frequently seen in dancers, it is possibly underreported and is accepted as a normal pattern which is also suggested by Winston (16) and Nolton (29). In our study, the snapping prevalence was 92.86 % for the dancers, which is compatible with the study conducted on 87 randomly selected ballet dancers from two different institutes. 26% of the snapping hips were bilateral, and this figure was well below what was offered in the same study (16). The majority of the snapping was in an anterior position, while 3 of them were localized laterally, and in one of the subjects, it was found anterior and lateral snapping together in one of the participants. Although snapping hip etiology is highly variable, pain-free snapping is often randomly determined (13). Iliopsoas tendon-related asymptomatic snapping has been reported to occur in 5-10% of the general population. It is thought that some activities such as ballet may lead to overuse injuries (30). Repetitive hip flexion with external rotation, femoral anteversion, hyperlordotic posture are accused on turn-out mechanisms (19). In addition, similar to Winston's study (16), 58.57% of the participants reported hip-groin pain at different grades and frequencies by free from the time loss.

There was no significant difference between HA strength levels and snapping hip presence in the study. It is possibly related to the complicated function of the GM, which is a crucial lumbopelvic stabilizer. As Grimaldi (19) suggests, it may not be possible to evaluate different muscle parts that have different functions and different innervations by a single test method. Furthermore, in a possible muscle dysfunction or weakness, other minor HA may play a predominant role and compensate the hip abduction function. Further studies seem to be very important in bringing more evident results in this regard.

Two trials have been reported of HA strength data so far. Both studies were performed in the same subject group on

8-11-year-old female ballet dancers. There was no difference between the dancers and the control group for basal HA strength in these studies (20,31). It is necessary to study the strength of the HA of dancers for a comparison. Although there is no significant difference between our study groups, in this sense, our practice can be the first step for reference values.

We found significant differences in the HAGOS scores between dancers with and without snapping. This study showed that in the presence of snapping hip, the mHAGOS, sHAGOS, and mHAGOS scores were lower in the snapping positive groups (H2, H3) than in snapping negative group (H1). There were also negative correlation between snapping intensity and all three HAGOS sub-scores ($p<0.01$). We also found moderate correlation between snapping intensity and sHAGOS (r=0,55); fair correlation between snapping intensity and pHAGOS (r=0.39) and mHAGOS (r=0.37). According to these results, as snapping intensity increases, HAGOS sub-scores decreases in ballet dancers. These findings show snapping intensity and HAGOS sub-scores are related. So, we may speculate that this scoring system seems to be usable in the preseason health evaluation program to be able to foresee the snapping hip. Additionally, this study's HA strength measurements may provide contributions to create reference values for ballet dancers.

This study has several limitations. Firstly, it was conducted with randomly selected dancers from the same company. Since the snapping is a common pattern for the ballet dancers, the sample size was small for the control group of this population. The sample group consists of randomly selected dancers from a single institute. Although the study has been conducted in an environment where training is based on a wide range of choreographies, choosing the participants from a single-center may be considered as a limitation.

The other aspects of pelvic stability could be related to the development of snapping hip, which can be the future study topics for dancers. This study may be repeated with more than one method of muscle strength measurements in a larger group.

CONCLUSION

There was a significant difference between HAGOS scores but not HA strength levels in ballet dancers. However, there is no significant difference between our study groups, our practice can be the first step for creating reference values. Multi-centered further studies with muscular strength measurements combined with different methods are suggested.

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Ethics Committee Approval / Etik Komite Onayı

The approval for this study was obtained from Queen Marry University of London Clinical Research Ethics Committee (Decision no: QMREC2014/24./123).

Conflict of Interest / Çıkar Çatışması

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Author Contributions / Yazar Katkıları

Concept All authors; Design All authors; Supervision All authors; Materials All authors; Data Collection and/or Processing All authors; Analysis and Interpretation All authors; Literature Review All authors; Writing Manuscript All authors; Critical Reviews All authors.

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