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Lumbar stiffness and femoroacetabular impingement - A case control study

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Abstract

Introduction: Femoroacetabular impingement (FAI) may be aggravated by lumbar hyperlordosis and/or stiffness: those conditions may increase the frequency of contact between acetabulum and femur neck. Aim of this study is to evaluate lumbar hyperlordosis and range of motion in patients with arthroscopically treated FAI and to compare those results with healthy subjects.

Materials and methods: 17 healthy volunteers (control group= CG) and 21 patients with surgically treated FAI (FAIG) were enrolled. Groups have been tested for heterogeneity of age and sex. Flexibility test (Sit and Reach test) and spine morphological analysis with Spinal Mouse were performed in both groups. Results were statistically analysed with descriptive statistics and one-way ANOVA.

Results: Two groups were comparable in terms of age, sex and BMI (all p values > 0.05). Lumbar ROM was significantly lower in FAIG (20.70 (SD 9.06) vs 27.77 (SD 9.95); p= 0.021), this group showed also significant higher values of lumbar stiffness (63.20 (SD 14.50) vs 72.62 (SD 11.87); p=0.040) and lower results at Sit and Reach tests (26,02 (SD 9,76) vs 33,48 (SD 9,81); p: 0,017). No other significant differences were found between the two groups (all p values >0.05).

Conclusion: Patients with FAI do not show higher hyperlordosis angles when compared to healthy subjects but present lower flexibility in lumbosacral movement. Those results suggest to add rehabilitation programs focused on the spine mobility in the post-arthroscopy rehabilitation protocol.

Introduction

Ganz [1] initially described the modern concept of mechanical femoroacetabular impingement (FAI) and subsequent researches showed that chondral damage occurs in the areas of mechanical contact [2]. Hack [3] showed that the cam-type deformity is not rare among the asymptomatic population and other studies [4,5] showed that not all the patients with anatomical abnormalities will report pain or develop arthritis during life. This incomplete correlation between FAI and arthritis may be related to several factors [6]. The frequency of contact between femur and acetabulum is thought as one of the most important prognostic factors [7] and the high incidence of pain due to FAI in hockey players [8] and ballet dancers [7] support this opinion.

The contact frequency has been recently evaluated by several studies [7] and a recent paper [9] suggested that it may be influenced by mechanical factors beyond the hip joint. Furthermore, a recent study by Philippon's group [10] showed that dynamic changes in pelvic tilt significantly influence the functional orientation of the acetabulum and suggested that dynamic anterior pelvic tilt results in earlier occurrence of FAI in the arc of motion.

Aim of this study is to evaluate lumbar hyperlordosis, lumbar and lumbopelvic ranges of motion in patients with arthroscopically treated FAI and to compare those results with healthy subjects. The general hypothesis is that lumbopelvic angle and lumbar bodies angles in standing, maximum flexion and extension are statistically different in those two groups.

Materials and methods

Cases and controls

Cases were recruited among patients treated arthroscopically for a FAI. All cases had been referred to the hospital with symptomatic, clinically severe FAI, and, on the preoperative xrays, all of them showed an abnormal alpha angle (>50 degrees) [7,8] in the hip lateral view or a crossover sign [7-8] in the standard anteroposterior pelvic view. All had undergone an arthroscopic correction of the bone deformity. Subjects were excluded from the study if they had surgical complication or the bone deformity correction was suboptimal or if the surgery was performed within the previous 6 months.

Control subjects were recruited from lists of people attending the universities building in which the study has been conducted. Individuals

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who had hip or lumbar symptoms have been excluded from the study. Both for case and control subjects participation was voluntary, and no incentives have been assigned. All the participants signed an informed consent to participate to the research. The ethical principles for medical research from the Helsinki Declaration have been adopted.

Cases and controls were further characterized and matched for the subsequent set of variables: gender, age, BMI, work condition, marital status and physical activity level. The two groups were compared for flexibility tests (modified Sit and Reach test) [11] and spine morphological analysis with Spinal Mouse [12].

Modified Sit-and-reach (SR) test in which a fingertips-to-tangent feet distance is measured are probably the most widely used lineal measures of flexibility [13]. The SR was performed using a box with a 80cm-long rail in the central part of the upper box. Within the rail is located a laser distance meter (Bosch, Germany), with ± 1mm of precision. The distance meter measures the length between the top of the fingers and the final part of the SR box. The person is seated in front of the SR box, with the lower limbs completely extended and the feet against the box. The test consists of one attempt of trunk flexion, with the arms completely extended, and one hand is on the top of the other.

Using the Spinal-Mouse® we were able to evaluate spine range of motion (ROM) and global curvature (Idiag, Volkerswill, Switzerland). This is an electronic computer-aided device that measures sagittal spinal ROM and intersegmental angles noninvasively using a surface technique. The intra-class coefficients for curvature measurement with Spinal-Mouse® are 0.92–0.95 [14]. To avoid inter-measure variation, all the measurements were done by one examiner who was experienced in assessing spinal function using the Spinal-Mouse® system. Each measurement was conducted three times and the mean value obtained.

Spine curvature, spine inclination (angle of the plumb line bisecting the trochanter major and running through the middle of the supporting area of the feet) and sacral inclination angle (Sac/Hip: sacral slope defined as the angle between the horizontal and the sacral plate) were evaluated in the neutral upright position by sliding of the Spinal-Mouse® along the spine [14]. All spine data were calculated and displayed on the computer automatically. Thoracic kyphosis was expressed as a positive value and lumbar lordosis expressed as a negative value. This process was repeated with the subject in a maximum bending position and a maximum extension position allowing for measurement of spinal mobility. Balance was related to spine inclination and the entire spine alignment measured by the angle of the whole trunk. A large angle indicated worst balance.

Statistical analysis has been performed to compare the two groups. Normality assumption was tested by means of the Shapiro-Wilk test. Since the data were normally distributed, a parametric statistical test (one-way ANOVA) was used. The significance level was set at $p<0.05$. The statistical analysis was conducted using the software Stata, version 12 (Stata Corporation, College Station, Texas, USA).

Results

Of the 38 participants, 21 (55.3%) were women. The mean age was 34.3 (SD= 10.1, range 20-55) years. Most of the participants were unmarried (57.9%), had a level of attainment corresponding to secondary school (63.2%), were employed (63.2%), and played sports or physical activities on a regular basis (63.2%). The characteristics of the sample are summarized in Table 1. Groups were comparable for each of the socio-demographic variables analyzed. However, GFAI showed a lower percentage of subjects regularly involved in sports or physical activity (p= .027). Comparisons between the FAI and control group are shown in Table 1.

The control group showed better performance at the sit and reach test when compared with FAI group: respectively 33,48 cm (SD 9,81) and 26,02 cm (SD 9,76) (p: 0,017)

Table 1. Participants characteristics

	Total (n= 38)	**CG (n= 17)**	**GFAI (n= 21)**	**P**
Age, years, mean (SD)	32.5 (10.1)	32.0 (10.7)	33.0 (9.8)	.693[a]
Gender, n (%)				
Male	17 (44.7)	8 (47.1)	9 (42.9)	.796[b]
Female	21 (55.3)	9 (52.9)	12 (57.1)	
Marital status, n (%)				
Unmarried	22 (57.9)	11 (64.7)	11 (52.4)	
Married	11 (28.9)	5 (29.4)	6 (28.6)	.476[b]
Divorced	5 (13.2)	1 (5.9)	4 (19.0)	
Level of education, n (%)				
Secondary school, 8 years	2 (5.3)	1 (5.9)	1 (4.8)	
High school diploma, 13 years	24 (63.2)	10 (58.8)	14 (66.7)	.883[b]
University degree, 18 years	12 (31.6)	6 (35.3)	6 (28.6)	
Employment, n (%)				
Yes	27 (71.1)	10 (58.8)	17 (81.0)	.135[b]
No	11 (28.9)	7 (41.2)	4 (9.0)	
Regular physical activity, n(%)				
Yes	24 (63.2)	14 (82.4)	10 (47.6)	.027[b]
No	14 (36.8)	3 (17.6)	11 (52.4)	
Physical activity, days/week, mean (SD)	3.0 (1.3)	3.0 (1.1)	3.0 (1.7)	.761[a]
Physical activity, hours/day, mean (SD)	1.0 (.6)	1.2 (.5)	1.0 (.8)	.551[a]

CG= control group

GFAI= group FAI

p= level of significance for comparisons between CG and GFAI

a= comparisons made with unpaired sample T test

b= comparisons made with χ^2

SD= standard deviation

Table 2. Comparisons of spine range of motion between CG and GFAI

Variable	Mean (SD)	F†	P
Lumbar flexion, grades, mean (SD) CG GFAI	 27.77 (9.95) 20.70 (9.06)	5.865	.021
Lumbar extension, grades, mean (SD) CG GFAI	 45.00 (11.03) 42.45 (9.81)	.594	.446
Lumbar left side bending, grades, mean (SD) CG GFAI	 20.53 (5.82) 21.90 (8.02)	.371	.547
Lumbar right side bending, grades, mean (SD) CG GFAI	 19.53 (5.71) 21.65 (6.51)	.978	.330
Lumbar ROM, grades, mean (SD) CG GFAI	 72.62 (11.87) 63.20 (14.50)	4.572	.040
Thoracic flexion, grades, mean (SD) CG GFAI	 67.25 (11.15) 66.62 (18.82)	.005	.946
Thoracic extension, grades, mean (SD) CG GFAI	 42.41 (12.63) 52.45 (15.77)	4.56	.040
Thoracic left side bending, grades, mean (SD) CG GFAI	 22.06 (9.03) 24.15 (8.49)	.637	.431
Thoracic right side bending, grades, mean (SD) CG GFAI	 31.12 (9.52) 29.35 (8.78)	.387	.538
Thoracic ROM, grades, mean (SD) CG GFAI	 24.94 (12.96) 17.25 (17.09)	2.410	.130

CG= control group

GFAI= group FAI

p= level of significance for comparisons between CG and GFAI

†= comparisons made with one-way ANOVA, controlling for age and gender

SD= standard deviation

The two groups showed significant differences for lumbar flexion on the sagittal plane and for lumbar ROM as shown in Table 2. No statistically significant differences were found for the other parameters.

Discussion

Aim of this study was to evaluate lumbar hyperlordosis, lumbar and lumbopelvic ranges of motion in patients with arthroscopically treated FAI and to compare those results with healthy subjects. Patients with FAI did not show differences in static posture when compared to healthy subjects but presented a lower flexibility in lumbosacral movement.

Previous studies [9,10] demonstrated significant changes in functional acetabular version and secondary terminal hip range of motion to impingement with relatively small changes in pelvic tilt. Our study raises the discussion about interaction between spine and hip motions to a more complicated level. Our results suggest that in static position there is no difference in lumbar curve between healthy people and subject with symptomatic FAI. On the other hand, if the relationship between the two segments is evaluated from a dynamic point of view, the demonstrated lower mobility of the lumbar spine may result in increased uses of the extreme hip ranges of motion [15,16]; therefore, it may lead to increased frequencies of femoroacetabular impacts in predisposed patients. If relatively small increases in posterior pelvic tilt could decrease the occurrence of the more traditional anteriorly based FAI [10], dynamic alterations in lumbar spine range of motion may act as an aggravating factor for those patients. According to our point of view, patient's lumbar mobility should also be evaluated in case a symptomatic FAI.

This conclusion has two implications for daily practice: first for the FAI clinical evaluation, then for its treatments. The classical approach to FAI is limited to objective examination of the interested hip and to radiographic and MRI evaluations. However, these strategies ignore any role that dynamic alterations in lumbar spine may have on the underlying hip kinematics and their ability to compensate or exacerbate proximal femur or acetabular deformities.

Secondly, rehabilitation for patients with FAI should include attempts to improve lumbar range of motion, which might partially compensate for impingement in some instances. Dynamic lumbar ROM changes may allow athletes with large, anteriorly based FAI deformities to lessen the occurrence of FAI.

This study introducing the concept of lumbar stiffness and its relationship with FAI might also guide further clinical investigation regarding nonoperative and postoperative rehabilitation protocols.

On the other hand, lumbar stiffness may not be one of the predisposing factors of FAI but may be the consequence of chronic pain due to the FAI. Furthermore, the demonstrated association between lumbar stiffness and FAI may not be a consequence of the interaction between those two problems but they may independently coexist in patients with overall joints stiffness. Further studies are required to better verify the cause-effect relationship between FAI and lumbar stiffness.

Design of our study (case control study) strongly supports our findings but several limitations due to the used measurements' methods should be acknowledged. First, the sit and reach test yield only a moderate validity for lower back flexibility. In fact, hamstring flexibility may influence the results [17] and in FAI group a limited function of the hamstrings may be expected and related to the preoperative limited hip motion. Second, the spinal mouse analysis presents high inter-measurement variability and the accuracy of the measurements is largely dependent on examiner's experience [14].

On the other hand the solution to avoid the limits of the spinal mouse is the use of conventional radiographies. It is questionable, however, whether radiographs should be chosen as the 'gold standard' and the use of radiographs is probably unjustifiable in terms of patient risk. The gold standard would probably be MRI scan but to obtain the ROM of the full spine several scans should be performed changing patient position and costs would be significant.

Conclusion

Patients with FAI do not show higher hyperlordosis angles when compared to healthy subjects but present lower flexibility in lumbosacral movement. Those results suggest to add rehabilitation programs focused on the spine mobility in the post-arthroscopy rehabilitation protocol.

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