Original Investigation / Özgün Araştırma

The Effect of Anthropometric Measures on Hip Osteoarthritis

Kalça Osteoartriti Üzerine Antropometrik Ölçümlerin Etkisi

Deniz Dülgeroğlu[1], Sibel Erkoç[1], Aytul Çakcı[1], Mehmet Sağır[2], Başak Koca Özer[2], Timur Gültekin[2], İsmail Özer[2], Gül Mete Civelek[1], Hatice Kaplanoğlu[3]

[1]Ankara Dışkapı Yıldırım Beyazıt Education and Research Hospital, Physical Medicine and Rehabilitation Clinic, Ankara, Turkey
[2]Ankara University Faculty of Languages, History and Geography, Department of Physical Anthropology, Ankara, Turkey
[3]Ankara Dışkapı Yıldırım Beyazıt Education and Research Hospital, Department of Radiology, Ankara, Turkey

ABSTRACT

Objective: In this study, we investigated the relationship between hip osteoarthritis and various anthropometric measurements. We expected that shorter leg length would result in greater loading on the hip joint.

Methods: The study was conducted at the physical therapy and rehabilitation clinic of the Ankara Dışkapı Yıldırım Beyazıt Education & Research Hospital. Thirty one patients with hip osteoarthritis (22 females and 9 males) and 31 healthy controls were included into the study. Anthropometric measurements were performed for the subjects' waist circumference, hip width, hip circumference, lower side length, upper leg length, lower leg length, knee height, knee width, calf circumference.

Results: Statistically significant differences were identified between the female patients and controls with regards to their neck circumference (p=0.022), upper leg length (p=0.00), and knee width (p=0.03). There were also statistically significant differences between the male patients and controls with regards to elbow width (0.001), hip width (p=0.021), upper leg length (p=0.00), lower leg length (p=0.007), and knee width (p=0.001).

Conclusion: The upper leg length of female patients was shorter in comparison to the controls, and this difference was found to be statistically significant. However, this observation is not enough the hypothesis that shorter leg length would contribute to the development of hip osteoarthritis.

Keywords: Anthropometry, hip, osteoarthritis

ÖZET

Amaç: Bu çalışmada, kalça osteoartriti ve farklı antropometrik ölçümler arasındaki ilişkiyi araştırdık. Bacak boyunun kısa olmasının kalça eklemi üzerine artmış yüklenmeye yol açabileceğini ön gördük.

Yöntemler: Bu çalışma Ankara Dışkapı Yıldırım Beyazıt Eğitim Araştırma Hastanesi, fizik tedavi rehabilitasyon kliniğinde yapılmıştır. Kalça osteoartritli 31 hasta (22 kadın, 9 erkek) ve 31 sağlıklı kontrol çalışmaya dahil edildi. Antropometrik ölçümler katılımcıların, bel çevresi, kalça genişliği, kalça çevresi, alt taraf uzunluğu, üst bacak uzunluğu, alt bacak uzunluğu, diz yüksekliği, diz genişliği, baldır çevresi olarak yapıldı.

Bulgular: Kadın hastalar ve kontrolleri arasında boyun çevresi (p=0.022),üst bacak uzunluğu (p=0.00) ve diz genişliği (p=0.03) açısından istatistiksel anlamlı fark bulundu. Erkek hastalar ve kontrolleri arasında da dirsek genişliği (0.001), kalça genişliği (p=0.021), üst bacak uzunluğu (p=0.00), alt bacak uzunluğu (p=0.007) ve diz genişliği (p=0.001) açısından istatistiksel anlamlı fark mevcuttu.

Sonuçlar: Kontrollerle karşılaştırıldığında, kadın hastaları üst bacak uzunluğu daha kısadır, bu fark istatistiksel olarak bulunmuştur. Buna rağmen, bu gözlem kısa bacak boyunun kalça osteoartriti gelişimine yol açacağı hipotezi için yeterli değildir.

Anahtar sözcükler: Antropometri, kalça, osteoartrit

Corresponding Author
Yazışma Adresi

Deniz Dülgeroğlu

Ankara Dışkapı Yıldırım Beyazıt Eğitim ve Araştırma Hastanesi, Fiziksel Tıp ve Rehabilitasyon Kliniği, Ankara, Turkey

E-mail: denizdulgeroglu@gmail.com

Received/Geliş Tarihi: 29.10.2014
Accepted/Kabul Tarihi: 01.12.2014

J PMR Sci 2015; 18: 107-114
FTR Bil Der 2015; 18: 107-114

Introduction

The osteoarthritis of hip is frequent source of functional disability and pain in people over 55 years of age (1). The prevalence of hip osteoarthritis (HOA) is 7-25% over the age of 55 (2). HOA is generally considered to have a negative impact on daily life due to its effect on joint range of motion (ROM) and physical activity (3). There are many studies in the literature regarding anthropometric measurements such height, weight, and body mass index (BMI) in hip and knee osteoarthritis (OA) (2,4,5). Major risk factors for OA include age and obesity. The mechanism concerning the association between BMI and knee and hip OA was traditionally assumed to be of a biomechanical nature, with excess weight inducing detrimental effects on the joints. Obesity is considered to be a risk factor for knee OA (5,6). However, the relationship between obesity and hip OA is controversial (7). A significant relationship between obesity and radiographically-identified HOA has been demonstrated in certain studies (8,9). In the large longitudinal study of Reijman et al. it was observed that high BMI values were not associated with hip OA (2). Data from the Chingford study on middle-aged women indicated an association between the highest tertile of BMI and hand OA, on the joints that are not directly weight bearing (10). A systematic review and meta-analysis published in 2002 concluded that only a moderate amount of evidence associated hip OA with obesity (11). Grotle et al. concluded that there was not sufficient evidence for associating hip OA with obesity (6).

Body mass index is an indicator of obesity, rather than fat distribution or body composition. Therefore, waist circumference and waist-to-hip ratio (WHR) estimates can be used for central adiposity (12). The effect of WHR on the development HOA has been investigated in only a limited number of studies (4,13).

Anthropometry is the measurement of the human body with regards to the dimensions of the bones, muscles, and adipose tissue. However, we identified no previous studies in the literature investigating the relationship between HOA and other anthropometric measurements (such as neck circumference, bust height, shoulder width, biceps circumference, elbow circumference, waist circumference, hip width, hip circumference, lower side length, upper leg length, lower leg length, knee height, knee width, and calf circumference). This study was planned in order to investigate whether the human height and leg length could have an effect on hip joint biomechanics, and thereby represent a risk factor for OA. Being taller and having a longer leg length may also reduce the load on the hip joint, and thus lower the risk of developing OA. Similarly, a lower height and shorter leg length may increase the load on the hip joint due to a shorter lever arm. Therefore, height, leg length and upper leg and lower leg length may all represent a risk factor for HOA. In the current study, we investigated the effect of other anthropometric measures on hip OA.

Patients and Methods

Thirty-one patients (22 females, 9 males) clinically diagnosed with HOA according to the American College of Rheumatism (ACR) criteria and admitted to our physical medicine and rehabilitation outpatient clinic between June 2011-June 2012 were voluntarily enrolled into our study (14). Patients between 50-72 year of age with ongoing hip pain for past ≥6 months were included into the study. The presence of rheumatoid arthritis, childhood joint diseases (such as Legg-Calve-Pertes disease, slipped femoral epiphysis, hip dysplasia), varus / valgus deformity of the knee, spine alignment disorders, total hip replacement, avascular necrosis of the femoral neck, severe chronic illness or dementia were considered as exclusion criteria. As control group, anthropometric measurements were taken from 31 healthy subjects (22 females and 9 male) at the faculty of physical anthropology department data bank, and the measurements of the patients were compared. Our study was planned as case control clinical study. The necessary approval was obtained from the Hospital Ethical Committee (Decision no. 01/07, dated 02.27.2012). Patients signed an informed consent form, expressing their willingness to participate voluntarily to the study. The principles of the Helsinki Declaration were taken into consideration when conducting the study.

The patients were questioned regarding the duration of hip pain and the involved side; the level and severity of hip pain was determined by using the visual analog scale (VAS). Passive ROM was assessed for the symptomatic hips by using a goniometer, and the result was expressed in degrees. The joint motion was continued until the movement was completed or the pain threshold was reached. A hip flexion of ≤94°, an external rotation of ≤23° and an internal rotation of ≤23° were accepted as the ROM limitation (15). A BMI of <18.5kg/m2 was considered lean, 18.5 – 24.9 was considered normal, 25 – 29.9 was considered overweight, and a BMI of >30 was considered obese (16). Disability was assessed by using a self-reporting questionnaire, the Lequesne index (LI). The Lequesne score is varies from 0 to 24 points, with 0 corresponding to normal function and 24 to a highest level of handicap (17).

Standing anteroposterior (AP) weight-bearing pelvic radiographies of patients were taken digitally while the feet were internally rotated by an angle of 15°-20.° The radiographies were taken and evaluated by a radiologist. Radiographs were performed by using an X-Ray unit

(Siemens FD-X). Radiographic disease severity was assessed using the Croft modification of the Kellgren/Lawrence (K/L) grading system, and the minimal joint space (MJS) as described by Croft (18). On the K/L scale higher grades indicate greater severity. In this study, only participants with a K/L score of 2 or higher were considered as having HOA. During evaluation, OA was considered absent if K/L grade was <2 and MJS was >2.5 mm; OA was considered to be of moderate severity if the K/L grade was ≥2 and MJS was <2.5 mm; and the OA was considered to be severe if the K/L grade was ≥4 and MJS was <1.5 mm (19). Patients were divided into two groups as the normal and marked narrowing groups according to the K/L and MJS values; the consistency of the radiological scores was then evaluated.

The subjects' anthropometric measurements were taken by four anthropologists. Neck circumference (NC), bust height (BH), shoulder width (SW), biceps circumference (BC), elbow circumference (EC), waist circumference (WC), hip width (HW), hip circumference (HC), lower side length (LSL), upper leg length (ULL), lower leg length (LLL), knee height (KH), knee width (KW), and calf circumference (CC) measurements were performed and recorded in millimeters (20) (see Appendix). The waist:hip ratio (WHR) was calculated by dividing waist circumference (WC) value by hip circumference (HC). Height was measured in millimeters by using a stadiometer, and weight was measured in kilograms by using a balance beam scale. BMI was calculated as weight expressed in kilograms divided by the square of height expressed in meters .

Data were analyzed with the SPSS for Windows, version 17.0 (SPSS Inc., Chicago, United States) software. Descriptive analysis of the study group was performed, and descriptive data were shown with means, medians or frequency tables. The non-parametric Mann Whitney-U test and Kruskal-Wallis tests were used for comparing non-normally distributed continuous variables (age, weight, BMI, duration of disease, VAS, LI, anthropometric measurements). Differences between the two groups and differences between more than two groups were compared with the Mann Whitney U test and the Kruskal Wallis tests, respectively. The chi-square test was used for comparing between groups the percentiles of patients with range of motion limitation. The Kappa test was used for assessing agreement between radiologic scores (K/L grading system and MJS) within the same patient group. p<0.05 was accepted as statistically significant.

Results

Twenty two of the patients were female and nine were male, while twenty two of the controls patients were female and nine were male. The median age of the patients was 58 years (range: 50 - 70 years). The demographic, clinical, and functional characteristics of the subjects (N=31) are shown in Table 1. Of the patients, 77.4 % were obese. Restricted joint mobility was identified especially in the internal rotation of the hip (80.6 %). Among the patients, 83.9 % were identified with at least one of the following ROMs values during their hip examination: flexion, internal rotation or external rotation ROM. According to the LI value, the functional handicap level was 11 (9-15). Comparison of the variables according to the K/L grade is presented in Table 2. Based on the

Table 1. Demographic, clinical, and functional characteristics and radiological features of the subjects with hip osteoarthritis (n=31).

Female*	71.0 (n=22)
Male*	29.0 (n=9)
Age (year)**	58.0 (50.0-70.0)
Weight (kg)*	77.0 (72.0-93.8)
BMI*	32.8 (30,1-37.1)
Obese*	77.4 (n=24)
Overweight*	19.4 (n=6)
Involved side (left) *	64.5 (n=20)
Involved side (right)*	35.5 (n=11)
Duration(month)**	18.0 (12.0-24.0)
VAS **	70.0 (60.0-80.0)
ROM-flexion(degree)**	120.0 (100.0-120.0)
ROM-internal rotation(degree)**	15.0 (10.0-15.0)
ROM-external rotation(degree)**	45.0 (25.0-60.0)
Limited flexion*	16.1 (n=5)
Limited internal rotation*	80.6 (n=25)
Limited external rotation*	22.6 (n=7)
Limitation in at least one ROM*	83.9 (n=26)
Lequesne**	11.0 (9.0-15.0)
Involved side-K/L*	
Normal	3.2 (n=1)
Doubtful	9.7 (n=3)
Definite narrowing	64.5 (n=20)
Marked	19.4 (n=6)
Severe	3.2 (n=1)
Involved side-MJS*	
Joint space >2.5 mm	22.6 (n=7)
1,5-2,5 mm	54.8 (n=17)
<1.5 mm	22.6 (n=7)

** %, ** Median (%25-75 IQR), **BMI:** Body mass index, **VAS:** Visual analog scale, **ROM:** range of motion, **K/L:** Kellgren/Lawrence, **MJS:** Minimal joint space.*

Table 2. Comparison of variables according to Kellgren/Lawrence grade.

	K/L grade 0,1 n=4	K/L grade 2, 3, 4 n=27	p
Age*(year)	71.0 (58.8-75.8)	58.0 (50.0-67.0)	0.094
Weight*(kg)	86.2 (73.4-105.4)	76.9 (69.9-92.2)	0.361
BMI*	35.8 (33.6-37.3)	32.4 (29.2-36.7)	0.141
Obese (%)**	-	25.9	0.550
Duration* (month)	15.0 (10.5-94.5)	18.0 (12.0-24.0)	0.834
VAS*	70.0 (45.0-87.5)	70.0 (60.0-80.0)	0.928
Flexion*	105.0 (92.5-110.0)	120.0 (100.0-120.0)	0.137
Internal rotation*	10.0 (2.5-32.5)	15.0 (10.0-15.0)	0.269
External rotation*	40.0 (18.8-57.5)	45.0 (25.0-60.0)	0.613
Lequesne*	13.5 (6.5-16.8)	11.0 (9.0-15.0)	0.635
Limited flexion (%)**	25.0	14.8	0.525
Limited internal rotation(%)**	75.0	81.5	1.000
Limited external rotation (%)**	25.0	22.2	1.000
At least one limited ROM (%)**	75.0	85.2	0.525

** Mann Whitney U, ** Chi-Square,* ***BMI:*** *Body mass index,* ***VAS:*** *Visual analog scale,* ***ROM:*** *Range of motion,* ***K/L:*** *Kellgren/Lawrence.*

Table 3. Comparison of variables according to minimal joint space.

	MJS>2.5 mm n=7	MJS=2.5-1.5 n=17	MJS<1.5 n=7	p
Age*(year)	58.0 (55.0-74.0)	56.0 (50.0-67.0)	60.0 50.0-73.0)	0.452
Weight(kg)*	77.7 (66.0-94.9)	77.0 (72.0-95.9)	74.0 (69.4-87.0)	0.515
BMI*	32.8 (30.1-37.1)	33.3 (28.3-38.9)	32.0 (31.2-33.5)	0.909
Obese (%)**	14.3	29.4	14.3	1.000
Duration *(month)	18.0 (12.0-60.0)	24.0 (10.5-30.0)	18.0 (12.0-24.0)	0.898
VAS*	60.0 (50.0-90.0)	70.0 (55.0-75.0)	80.0 (60.0-80.0)	0.648
Flexion*	120.0 (110.0-120.0)	120.0 (100.0-120.0)	100.0 (90.0-130.0)	0.724
Internal rotation*	15.0 (10.0-40.0)	15.0 (10.0-15.0)	10.0 (10.0-40.0)	0.497
External rotation*	60.0 (50.0-70.0)	40.0 (22.5-60.0)	25.0 (10.0-60.0)	0.074
Lequesne*	10.0 (5.0-13.0)	11.0 (9.5-15.0)	14.0 (11.0-17.0)	0.239
Limited flexion (%)**	-	17.6	28.6	0.153
Limited internal rotation (%)**	71.4	88.2	71.4	1.000
Limited external (%) **	-	23.5	42.9	0.059
At least one limited ROM (%)**	71.4	88.2	85.7	0.475

** Kruskal Wallis, ** Chi-square,* ***MJS:*** *Minimal joint space,* ***BMI:*** *Body mass index,* ***VAS:*** *visual analog scale,* ***ROM:*** *Range of motion<0}.*

K/L value, no correlation was identified between the radiological severity of OA and the clinical examination and LI value. The comparison of the variables according to MJS is presented in Table 3. Based on the MJS, no correlation was identified between the radiological severity of OA and the clinical examination and LI value. The agreement between K/L and MJS is presented in Table 4. These two scores were significantly agreement

Table 4. Agreement between radiological scores.

		Minimal joint space	
		>2.5 mm	2.5-1.5 and <1.5
Kellgren/ Lawrence	K/L grade 0,1	3 (42.9)	1 (4.2)
	K/L grade 2,3,4	4 (57.1)	23 (95.8)

p=0.007, Kappa value=0.467

with one another, thus demonstrating the radiological severity of HOA (p=0.007, Kappa value=0.467).

The demographic features and anthropometric measurements of the female and male subjects within the patient and control groups are presented in Table 5. The median age of the women and men in the control group was 43.5 years (range, 40 - 60 years) and 59 years (range, 56.5 - 60.5 years), respectively. No difference was identified between the female patients and controls with respect to age (p=0.452), height (p=0.860), weight (p=0.200), and BMI (p= 0.085). In terms of anthropometric measurements, there were statistically significant differences between the female patients and controls with regards to NC (p=0.022), LLL (p=0.000), and KW (p=0.030). No significant differences were identified between the female patients and the controls with respect to their measurements for BH (p=0.860), SW (p=0.289), BC (p=0.691), EW (p=0.657), WC (p=0.270), HW (p= 0.895), HC (p=0.070), WHR (p=0.756), LSL (p=0.566), LLL (p=0.507), KH (p=0.895), CC (p=0.216)..

A statistically significant difference was identified between the male patients and controls with regards to age (p=0.005), weight (p=0.042), and BMI (p=0.011). There were statistically significant differences between the male patients and controls with regards to their measurement for EW (0.001), HW (p=0.021), ULL (p=0.000), LLL (p=0.007), and KW (p=0.001). No significant differences were identified between the male patients and controls with respect to their measurements for NC (p=0.953), BH (p=0.851), SW (p=0.769), BC (p=0.129), WC (p=0.379), HC (p=0.100), WHR (p=0.581), LSL (p=0.166), KH (p=0.814), CC (p=0.169).

Discussion

Obesity is of particular interest among the risk factors for hip osteoarthritis. The effect of obesity on osteoarthritis is associated with the greater load that is observed in the lower extremities. It is possible that an excessive body mass for prolonged periods may increase the risk of subsequently developing HOA and worsening

Table 5. Demographic features and anthropometric measurements of the patients and controls.

	Female			Male		
	Patient (n=22)	Control (n=22)	p	Patient (n=9)	Control (n=9)	p
Age* (y)	58.0 (50.0-70.3)	43.5 (40-60)	0.452	**65.0 (50.5-71.5)**	**59.0 (56.5-60.5)**	**0.005**
Height*	1532.5 (1497.3-1565.0)	1530.0 (1497.5-1572.5)	0.860	1666.0 (1574.5-1733.0)	1630.0 (1615.0-1685.0)	0.698
Weight*	77.2 (65.9-93.8)	67.2 (61.1-79.5)	0.200	**81.3 (72.5-99.6)**	**71.4 (68.2-83.6)**	**0.042**
BMI*	33.1 (29.9-38.3)	28.6 (25.3-34.0)	0.085	**31.2 (27.1-35.6)**	**26.6 (25.2-30.6)**	**0.011**
NC*	**345.0 (330.0-365.0)**	**341.5 (323.5-371.3)**	**0.022**	404.0 (379.0-422.5)	370.0 (361.5-376.0)	0.953
BH*	817.5 (799.5-835.3)	818.5 (784.8-836.5)	0.860	851.0 (817.5-904.5)	858.0 (837.0-901.5)	0.851
SW*	363.0 (355.8-384.0)	365.0 (349.0-378.3)	0.289	386.0 (372.5-417.5)	373.0 (348.5-407.0)	0.769
BC*	305.0 (290.0-340.0)	293.0 (263.3-318.8)	0.691	322.0 (270-338)	286 (270.5-318.5)	0.129
EW*	66.0 (62.5-72.0)	60.0 (55.8-63.0)	0.657	**71.0 (66.5-76.5)**	**72.0 (68.0-73.5)**	**0.001**
WC*	960.0 (887.5-1075.0)	903.5 (813.3-104.0)	0.270	1009.0 (865.0-1113.5)	944.0 (917.0-976.0)	0.379
HW*	334.5 (318.8-368.3)	320.5 (289.0-342.3)	0.895	**316.0 (305.0-348.0)**	**325.0 (299.5-332.5)**	**0.021**
HC*	1113.5 (1077.5-1206.3)	1062.5 (1004.5-1165.0)	0.070	1088.0 (965.0-1130.5)	1005.0 (968.5-1032.5)	0.100
WHR*	0.9 (0.8-0.9)	0.9 (0.8-0.9)	0.756	0.9 (0.9-1.0)	1.0 (0.9-1.0)	0.581
LSL*	873.5 (832.3-900.8)	855.0 (795.0-883.0)	0.566	941.0 (909.0-963.0)	943.0 (929.0-977.0)	0.166
ULL*	**535.0 (509.5-550.8)**	**463 (448.3-480.3)**	**0.000**	**564.0 (542.5-579.0)**	**472.0 (458.0-487.5)**	**0.000**
LLL*	447.5 (436.5-465.0)	428.5 (402.3-442.3)	0.507	**452.0 (407.0-502.5)**	**445.0 (430.5-454.0)**	**0.007**
KH*	476.5 (449.5-496.8)	472.0 (458.3-495.8)	0.895	518.0 (490.0-538.0)	508.0 (505.0-521.5)	0.814
KW*	**102.5 (95.0-115.0)**	**91.0 (77.5-99.3)**	**0.030**	**107.0 (99.5-114.5)**	**96.0 (89-99.5)**	**0.001**
CC*	382.5 (363.8-398.5)	366.0 (343.0-391.8)	0.216	390.0 (350.0-407.0)	355.0 (335.5-384.0)	0.169

** median (25-75% IQR), Mann Whitney U, p<0.05 is statistically significant. Measurements in millimeters (mm), kilogram (kg),*
***NC:** Neck circumference, **BH:** Bust height, **SW:** Shoulder width, **BC:** Biceps circumference, **EC:** Elbow width, **WC:** Waist circumference,*
***HW:** Hip width, **HC:** Hip circumference, **WHR:** Waist hip ratio, **LSL:** Lower side length, **ULL:** Upper leg length, **LLL:** Lower leg length,*
***KH:** Knee height, **KW:** Knee width; **CC:** Calf circumference.*

of the disease (1). The anthropometric characteristics investigated as risk factors in the etiology of HOA have been limited to studies on the waist:hip ratio (2,4,6,12,13). However, we did not find any study in the literature on other anthropometric characteristics, particularly leg length, upper leg and lower leg length, and hip width. Being taller, and hence having a longer leg, length may decrease the load on the hip joint by resulting in a longer lever arm. On the other hand, a shorter leg length may increase the load on the hip joint by resulting in a shorter lever arm. It has been reported that obesity and the muscles around the hip affect the hip ROM degrees during daily activities such as walking, climbing stairs, sitting and standing up (21). Similarly, leg length may also affect hip ROM degrees during these activities. Obesity was shown to increase the degree of hip abduction while walking (22). In our study, 77.4 % of the patients were obese. However, the difference in BMI was statistically significant only between the male patients and control patients.

Hip extensor and flexor strength is important during lower extremity movement. Decreased muscle strength increases the load on the joint. Moreover, it is probable that other factors such as the standing balance and the lumbopelvic (core) control may also be affected by anthropometric characteristics (e.g., leg length). Impairment of the standing balance and lack of lumbopelvic control may lead to OA by increasing the physical load on the hip joint. Lower extremity length, particularly the hip-knee distance (upper leg length), forms the lever arm length (23). Longer leg length may decrease the load on the hip joint, since it results in a lengthened lever arm of the load. This fact may be one of the reasons why women have relatively more hip fractures and HOA than men (21).

Steultjens et al. investigated the association between joint ROM and disability in patients with hip and knee OA (24). They evaluated the ROMs of 198 patients with HOA and assessed their physical activities with the Lequesne index. The greatest limitation was identified in the external rotation ROM of the hip. In conclusion, low ROMs were associated with high levels of disability. It was reported that external rotation of the hip was identified as being most closely associated with disability.

An evaluation of the clinical characteristics of the patients in our study revealed that, while the disability level measured with the LI was moderately severe, there was a marked limitation of internal rotation. We also identified a marked limitation in internal rotation between the ROMs of the hip joints. There was no correlation among our patients between the ROMs of hip joints and the disability.

We used K/L and MJS measurements in the radiological assessment of HOA. No positive correlation was identified between the level of severity identified by radiological measurements and the ROM limitation and LI. No correlation was identified between the radiological severity of the disease and the clinical characteristics. However, we determined that the K/L and MJS values were consistent with one another. Similar to K/L, the MJS measurement is also a reliable method for showing OA severity quantitatively during radiological evaluation of HOA.

Studies on the distribution of adipose tissue have made use the of the waist:hip ratio, which is considered as a marker of central obesity. Various studies have shown that the role of the waist and hip adipose tissue in the biomechanical loading of the hip joint is relatively more significant (6,12,13). The methods used in these studies included anthropometric measurements of the waist circumference and hip circumference. Similarly, data on other obesity measures such as the waist circumference, hip circumference, body shape and the risk of knee and hip OA are limited. In their study, Sanghi et al. investigated the association of BMI and other anthropometric measurements with the severity of known osteoarthritis in non-obese subjects (4). They demonstrated that the waist:hip ratio in women was strongly associated with disease severity. Contrary to what is generally accepted, it was observed that knee OA had a stronger correlation with peripheral fat in males and with central fat in females than the body weight. In our study, there was no difference between female patients with HOA and the controls in terms of BMI; on the other hand, a statistical difference (p=0.011) was identified between male patients and controls. However, it is seems difficult to propose that BMI has an effect on HOA in men, since nine patients cannot be representative of the general population. In our study, we did not perform measurements of skin fold thickness, but performed measurements of the waist:hip ratio, which indicates the central adipose depot. In this context, no differences were identified between the groups with respect to their waist:hip ratio. This finding was consistent with the waist:hip ratio-related results in Wang's study (12).

In their large case-control study, Holliday et al. investigated by using BMI the effects of obesity and other anthropometric measurements associated with obesity on severe knee OA and HOA (9). It was observed that higher WC and HC values were associated with the risk of knee and hip OA, but also that this association was lower in comparison to the BMI. When only women were evaluated, the HOA risk was observed to be associated with the waist:hip ratio.

In their 10-year prospective cohort study, Wang et al. investigated the effect of fat distribution on knee and hip OA (12). The study included 1009 patients with joint replacement (541 knee replacements and 468 hip replacements) and 36014 individuals without any replacement. This study demonstrated that, the weight, BMI, waist circumference, waist:hip ratio, fat mass, and percentage fat were all associated with an increased risk for primary joint replacement.

Another study investigating the effect of anthropometric measurements on OA was the study conducted by Zhang et al. (25). This case-control study investigated the association of low index finger/ring finger ratio (2D:4D) with knee and hip OA. The 2D:4D ratio is a characteristic of sexual differentiation. In humans, the 2nd finger is typically shorter than the 4th finger, while in women they are generally equal. A shorter 2nd finger is associated with prenatal high testosterone, high sperm count and low estrogen concentration. Lower 2D:4D ratios were associated with features such as sexual, physical and athletic ability and masculine face shape. The author proposed that hormonal estrogen deficiency may affect joint biomechanics by causing physical inactivity. It was concluded that the OA risk for the hip was inconsistent.

We did not perform finger length measurements in our study. However, we did perform neck circumference, bust height, shoulder width, biceps circumference and elbow width measurements in the upper body, in addition to the lower extremities. The measurements other bust height were related to weight. However, we believe that these measurements do not have a direct effect on the hip joint. The significant difference observed in neck circumference in women and in elbow width in men in comparison to the controls could have been caused by weight and the bone structure. We determined that the upper leg length and knee width values of the female patients were statistically significantly higher in comparison to the controls. However, this finding does not support our hypothesis that short leg length leads to the development of HOA. In male patients, hip width and upper leg length were shorter to a statistically significant degree in comparison to the controls. However, lower leg length was longer in a manner inconsistent with this finding, and the difference with the controls was statistically significant. The knee width measurement of male patients was significantly higher in comparison to the controls. Although upper leg length was short in males, we nevertheless believe that this finding cannot be extrapolated to the general population due low number of patients in our study.

A limitation of our study was the small sample size. Moreover, if the muscle and fat mass of the lower extremities had been measured, the effects of all anthropometric characteristics on hip biomechanics could have been better elucidated. In future studies, the effect of anthropometric measurements, leg muscles and fat tissue on osteoarthritis can be investigated in a larger number of patients with HOA.

In conclusion, it is difficult in light of the study data to consider shorter leg length as a risk factor for the development of osteoarthritis in the hip joint.

References

1. Sulsky SI, Carlton L, Bockmann F, Ellegast R, Glitsch U, Hartmann B et al. Epidemiological evidence for work load as a risk factor for osteoarthritis of the hip: A systematic review. PLoS One 2012;7(2):e31521. PMID:22348095
2. Reijman M, Pols HA, Bergink AP, Hazes JM, Belo JN, Lievense AM et al. Body mass index associated with onset and progression of osteoarthritis of the knee but not of the hip. The Rotterdam study. Ann Rheum Dis 2007;66:158-62. PMID:16837490
3. Jordan JM, Helmick CG, Renner JB, Luta G, Dragomir AD, Woodard J, et al. Prevalence of hip symptoms and radiographic and symptomatic hip osteoarthritis in African-american and Caucasians: The Johnston County Osteoarthritis Project. J Rheumatol 2009;36:809-15. PMID:19286855
4. Sanghi D, Srivasta RN, Singh A, Kumari R, Mischra R, Mishra A. The association of antropometric measures and osteoarthritis knee in non-obese subjects: a cross sectional study. Clinics 2011;66(2):275-6. PMID:21484046
5. Abbate LM, Stevens J, Schwartz TA, Renner JB, Helmick CG, Jordan JM. Anthropometric measures, body composition, body fat distribution, and knee osteoarthritis in women. Obesity 2006;14(7): 1274-81. PMID:16899809
6. Grotle M, Hagen KB, Natvig B, Dahl FA, Kvien TK. Obesity and osteoarthritis in knee, hip and/or hand: An epidemiological study in the general population with 10 years follow-up. BMC Musculoskeletal Disorders 2008;9:132 PMID:18831740
7. Woolf AD, Breedveld FC, Kvien TK: Controlling the obesity epidemic is important for maintaining musculoskeletal health. Ann Rheum Dis 2006;65:1401-12. PMID:17038450
8. Jarvholm B, Lewold S, Malchau H, Vingard E. Age, bodyweight, smoking habits and the risk of severe osteoarthritis in the hip and knee in men. Eur J Epidemiol 2005;20:537-42. PMID:16121763
9. Holliday KL, McWilliams DF, Maciewicz RA, Muir KR, Zhang W, Doherty M. Lifetime body mass index, other anthropometric measures of obesity and risk of knee or hip osteoarthritis in the GOAL case-conrol study. Osteoarthritis and Cartilage 2011;19:37-43. PMID:21044695
10. Hart DJ, Spector TD.The relationship of obesity, fat distribution and osteoarthritis in women in the general population: the Chingford Study. J Rehaumatol 1993;20:331-5.

11. Lievense AM, Bierma-Zeinstra SM, Verhagen AP, van Baar ME, Verhaar JA, Koes BW. Influence of obesity on the development of osteoarthritis of the hip: a systematic review . Rheumatology (Oxford) 2002;41(10): 1155-62.

12. Wang Y, Simpson JA, Wluka A, Teichtahl AJ, English DR, Giles GG, et al. Relationship between body adiposity measures and risk of primary knee and hip replacement for osteoarthritis: a prospective cohort study. Arthritis Research and Theraphy 2009, 11:R31 (doi:10.1186/ar2636)

13. Lohmander LS, Gerhardsson M, Rollof J, Nilsson PM, Engstrom G. Incidence of severe knee and hip osteoarthritis in relation to different measures of body mass. A population-based prospective cohort study. Ann Rheum Dis 2009;68:490-6. PMID:18467514

14. Altman R, Alarcon G, Appelrouth D, Bloch D, Borenstein D, Brandt K et al. The American College of Rheumatology criteria for the classification and reporting of osteoarthritis of the hip. Arthritis Rheum 1991;34:505-14.

15. Norkin CC, White DJ. Measurement of joint motion: a guide to goniometry. Philadelphia: F. A. Davis, 1986.

16. Marks R, Allegrante JP. Body mass indices in patients with disabling hip osteoarthritis. Arthritis Res 2002,4:112-6.

17. Lequesne M. Coxarthrose. Rev praticien 2002;52:605-10.

18. Croft P, Cooper C, Wickham, Coggon D. Defining osteoarthritis of the hip for epidemiologic studies. Am J Epidemiol 1990;132:514-22

19. Zhang W, Doherty M, Arden N, Bannwarth, Bijlsma J, Gunther K et al. EULAR evidence based recommendatios for the management of hip osteoarthritis: report of a task force of the EULAR Standing Committee for international Clinical Studies Including Therapeutics (ESCISIT). Ann Rheum Dis 2005;64(5):669-81. PMID:15471891

20. Tilley, AR (1993). The measure of man and woman, New York: The Whitney Library of Design, an imprint of Watson-Guptill Publications.

21. Byrne DP, Mulhall KJ, Baker JF. Anatomy and biomechanics of the hip. The Open Sports Medicine Journal 2010;4:51-7.

22. Runhaar J, Koes BW, Clockkaerts, Bierma-Zeinstra. A systematic review on changed biomechanics of lower extremities in obese individuals: a possible role in development of osteoarthritis. Obesity Reviews 2011;1-12.

23. Bonitas I. Amorphological index for assessing hip osteoarthritis severity from radiographic images. Br J Radiol 2008;129-36

24. Steultjens MPM, Dekker J, van Baar ME, Oostendorp RAB, Bijlsma JWJ. Range of joint motion and disability in patients with osteoarthritis of knee or hip. Rheumatology 2000;39:955-61.

25. Zhang W, Robertson J, Doherty S, Liu JJ, Maciewicz RA, Muir KR et al. Index to ring finger length ratio and the risk of osteoarthritis. Arthritis Rheum 2008;58(1):137-44. PMID:18163515

Appendix

Methods for anthropometric measurements

- Neck circumference: Circumference of the neck below the thyroid cartilage.
- Bust height: Distance from the highest point of the head to the lowest point of the hip in sitting position.
- Shoulder width: Distance between the outermost points of the shoulder.
- Biceps circumference: Measurement of the circumference of the biceps muscle of the arm at the standing position with the arm hanging down.
- Elbow circumference: Measurement of elbow circumference.
- Waist circumference: Measurement of the circumference of the narrowest point between the lowest rib and spina iliaca anterior superior (SIAS).
- Hip width: Longest distance between the outer points of the hip at the sitting position.
- Hip circumference: Greatest diameter measured between the trochanters in standing position while the legs are separated by 20-30 cm.
- Lower side length: Distance from the heel to SIAS in standing position.
- Upper leg length: Distance from trochanter major the knee joint.
- Lower leg length: Distance between the highest point of the knee and lateral malleolus while the knee joint and ankle joint are in 90°flexion.
- Knee height: Distance between the heel and the knee in sitting position.
- Knee width: Distance between the femoral epicondyles.
- Calf circumference: Circumference of the calf at the widest point while the person is sitting on an examination table, with his/her feet hanging downwards.