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Influence of Obesity on the Progression of Knee and Hip Arthrosis

ABSTRACT

Introduction: Hip and knee joints represent a simple functional construction composed of strong, durable material. They enable the person to make everyday, long-range and painless leg movements. Obesity progressively accelerates the arthrosis, and subsequently, the dysfunction of joints.

The aim of the study: The aim of this study is to, within the test sample of 52 patients, establish the influence of obesity on the progression of primary knee and hip arthrosis.

Subjects and methods: The paper represents a retrospective - prospective analysis of data on the obesity of 52 subjects. 30 patients with primary coxarthrosis, mean age 56.90 ± 6.22 (46-70 years), were treated with endoprosthesis. The survey and medical record review showed that, due to primary coxarthrosis, 22 patients (76%) were treated with endoprosthesis. An average BMI of 25-29.99 (13.10 ± 2.86 years) was established in the aforementioned patients. In 22 patients, mean age 50.32 ± 7.32 (40-66 years), gonarthrosis was treated with endoprosthesis. The survey and medical record review showed that 18 patients (81.4%) with primary gonarthrosis had an average BMI of 25-29.99 in adolescence.

Results: In the analysis, patients treated with endoprosthesis due to primary gonarthrosis, had I^o obesity at the average age of 19.86 ± 2.30 (17-26 years). At primary coxarthrosis, I^o obesity was present at the average age of 22.27 ± 4.83 (17-36 years). II^o obesity was present in patients treated for primary gonarthrosis at the average age of 47.60 ± 6.65 years, and in coxarthrosis, at the average age of 54.38 ± 5.57 years.

Conclusion: All patients had been pre-obese since their childhood. With the increase of BMI, primary hip and knee arthrosis progressed.

Keywords: obesity, gonarthrosis, coxarthrosis

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Introduction

At the moment of shifting body weight on one leg while walking, a full range of biomechanical actions that allow pelvis to remain in horizontal, that is, a man in an upright position, transpire.¹

The force of gravity at the moment of shifting body weight on one leg is directed eccentrically on the hip joint. Abduction muscle force acts as a counterweight to the gravitational force. Three times greater strength of pelvitrohanter musculature is needed in order for the person's body to be upright and for the force of gravity to annul.¹ At that point, the entire loading of the lower extremities is four times greater than the person's weight. A person who weighs 100 kg generates 400 kg of loading on one leg while walking.¹

A few millimeters thick hyaline cartilage of the joint endures indicated extreme loading thanks to its hydroelastic system. The system is based on its high capacity of water binding with a cartilage matrix, which is composed of: chondrocytes, different types of collagen, proteoglycan and enzymes. Weight-bearing leads to the displacement of water from the matrix which then enters into the synovial space. By relieving the wrist, the liquid is absorbed back into the matrix.^{1,2}

With increased loading on the joint, the quality of hyaline articular cartilage decreases. Increased body weight in people produces disproportion between the matrix quality and mechanical loading. The first step in the matrix degradation is the physical overload of the chain of collagen fibers, which arise due to overloaded cyclic impacts. The loss of tolerance of articular cartilage leads to bursting of collagen fibers in the matrix and the release of enzymes that dismantle the matrix progressively.²

Arthrosis is divided into primary and secondary. Degenerative processes in primary arthrosis appear and usually progress due to disproportion between the loading and the possibility of bearing these loadings.² Secondary arthrosis occurs after intra-articular fractures, incongruities of joints due to developmental disorders, metabolic and endocrine diseases, infections, etc.³

The aim of the study

The aim is to determine, within the test sample, the influence of obesity on the progression of primary hip and knee osteoarthritis. Furthermore, to quantify negative influence of obesity on knee and hip functionality in performing everyday physical activities: getting up, walking, standing, climbing, etc.

Patients and Methods

The paper is a retrospective and prospective study of 52 patients who were treated with endoprosthesis due to primary hip and knee arthrosis.

52 patients were examined as follows: 22 with primary gonarthrosis and 30 with primary coxarthrosis. 22 patients (5 males and 17 females) included in this study were selected from a group of patients who had undergone the implantation of total knee endoprosthesis. 30 patients (9 males and 21 females) constituted the group of patients who had undergone the implantation of total hip endoprosthesis. The testing was conducted from 2002 to 2014 at the Clinic of Traumatology, Clinical Center Banja Luka and the Department of Orthopedics and Traumatology, UCCS, Sarajevo. The following was used for the research: medical records of the patients, surveys, clinical and radiographic examination, and Body Mass Index (BMI) to determine the degree of obesity.⁴

Conditions for the inclusion of the patients were as follows: clear clinical and radiologic image of knee and hip osteoarthritis of unknown etiology. Prior disease, hip and knee injuries, neurological deficits, rheumatoid arthritis, etc. were excluded by radiography and anamneses. The paper analyzed the following: patient's age, duration of symptoms, degree of obesity- BMI, strength and functionality of the knee using the Knee Society Knee Score (KSKS)^{5,6} as well as pain and functionality of the hip using Harris Hip Score (HHS).⁷ Data on obesity were obtained by reviewing medical records and an interview performed by the same examiner. Calculating BMI is a method that best represents the state of obesity of the patient, and is determined by the formula: $BMI = \text{weight (kg)} / \text{height}^2(\text{m})$. The values of BMI below 18.5 are considered malnutrition, 18.5-25 - normal nutritional status, 25-30- moderate obesity, and more than 30- very severe obesity.⁴

Results

Primary coxarthrosis was treated with endoprosthesis in 30 patients: 9 males and 21 females, mean age 56.90 ± 6.22 (46-70 years). The average age of treated males was 62.22 ± 5.61 (50-70 years), while females was 54.62 ± 4.94 (46-66 years). There was a statistically significant age difference between males and females treated for primary arthrosis ($p = 0.0051$). The survey and the medical record review showed that 22 patients (76%) with primary coxarthrosis had already been pre-obese in adolescence, with the BMI of 25-29.99 since they were commonly 13.10 ± 2.86 years old. There was a statistically significant difference in the adolescent age of pre-obese males and females treated for primary arthrosis ($p = 0.0040$). Gonarthrosis was treated with endoprosthesis in 22 patients: 17 females and 5 males, mean age 50.32 ± 7.32 (40-66 years). The mean age of females was 48.94 ± 7.13 (40-62 years), while males was 55.00 ± 5.87 (50-66 years). There was no statistically significant age difference between females and males treated for primary knee OA ($p = 0.1194$). The medical record review and conducted survey showed that 18 patients (81.4%) with primary gonarthrosis had already been overweight in the adolescent age with the

BMI of 25-29.99 since they were approximately 12-year-olds. There was no statistically significant age difference between females and males treated with primary knee gonarthrosis ($p = 0.0803$).

Comparison between the group of patients treated with gonarthrosis and the group of patients treated with coxarthrosis confirmed that there was a statistically significant age difference between the abovementioned groups ($p = 0.0018$). Furthermore, there was a statistically significant age difference between the female groups ($p = 0.0116$), although not between males ($p = 0.0771$). There was no statistically significant age difference between the groups of patients treated with endoprosthesis due to primary gonarthrosis- coxarthrosis ($p = 0.1139$). Regarding the obesity, there was no statistically significant difference between the groups of females treated for primary gonarthrosis-coxarthrosis ($p = 0.7242$), while there was a statistically significant difference between the groups of males treated for primary gonarthrosis - coxarthrosis ($p = 0.0249$).

I° obesity (BMI 30.00 to 34.99) occurred in all patients in the third decade of their lives. Female patients cited pregnancy and childbirth as the reason for obesity. They could not reduce a given weight from pregnancy and after childbirth. In the survey, males cited that their obesity occurred upon arrival from the army, marriage and employment. The respondents were rather oblivious about obesity and without any need to reduce weight, because they lived in an environment where obesity was considered a healthy trait.

I° obesity (BMI 30.00 to 34.99) in patients treated for gonarthrosis, occurred at the age of 19.86 ± 2.30 (17-26), that is, females at the age of 19.29 ± 1.81 (17-22), males at the age of 21.80 ± 2.71 (19-26). In patients treated for coxarthrosis, I° obesity occurred at the age of 22.27 ± 4.83 (17-36), that is, females at the age of 19.86 ± 2.36 (17-26), and males at the age of 27.89 ± 4.43 (20-36). There was no statistically significant age difference between female and male patients with gonarthrosis ($p = 0.1410$). There was a statistically significant age difference between female and male patients with coxarthrosis ($p = 0.0007$).

The comparison confirmed that there was a statistically significant age difference of I° obesity between groups of patients treated for primary gonarthrosis and coxarthrosis ($p = 0.0240$). There was no statistically significant age difference of I° obesity between the female groups of patients treated for primary gonarthrosis - coxarthrosis ($p = 0.4226$). There was a statistically significant age difference of I° obesity between the male groups of patients treated for gonarthrosis-coxarthrosis ($p = 0.0129$).

II° obesity with the BMI of 35.00 to 39.99 occurred in 5 patients (22.72%) treated for primary gonarthrosis (23.53% females /20.00% males). The average age of patients with II° obesity treated for gonarthrosis was 47.60 ± 6.65 (36-55

years)-females at the age of 48.25 ± 7.29 (36-55), males at the age of 45.00 ± 0.00 (45). In the treatment of coxarthrosis, there were 8 patients (26.67%) in total, specifically, 4 females (19.05%) and 4 males (4.44%), with BMI from 35.00 to 39.99. The average age of patients with II° obesity treated for coxarthrosis was 54.38 ± 5.57 (45-62), that is, females at the age of 49.25 ± 2.59 (45-52), males at the age of 59.50 ± 1.66 (58-62).

There was a statistically significant age difference of II° obesity between males and females treated for coxarthrosis ($p = 0.0020$). There was no statistically significant age difference of II° obesity between the groups of patients treated for gonarthrosis - coxarthrosis ($p = 0.1277$). There was no statistically significant age difference of II° obesity between the female group of patients treated for primary gonarthrosis - coxarthrosis ($p = 0.8346$).

Pain and limited movements, in patients suffering from primary gonarthrosis, were treated with conservative therapy for 8.55 ± 3.51 (4-16 years) on average (females for 8.65 ± 3.20 (4-14 years), males for 8.20 ± 4.40 (4-16 years)). Pain and limited movements, in patients suffering from primary coxarthrosis, were treated with conservative therapy for, on average, 8.55 ± 3.51 (4-16 years) - females for 8.67 ± 3.55 (4-14) years, males for 8.20 ± 4.40 (4-16) years. There was no statistically significant difference in duration of pain treatment of primary knee OA patients between women and men ($p = 0.8559$). There was no statistically significant difference in the length of pain treatment between the groups of patients treated conservatively for primary gonarthrosis - coxarthrosis ($p = 1.0000$). Statistically, there was no significant difference in duration of conservative pain treatment between the female groups of patients treated for primary gonarthrosis - coxarthrosis ($p = 0.9862$).

The average value of the Knee Society Knee Score before surgical treatment in this study was 118.1 points, and the Harris Hip Score value was approximately 54 points. All patients treated for primary gonarthrosis usually had the following comorbidities: hypertension 14 (64%), diabetes mellitus 9 (41%), cholelithiasis 3 (14%), hyperlipidemia 4 (18%), and nephrolithiasis 2 (9%). The subjects treated for primary coxarthrosis usually had the following co-morbidities: hypertension 24 (80%), diabetes mellitus 12 (40%), cholelithiasis 9 (30%), hyperlipidemia 9 (30%), and nephrolithiasis 7 (20%). There was no statistically significant difference in comorbidities between the groups of patients treated for primary gonarthrosis and coxarthrosis ($p = 0.9781$).

The average age of obese adolescent patients who were treated for gonarthrosis was 12.00 ± 1.98 (8-17) years, while the abovementioned age for patients treated for coxarthrosis was 13.10 ± 2.86 (8-20) years. There was a statistically significant age difference between the groups of

adolescent pre-obese patients treated for gonarthrosis and coxarthrosis ($p = 0.0018$).

In view of this, we can discuss the age difference of I° obesity between females and males with gonarthrosis. There was no statistically significant age difference of I° obesity between male and female patients treated for primary gonarthrosis ($p = 0.1410$).

In the case of coxarthrosis, there was a statistically significant age difference of I° obesity between male and female patients treated for primary coxarthrosis ($p = 0.0007$).

There were 9 patients (17.31%) with II° obesity and BMI of 35.00 to 39.99, while I° obesity occurred in 43 patients (82.69%). There was a statistically significant difference in treatment of II° and I° obesity in favor of I° obesity ($p = 0.0000$).

There was no statistically significant difference in pain tolerance between patients treated for primary gonarthrosis and primary arthrosis ($p = 1.0000$).

There was no statistically significant difference in comorbidities between the groups of patients with gonarthrosis and coxarthrosis (chi-square; $p = 0.9781$).

Discussion

Epidemiological studies have shown that in highly developed countries, in 50% of all people above the age of 40, changes in osteoarthritic knee joints, which are clinically asymptomatic, may be morphologically proven.⁴ First, second, and specially third degree obesity was long ago recognized as risk factors for the development of arthritis of the joints, especially gonarthrosis.⁵ Patients with a body mass index BMI > 30 should be advised to lose weight before total knee arthroplasty.⁵ They should maintain the weight subsequently, because it is the safest way to prevent all the complications that accompany intra and postoperative course of treatment of gonarthrosis with endoprosthesis.^{5,6}

Results from the Framingham study showed that females, who lost about 5 kg of body weight (BW) had a 50% reduction in clinical signs of gonarthrosis.⁷ The same survey showed that the loss of BW was significantly associated with reduced risk for development of radiographic signs of gonarthrosis. BW reduction caused pain decrease and improved function of the knee.⁷ Nutrition, physical activity, exercise and sport are effective in BW reduction.⁷ The results of the meta-analysis showed that the joint pain decreased by about 5% in proportion to the reduction of BW for about 5%.⁸

Orthopedist doesn't share the unique attitude towards the relationship between excessive body weight and

coxarthrosis. There is a strong evidence that the obesity increases the risk of bilateral coxarthrosis manifested clinically and radiographically.⁶ In the Nurses' Health Study, an increased BMI at the age of 18 is strongly associated with an increased risk of coxarthrosis.⁹ Increased body weight is probably the main, but not the only factor that accelerates changes related to coxarthrosis and gonarthrosis. Knee and hip overloading damage synovial, ligamentous stabilizers and other joints. Unstable joint progressively accelerates changes related to osteoarthritis.¹⁰ For every excessive 5kg, the risk of knee arthritis is increased for about 35%.¹⁰ In addition, an obese patient, as opposed to a non-obese patient, bears a much higher risk of intraoperative complications and significantly shorter lifespan of knee prostheses.¹⁰

The study that was conducted on patients with knee and hip osteoarthritis showed that gonarthrosis of 2nd and 3rd degree occurred in 97.1% of patients with the BMI of 30-35, while gonarthrosis of 3rd and 4th degree occurred 83.3% of the patients with a BMI > 40.¹¹ In female population aged between 48 and 70 years, it was established that the risk for development of knee and knuckle osteoarthritis increased from 9% to 13% per each kilogram of body weight obtained. The abovementioned suggests that even a small reduction in weight can affect the prevention of osteoarthritis, while any increase of 5kg in body weight increases the risk for development of knee osteoarthritis by 36%.¹²

After six years of monitoring 3,585 people over the age of 55, Reijman and associates found that the progression of radiologically confirmed knee, but not hip arthrosis, correlated with increased BMI.¹³ In another study, which lasted for eleven years and included 30,000 people, Grotle and associates found that BMI > 30kg/m² represented a strong risk factor for the development of gonarthrosis, while the risk of coxarthrosis was weaker but still statistically significant.¹⁴

The exact mechanism for the occurrence of arthrosic changes in joints affected by increased BW is not completely rendered, but it may be simultaneously affected by both biomechanical and metabolic factors.¹² Consequent damage of cartilage occurs in patients with increased BMI, due to mechanical load-bearing joints.¹² The load-bearing joints of the lower extremities can withstand considerable loading (increased body weight). However, the hip joint has an anatomical advantage over the knee joint. This can be explained by the shape of intra articular bones of the hip joint and strong muscle binding apparatus surrounding the joint, increasing its stability when compared to the knee joint.¹²

Degenerative idiopathic changes caused by obesity are 25% more common for those who have excess fat in the hips. The risk is five times higher in females who had BMI > 30 before the age of 18.¹⁵ In 24% of cases of I° obesity, if

BW is reduced for 5kg, endoprosthesis installment can be avoided.¹⁵

In the Republic of Srpska, 550 endoprosthesis for primary hip and knee arthrosis are installed. 3 million euros are the costs of Health Insurance Fund for this treatment. By reduction of patients' BW for 5kg, a surgical treatment of about 133 patients can be avoided and hence, costs can be reduced by around 800,000 euros.

Higher body mass index (BMI>30) of males in the age of 20-29 is associated with an increased risk of gonarthrosis in relation to coxarthrosis.¹² When compared to patients in previously mentioned life age with BMI<30 a risk for gonarthrosis is increased by 4% in patients over 65 with BMI >30.¹²

Conclusion

All patients had been pre-obese since their childhood. With the increase of BMI, primary hip and knee arthrosis progressed. Regular medical examinations are required in order to verify pre-obese and obese children. Furthermore, it is necessary to educate teachers in schools, parents and children about the problems of obesity and introduce special programs in kindergartens and schools so that pre-obese and obese children can be educated about diet and physical activity as measures for the prevention and treatment of obesity.

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Uticaj gojaznosti u progresiji artroze kuka i koljena

SAŽETAK

Uvod: Zglobovi kuka i koljena predstavljaju jednostavnu funkcionalnu konstrukciju, sačinjenu od jakog, izdržljivog materijala. Omogućuju čovjeku svakodnevne, dugogodišnje i bezbolne pokrete nogu. Gojaznost progresivno ubrzava artrozu, a samim tim i disfunkciju zglobova.

Cilj rada: Cilj ovog istraživanja je da se, u okviru ispitivanog uzorka od 52 pacijenta, utvrdi uticaj gojaznosti na progresiju primarne artroze kuka i koljena.

Ispitanici i metode: Rad predstavlja retrospektivno - prospektivnu analizu podataka o gojaznosti 52 ispitanika. Endoprotezom je liječena primarna koksartroza kod 30 ispitanika, prosječne životne dobi $56,90 \pm 6,22$ (46-70) godina. Anketom i uvidom u zdravstveni karton utvrđeno je da su 22 ispitanika (76%) bila liječena endoprotezom zbog primarne koksartroze. Kod njih je konstatovano da su u prosjeku ($13,10 \pm 2,86$ godina) imali BMI 25-29,99. Endoprotezom su liječene gonartroze kod 22 ispitanika, prosječne životne dobi $50,32 \pm 7,32$ (40-66) godina. Uvidom u zdravstveni karton i anketom sprovedenom na 18 ispitanika (81,4%) sa primarnom gonartrozom, ustanovljeno je da je njihov prosječni BMI u adolescentskom dobu bio 25-29,99.

Rezultati: U ispitivanom uzorku, liječeni endoprotezom zbog primarne gonartroze bili su I^o gojazni u životnoj dobi od $19,86 \pm 2,30$ (17-26) godina. Kod primarne koksartroze, I^o gojaznost je bila prisutna u dobi od $22,27 \pm 4,83$ (17-36) godina. Gojaznost II^o su imali ispitanici liječeni zbog primarne gonartroze u životnoj dobi od $47,60 \pm 6,65$ godini, a zbog koksartroze u dobi od $54,38 \pm 5,57$ godine života.

Zaključak: Svi ispitanici su bili predgojazni od djetinjstva. Sa povećanjem BMI, kod ispitanika progredira primarna artroza kuka i koljena.

Glavne riječi: gojaznost, gonartroza, koksartroza