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Causal role of gender in hip arthroplasty: affected hip, previous diagnosis and hospitalization duration

Papel causal do sexo nas artroplastias de quadril: quadril acometido, diagnóstico prévio e tempo de internação

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ABSTRACT

Causal relationship between the gender of patients who underwent hip arthroplasty with regard to affected hip, previous diagnosis, type of arthroplasty and hospitalization duration is analyzed by a retrospective and cross-sectional study with 100 patients from an orthopedic clinic, who underwent total (THA) and partial (PHA) hip arthroplasty. The sample was collected between March 2018 and January 2019. The analysis consisted of a comparative causal model between males and females through propensity score. The covariates were illustrated by the Directed Acyclic Graph (DAG). The patient's gender was causally associated with the affected hip ($p = 0.038$), previous diagnosis - osteoarthritis or femoral neck fracture ($p = 0.004$) and duration of hospitalization ($p < 0.001$), but failed to explain the hip arthroplasty type ($p = 0.385$). The left hip was more affected in males (71%), whilst females had a prevalent diagnosis of femur fracture (69.3%) and osteoarthritis in males (65.7%). Further, 71% of males underwent THA, similar to females. Males were hospitalized for -2.12 days less than females. Gender had a causal relationship with affected hip, previous diagnosis, and length of stay in THA, but it was not associated with type of arthroplasty.

Keywords: Causality. Hip arthroplasty. Gender duration. Propensity score.

RESUMO

O objetivo deste trabalho foi analisar uma relação causal entre o sexo dos pacientes que realizaram artroplastia de quadril quanto ao quadril acometido, diagnóstico prévio, tipo de artroplastia e tempo de internação. Trata-se de estudo retrospectivo e transversal com 100 pacientes de um serviço de ortopedia que realizaram artroplastia total (ATQ) e parcial (APQ) de quadril. A amostra foi coletada entre março de 2018 a janeiro de 2019. A análise consistiu de um modelo causal comparativo entre homens e mulheres através de escore de propensão. As covariáveis foram ilustradas pelo Gráfico Acíclico Direcionado (DAG). O sexo do paciente associou-se causalmente com o quadril acometido ($p = 0.038$), diagnóstico prévio - osteoartrose ou fratura do colo do fêmur ($p = 0.004$) e tempo de internação ($p < 0.001$) mas não explicou a escolha do tipo de artroplastia ($p = 0.385$). O quadril esquerdo foi mais acometido nos homens (71%). As mulheres tiveram diagnóstico prevalente de fratura de fêmur (69,3%) e os homens por osteoartrose (65,7%). 71% dos homens realizaram ATQ e as mulheres não diferiram. Os homens ficaram internados -2.12 dias que as mulheres. O sexo apresentou uma relação causal com o quadril acometido, o diagnóstico prévio e o tempo de internação nas ATQ, mas não se associou ao tipo de artroplastia.

Palavras-chave: Artroplastia de quadril. Causalidade. Escore de propensão. Sexo. Tempo de internação.

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INTRODUCTION

Total hip arthroplasty (THA) is currently one of the most common hip surgeries[1]. Indications comprise osteoarthrosis and the fracture of the femur neck[2]. THAs are common interventions, motivating heated discussions and epidemiological studies[3,4] for the patients´ best prognostic and its impacts on clinical outcome and life quality[5].

An increase in these procedures has occurred in several country during the last decades, due to great number of obese people, aging of the population and the growth of chronical and degenerative diseases[6]. Although procedures are safe and effective, great disparities occur in this type of surgery in Brazil. Most procedures are concentrated in the south and southeastern regions (17.3 and 10.99 THA/100.000 inhabitants), with worst indexes in the north and northeastern regions of Brazil (0.96 and 3.25 THA/100.000 inhabitants)[7]. Further, individual features, such as gender and age, seems to delay hospital discharge and cost increase [8]. It seems that several patients wait during longer periods for the procedures, especially in northeastern Brazil, with the consequent worsening of functionality and increase of limitations in the patient.

Osteoarthrosis is the main cause for THAs which are optional high complexity surgical interventions. Osteoarthrosis is a non-inflammatory disease that impacts joints and cause joint destruction, with the subsequent prosthetic replacement of the joint[9-11]. THAs are currently safe and efficacious procedures in pain decrease, in better joint function, and provide a good life quality to the patient even in elderly ones or with associated co-morbidities[12,13].

It is a well-known fact that most THAs are performed more in females than in males even though a systematic review in several countries have indicated similarity with regard to gender [6]. There has been a decrease in the hospitalization period, namely, from 4.06 (mean/days) in 2002 to 2.75 in 2013 due to progress in surgery techniques, in the type of anesthetics and new care model[14]. However, few studies focus on the incidence of compromised hip[2,15], right or left, since, depending on dominant hemibody, changes may have occurred in long term therapeutic response and rehabilitation strategies.

THA occurs due to high degree osteoarthrosis and hip fractures at lower percentages [16]. However, it is not known whether the previous diagnosis may be gender-cause explained. Similarly, few studies have been undertaken on non-modifiable causes, such as gender and their relationship with longer hospitalization period. A recent study has pinpointed some modifiable causes which directly impacted hospitalization of females in post-surgery of PHA and THA such as the greater presence of comorbidities and low weight[17].

Current paper analyzes the causal relationship between the gender of patients who were operated for hip arthroplasty taking into account compromised hip, previous diagnose, arthroplasty type and hospitalization length.

METHODOLOGY

Current transversal, retrospective, quantitative and analytic study employed data from an investigation called "Aspects associated with patients´ hospitalization duration in a surgical clinical of a university hospital", developed by professionals and residents of the University Hospital of the Universidade Federal do Maranhão (HUUFMA) in São Luís MA Brazil.

Current study was conducted at the Presidente Dutra Unit (UPD) of the HUUFMA. Data were retrieved from medical records of patients hospitalized in the Neuromuscular and Traumato-Orthopedic Care sector, in the same UPD, which provides assistance to traumatic, orthopedic, neurological and bariatric patients. Medical records may be found at the Medical and Statistical Archive Service (SAME) of UPD. Patients hospitalized between January and December 2017 were included, with complete data according to the research tool. All had undergone the proposed surgery after being hospitalized in the unit. Patients excluded comprised those whose surgery was cancelled and were discharged from the hospital, patients with incomplete data in the medical records

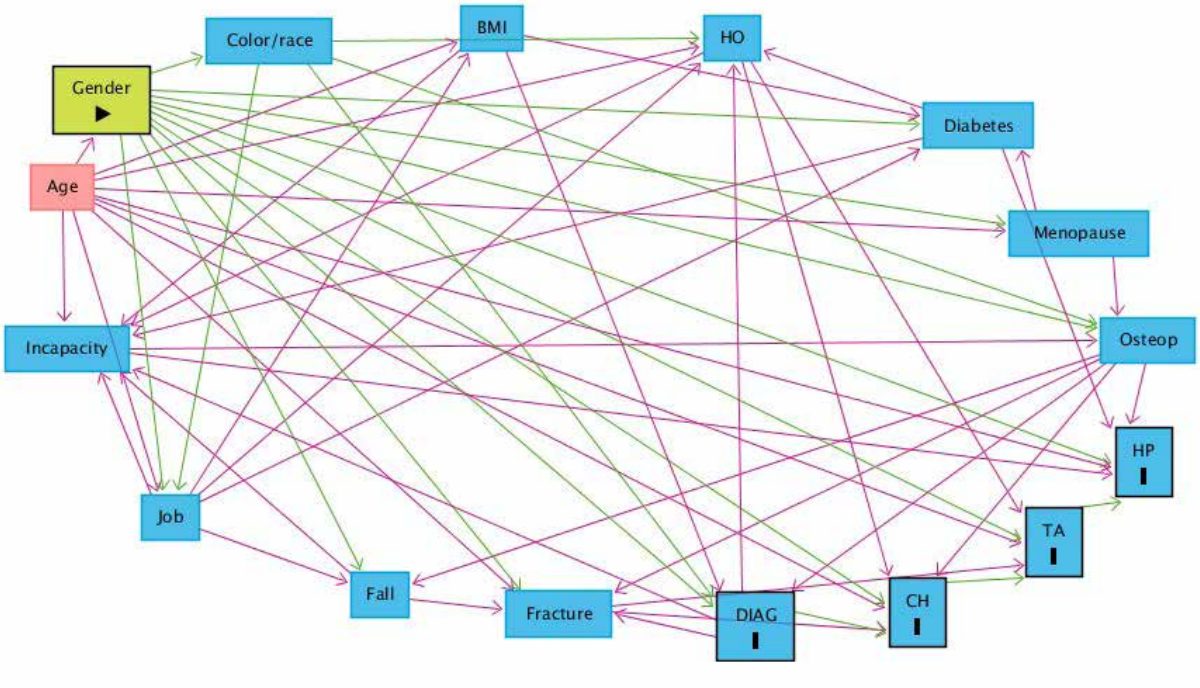
and medical records absent from the printed list of hospital management software.

Sample was randomized and probabilistic according to the specificity of each patient (traumatic-orthopedic, neurological and bariatric). Initial study comprised a sample of 630 patients. The data of 382 orthopedic and traumatological patients were retrieved, featuring people who underwent total or partial hip arthroplasty. Sample took into account 328 hip arthroplasty surgeries in the state of Maranhão in 2018[7], with a sample error of 5%, confidence level at 95% and a homogeneous distribution of the population under analysis, with a sample of 141 people. Since 41 medical records were missing, the final sample comprised 100 individual and an 8.18% margin error.

Data were collected from the medical records through a form elaborated by the researchers featuring the patients´ sociodemographic and clinical aspects. Data retrieval occurred between March 2018 and January 2019.

The primary results comprised the diseased hip (right or left) for hip arthroplasty. Secondary results comprised the type of arthroplasty performed, whether partial or total of the hip joint, previous diagnosis (osteoarthrosis or femur fracture) and duration of hospitalization. Exposition consisted of the variable gender, since causes and consequences with regard to the variable tended to be pre- and post-surgery differences.

Model adjustments comprised sociodemographic variables age, ethnicity, place of residence (capital city or interior of the country), schooling, job and income. Clinical variables for adjustment were pre-surgery (hip fracture or hip osteoarthrosis), hypertension and diabetes. Inclusion criterion was a minimum set by DAG (Figure 1), through backdoor criterion, with age alone for the analysis of cause relationship.



Notes: HO – hip osteoarthrosis; Osteop – Osteoporosis; HP – hospitalization period; TA – type of hip arthroplasty; CH – compromised hip; DIAG – diagnosis; Incapacity – incapacity level; BMI – body mass index.

Figure 1. Directed Acyclic Graph (DAG) with theoretical relationships between variables and minimum set for adjustment (age), São Luís, Brazil, 2019.

STATISTICAL ANALYSIS

Data were analyzed by Stata® 14.1 for Windows. Descriptive statistics (absolute and percentage frequencies) and center-biased measurements (mean + standard deviation) were employed for better data analysis. Normality of variables age and hospitalization duration were analyzed by Kolmogorov-Smirnov test ($p > 0.05$). Further, bivariate analysis (Student´s *t* test and Pearson´s chi-square test) between variable gender and socio-demographic and clinical variables was conducted to verify possible associations and detect confounding variables in equilibrium when modeling causal roles. A theoretical model (Figure 1) was built by directed acyclic graphs (DAGs) to analyze association between gender and results. They were produced by DAGitty 2.3 to identify confounding variables and for which the analysis should be controlled.

Each variable was organized according to its specific temporal relationship: demographic (gender, ethnicity, age), socioeconomic (place of origin, education, job and income), clinical (SAH, diabetes, diagnosis, fall, level of dependence) and surgical (type of arthroplasty and duration of hospitalization). The identification of duration facilitates analysis of relationship between the variables. In fact, paths were constructed between variables based on temporality and theoretical assumptions. Multivariate analysis consisted of a comparative causal model of the patients (males) and controls (females) by trend score adjusted for the covariates indicated by back door criterion.

ETHICAL ASPECTS

Data collection was undertaken after approval by the Scientific Committee (COMIC) and by the Committee for Ethics in Research HUUFMA (no. 2,708,691/2018) by Brazil Platform. The Free and Informed Consent Form (TCLE) for data collection was not required because data were obtained from medical records, formalized by the Terms of Commitment in Data Usage (TCUD).

RESULTS

Social, economic and demographic variables (Table 1) reveal a prevalence of females (62%), mixed-race (38%), mean age (69±1.92 years old), most from the capital city of the state (32%), incomplete elementary schooling (26%), retired (49%), with an income of one minimum wage (49%). Males (38%), mostly mixed-race (18%) had a mean age of 63±2.31 years old, most from the interior of the state (23%), with incomplete elementary schooling (19%), retired (26%), with income of one minimum wage (27%).

Table 1. Social, economic and demographic profile of sample with regard to gender (n=100), São Luís, Brazil, 2019

(To be continued)

Variable	Male (n=38)	Female (n=62)	Value *p*
Age†	63 (±2.31)	69.1 (±1.92)	***0.022****
Ethnicity			
Negro	10 (10%)	07 (07%)	
Mixed-race	18 (18%)	38 (38%)	*0.138***
White	10 (10%)	17 (17%)	
Place of origin			
Capital city	15 (15%)	32 (32%)	*0.238***
Interior	23 (23%)	30 (30%)	

(Conclusion)

Schooling			
Illiterate	07 (07%)	18 (18%)	
Incomplete basic	19 (19%)	26 (26%)	
Complete basic	03 (03%)	04 (04%)	*0.883***
Incomplete high school	02 (02%)	02 (02%)	
Complete high school	06 (06%)	10 (10%)	
Higher education	01 (01%)	02 (02%)	
Job			
Unemployed	-	02 (02%)	
Agriculture	03 (03%)	04 (04%)	
Retired	26 (26%)	49 (49%)	*0.227***
Building workman	02 (02%)	-	
Commerce	07 (07%)	06 (06%)	
Educational job	-	01 (01%)	
Income			
No income	-	01 (01%)	
1 minimum wage	27 (27%)	48 (48%)	*0.509***
2 minimum wages	03 (03%)	06 (06%)	
3 minimum wages	08 (08%)	07 (07%)	

*Student´s t test; ** chi-square test; †Mean (±standard deviation).

Clinical and surgical characteristics (Table 2) revealed that one third of females were hypertensive (35%), without diabetes (53%), with fracture of the femoral neck (43%) caused by fall (40%). In females, both hips (right and left) were affected with equal percentages (31%). Further, 22% were independent for in-hospital activities and also underwent partial arthroplasty (31%) and total hip (31%) surgery. Mean duration of hospitalization was 6 days. Most men were neither hypertensive (22%) nor diabetic (32%); they were hospitalized for arthroplasty due to gonarthrosis (25%) as the main cause and mostly confined to bed (14%). Moreover, 27% of males underwent total hip arthroplasty, predominantly on the left (27%) and mean hospitalization of 4 days.

Table 2. Clinical and surgical profile of sample with regard to gender (n=100), São Luís, Brazil, 2019

Variable	Male (n=38)	Female (n=62)	Value *p*
AHS			
Yes	16 (16%)	35 (35%)	*0.164**
No	22 (22%)	27 (27%)	
Diabetes			
Yes	06 (06%)	09 (09%)	*0.863**
No	32 (32%)	53 (53%)	
Previous diagnose			
Gonartrose	25 (7%)	19 (18%)	***0.001****
Fracture of femur neck	13 (1%)	43 (43%)	
Fall			
Yes	14 (14%)	40 (40%)	***0.007****
No	24 (24%)	22 (22%)	
Compromised hip			
Right	11 (11%)	31 (31%)	***0.038****
Left	27 (27%)	31 (31%)	
Pre-surgery dependence degree			
Independent	12 (12%)	22 (22%)	
Locomotion with aid	12 (12%)	20 (20%)	*0.880**
Bed-ridden	14 (14%)	20 (20%)	
Arthroplasty type			
Partial	11 (11%)	31 (31%)	***0.038****
Total	27 (27%)	31 (31%)	
Hospitalization period†	4.18 (±0.39)	6.08 (±0.42)	***0.001*****

*chi-square test; ** Student´s t test; † Mean (±standard deviation).

Analysis of estimation of the causal effect of gender on outcomes (Table 3) showed 38 males and 62 female controls. Age matching was performed according to the minimum set observed in DAG.

Table 3. Coefficients of causal role of gender in outcomes CH, DIAG, TA and HP in elderly people undergoing arthroplasty adjusted by age, São Luís, Brazil, 2019

Result	Coef.	IC 95%	Value *p*
CH	0.23	[0.01 - 0.45]	**0.036**
DIAG	-0.25	[-0.43 - -0.08]	**0.004**
TA	0.08	[-0.10 - 0.27]	0.385
HP	-2.12	[-3.08 - -1.16]	**<0.001**

Abbreviations: CH – compromised hip (right or left), DIAG – diagnosis (osteoarthrosis or fracture), TA – type of arthroplasty (partial or total) and HP – hospitalization period.

Propensity scores showed a causal association between gender and the affected hip, since males had a 23% greater trend to have the left hip affected when compared to female controls. Gender foregrounded previous diagnosis since males were likely to be more affected by gonarthrosis, whereas females were affected by fractures of the femoral neck. Males were 25% less likely to have hip fracture prior to arthroplasty. However, gender failed to foreground partial or total arthroplasty, because there were other variables that would better explain the outcome, comprising the joint´s bone structure of the joint, among others. In the case of duration in hospital, males were hospitalized for 2 days less (coeff.: -2.12) than females.

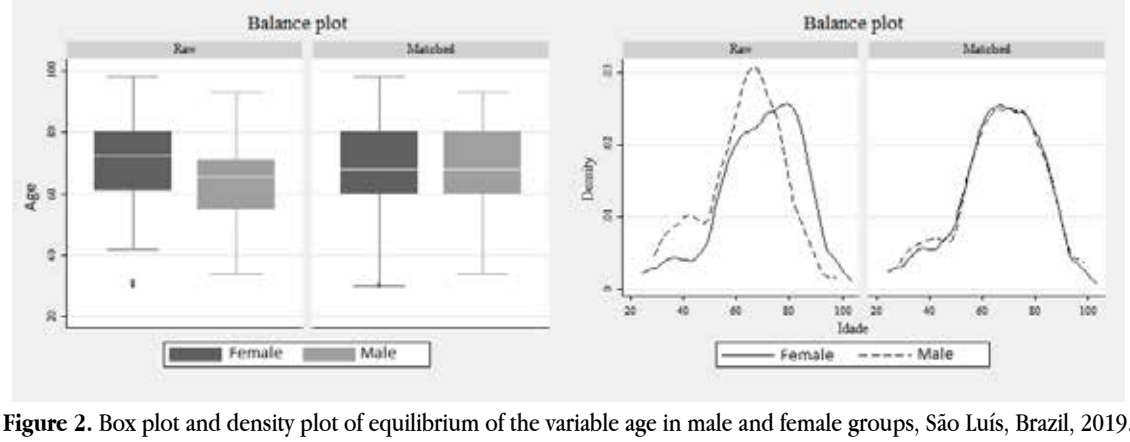


Figure 2. Box plot and density plot of equilibrium of the variable age in male and female groups, São Luís, Brazil, 2019.

It seems that gender provided a causal explanation with regard to duration of hospitalization. Equilibrium of variable age matching was verified by standardized mean differences (raw= -0.420; matched=0.009) and variance rates (raw= 0.887; matched=1.01). Age balancing was also verified by box plot and density graph (Figure 2). In fact, there was an excellent balance of groups for variable age ranking second to propensity score.

Table 4. Standard difference and rates of raw and matched variances in equilibrium of groups according to variable age, São Luís, Brazil, 2019

Variable	Standard differences		Variance rate	
	Raw	Matched	Raw	Matched
Age	-0.420	0.009	0.887	1.01

DISCUSSION

Current analysis revealed that age and gender varied significantly among clinical results. Females and males´ mean age were 69 years and 63 years old respectively, confirming international studies[18]. A study that analyzed 2.8 million THA in the USA between 2002 and 2013 detected that 55.8% of the population were 65 years of age or older and 54.6% were female[14]. The literature identifies women as those who most undergo THA surgery [19], perhaps due to their greater propensity to fall-caused fractures either because of decreasing bone mineral density or imbalance of the center of gravity caused by advanced

age. In fact, most women undergoing THA are older[20]. Contrastingly, one study reported a higher prevalence of osteoarthrosis in females[21].

It has been reported that females were affected in both hips (right and left) at the same proportion. This is due to greater female exposure to the two main causes of arthroplasties, or rather, fractures and osteoarthrosis[22]. The left hip was predominant in males, caused by osteoarthrosis. It may be hypothesized that the labor load and greater biomechanical overload on the left hemibody may be partly plausible explanations.

Worldwide reports on hip arthroplasty show that more replacements of the right hip are performed [23]. Since more than 85% of individuals are right-handed, there is an association between hemidominance and the affected side. A recent study[23] reported that there was a predominant 67.4% of people requiring unilateral hip arthroplasty, or rather, hip arthroplasty on the dominant side is more likely than on the contralateral hip. A Brazilian study corroborates this result, showing prevalence of the right side[24].

One may say that different mechanisms foreground the relationship between the affected hip and gender. An abnormal concentration of strength through the hip joint due to male occupation during their life time may explain the bone-muscular imbalance between the affected limb and the normal contralateral one[25]. Pre-existing diseases and scanty functional reserve worsen conditions[26].

Results revealed that males were mostly diagnosed with osteoarthrosis and, to a lesser extent, fracture of the femoral neck. This is due to the rupture of homeostatic balance caused by advanced age-caused failure in the joint´s repair mechanism [27] and also to occupational issues. A prevalence of fractures of the femoral neck was detected in females. Osteoporosis, obesity and falls are more serious, based on postmenopausal hormonal issues[28]. However, a Brazilian[9] and a North American[29] study differed from the above characteristics and detected that females are the group most affected by osteoarthrosis.

Although there was a significant association between gender and partial or total arthroplasty by bivariate analysis, the association disappeared when the causal role with propensity scores was investigated. Therefore, gender failed to explain the choice of arthroplasty type. Other more important criteria should be taken into account in the choice, such as the bone´s proximal situation, age, comorbidities and possible complications during surgery[19].

Results have revealed a hospitalization period -2.12 days for males when compared to females. Since a longer hospitalization period means greater costs, reducing hospitalization period is the aim of big Brazilian tertiary hospitals to reduce costs in the wake of limited resources[30].

Specialized literature insists that advanced age and female gender, coupled to factors related to comorbidities, are related to a longer hospitalization period and bad THA results[31]. Other factors featuring great impact interfere with the THA hospitalization stay, such as the number of procedures performed by the surgeon during surgery, patients´ previous conditions, rehabilitation and standardization of perioperative processes[4,32]. A retrospective study with about 10,000 arthroplasty cases (TAJ and THA) to evaluate the prevalence of causes related to discharge delay identified drains, delay in patient mobilization, preconditions of health and conditions acquired at admission are the main causes[32].

Over 64-years old, surgery duration, surgical risk score by the American Society of Anesthesiology (ASA) greater than or equal to 2, and comorbidities were the main risk factors for longer THA hospitalization period. Further, sociodemographic aspects also influenced the length of stay, or rather, low socioeconomic status patients and belonging to ethnic minorities contribute synergistically to age, comorbidities and in-hospital factors to increase hospitalization duration period[33].

According to Otero et al. [34] when a person who has undergone surgery is hospitalized for more than 3 days, there is an increase in clinical complications and a readmission within 30 days (11.02% for THA). However, when the patient is discharged on the same day of surgery, an increase in complications may occur within 30 days[34].

A systematic review published in 2019 underscored that people over 70 years old, females, body mass index (BMI) > 30 kg/m2, non-white ethnicity, classification of the American Society of Anesthesiology (ASA) > 2, prior to surgery, Charlson´s comorbidity index (CHF) > 0 and hemoglobin < 13 g/dl, prior to surgery, predict a longer hospitalization period and, consequently, with worse results for patients and higher costs for the institution[35].

Current study has several limitations that should be taken into consideration. Since it is a retrospective study in which some important variables for the better characterization of the population were unavailable, such as preoperative risk, the disease´s evolutionary degree that led to joint destruction (in cases of osteoarthrosis), control of surgery indication related to surgical procedure (type of approach and implanted materials). The study´s greatest strength is the sample of people who underwent arthroplasties and the statistical technique employed, which analyzed causal role and reduced selection bias. Further, DAG in the selection of variables reduced confounding bias.

CONCLUSION

Patient´s gender provided a causal relationship with impaired hip, previous diagnose and hospitalization period in THA. However, it did not show any direct relationship with arthroplasty type. Surgical strategies and rehabilitation should take into consideration the patient´s gender for equity in care and reduction in hospitalization period.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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