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ORIGINAL ARTICLE

Retrospective Study

Overweight and obesity in hip and knee arthroplasty: Evaluation of 6078 cases

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Abstract

AIM: To evaluate a possible association between the various levels of obesity and peri-operative characteristics of the procedure in patients who underwent endoprosthetic joint replacement in hip and knee joints.

METHODS: We hypothesized that obese patients were treated for later stage of osteoarthritis, that more conservative implants were used, and the intra- and perioperative complications increased for such patients. We evaluated all patients with body mass index (BMI) ≥ 25 who were treated in our institution from January 2011 to September 2013 for a primary total hip arthroplasty (THA) or total knee arthroplasty (TKA). Patients were split up by the levels of obesity according to the classification of the World Health Organization. Average age at the time of primary arthroplasty, preoperative Harris Hip Score (HHS), Hospital for Special Surgery score (HSS), gender, type of implanted prosthesis, and intra-and postoperative complications were evaluated.

RESULTS: Six thousand and seventy-eight patients with a BMI ≥ 25 were treated with a primary THA or TKA. Age decreased significantly ($P < 0.001$) by increasing obesity in both the THA and TKA. HHS and HSS were at significantly lower levels at the time of treatment in the super-obese population ($P < 0.001$). Distribution patterns of the type of endoprostheses used changed with an increasing BMI. Peri- and postoperative complications were similar in form and quantity to those of the normal population.

CONCLUSION: Higher BMI leads to endoprosthetic treatment in younger age, which is carried out at significantly lower levels of preoperative joint function.

Key words: Adiposity; Total knee arthroplasty; Total hip arthroplasty; Obesity; Overweight; Prosthesis

Core tip: Our study demonstrates that total hip arthroplasty and total knee arthroplasty can be performed in all stages of obesity with low perioperative risk. We have to mention that good preparation is indispensable. Co-morbities should be assessed and the set-up should be related to high weight. Sometimes special operation-tables, beds, and crutches are required. Higher body mass index leads to endoprosthetic treatment in younger age, which is carried out at significantly lower levels of preoperative joint function.

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INTRODUCTION

The prevalence of overweight patients is steadily increasing in the general population. 67.1 % of men and 53.0% of women in our country have a body mass index (BMI) ≥ 25 kg/m^2. 23.3% of men and 23.9% of women have a BMI ≥ 30 kg/m^2[1]. The data of the world's population are similar to this[2]. As defined by BMI, 1 of every 3 Americans is overweight[3]. It is known that obesity has a negative influence on the formation of osteoarthritis[4]. An increased BMI leads to an increased risk of needing a joint replacement. Waist circumference and waist-to-hip ratio were less strongly associated with this risk[5]. Several studies have examined the influence of obesity on the need for endoprosthetic joint replacement[6,7]. However, to our knowledge, there is no study that evaluated the influence of the respective stage of obesity in a monocentric setting with large number of cases. If a decision for an endoprosthetic joint replacement was made, the kind of implant for artificial hip and knee arthroplasty is up to the individual surgeon.

Obese patients with severe osteoarthritis, axis deviation, and ligamentous instability are a major challenge for the surgeon[8]. These patients often lack the ability of postoperative partial weight bearing. There is no study in modern literature that deals with the influence of obesity on the choice of the individual implant.

There are studies showing that obesity is associated with an increased risk of infection and impaired wound healing[9]. However, a large number of morbidly obese people seem to consider that the benefits outweigh the risks[10].

The aim of this study was to evaluate if there is an association between the various levels of obesity and peri-operative characteristics of the procedure in patients who underwent total hip arthroplasty (THA) and total knee arthroplasty (TKA). Furthermore, it should be issued if an increasing BMI has an influence on the choice of the implant by the individual surgeon and whether the intra-and perioperative complications are increased or not. We hypothesized that obese patients were treated with later stage of OA and more advanced stage implants like cemented THA and constrained TKA.

MATERIALS AND METHODS

We evaluated all patients with a BMI ≥ 25 kg/m^2 who were treated in the period from January 2011 to September 2013 in our institution for a primary THA or TKA. These patients were split up by stages of obesity according to the classification of the World Health Organization[2]. Data from the hospitals database were analyzed.

We evaluated the average age at time of primary arthroplasty. Furthermore data collection included the preoperative Harris Hip Score (HHS) for total hip arthroplasty[11], the Hospital for Special Surgery Score (HSS) for total knee arthroplasty[12], the gender, the type of implanted prosthesis, the comorbidities and the intra-and postoperative complications. The study was conducted according to the guidelines of the local ethics committee. Informed consent for this retrospective study was obtained from every single patient.

The data were processed with the statistical software package SPSS (version 20.0, SPSS Inc., Chicago, United States). Interference statistical analyses were performed for two independent samples using the Mann-Whitney *U* test. The Kruskall-Wallis test was used to check several independent samples. Multivariate analysis was performed to evaluate whether there is an independent association between the level of obesity, BMI, functional status (HHS/HSS), gender and age at THA/TKA. Logistic regression was performed to evaluate the association between BMI, gender, functional status and the used prosthesis type.

A power analysis was performed based on previously reported values of HHS and HSS following THA and TKA. It was determined that the available sample size was sufficient to detect a ten point difference in the scores between the groups with $\alpha = 0.05$ and a power of 0.95.

RESULTS

In the period from January 2011 to September 2013, 9742 primary hip or knee arthroplasties were performed in our institution. Six thousand and seventy-eight patients with a BMI ≥ 25 kg/m^2 were treated with a primary hip or knee arthroplasty (62.4 % of total number of primary THA and TKA).

Table 1 presents the distribution of patients to the different stages of overweight and obesity. The dissemination of comorbidities was comparable between the different stages (Table 2). The age in which an endoprosthetic treatment was necessary decreased significantly ($P < 0.001$) by increasing overweight and obesity in both the hip and knee arthroplasty. In the higher stages of obesity, both HHS and HSS were at significantly lower levels at the

Table 1 Distribution of patients to the different degrees of overweight and obesity

BMI (kg/m²)	25-29.9 total	(Overweight) percent	30-34.9 total	(Stage Ⅰ) percent	35-39.9 total	(Stage Ⅱ) percent	≥ 40 total	(Stage Ⅲ) percent	Total amount
THA	1920	60.5%	899	28.3%	285	9.0%	70	2.2%	3174
TKA	1394	48.0%	961	33.1%	432	14.9%	117	4.0%	2904
THA and TKA	3314	54.5%	1860	30.6%	717	11.8%	187	3.1%	6078

THA: Total hip arthroplasty; TKA: Total knee arthroplasty; BMI: Body mass index.

Table 2 Comorbidities in total hip arthroplasty and total knee arthroplasty

BMI (kg/m²)	25-29.9 total	(Overweight) percent	30-34.9 total	(Stage Ⅰ) percent	35-39.9 total	(Stage Ⅱ) percent	≥ 40 total	(Stage Ⅲ) percent
Anemia	498	15.00%	273	14.70%	106	14.80%	27	14.40%
Cancer diseases	9	0.30%	6	0.30%	3	0.40%	1	0.50%
Congestive heart failure	86	2.60%	48	2.60%	19	2.60%	5	2.70%
Chronic pulmonary disease	629	19.00%	353	19.00%	136	19.00%	36	19.30%
Coagulopathy	23	0.70%	13	0.70%	5	0.70%	1	0.50%
Depression	497	15.00%	279	15.00%	108	15.10%	28	15.00%
Diabetes	1100	33.20%	616	33.10%	238	33.20%	67	35.80%
Fluid and electrolyte disorder	230	6.90%	130	7.00%	50	7.00%	15	8.00%
Gastro esophageal reflux disease	63	1.90%	35	1.90%	14	2.00%	6	3.20%
Hypertension	2550	76.90%	1431	76.90%	553	77.10%	148	79.10%
Hypothyroidism	497	15.00%	279	15.00%	108	15.10%	30	16.00%
Liver disease	13	0.40%	10	0.50%	4	0.60%	1	0.50%
Obstructive sleep apnea	695	21.00%	409	22.00%	150	20.90%	44	23.50%
Paralysis	3	0.10%	2	0.10%	1	0.10%	0	0.00%
Peripheral vascular disease	30	0.90%	17	0.90%	6	0.80%	2	1.10%
Psychoses	46	1.40%	26	1.40%	10	1.40%	2	1.10%
Pulmonary circulation disorders	20	0.60%	11	0.60%	4	0.60%	1	0.50%
Renal failure	73	2.20%	39	2.10%	16	2.20%	4	2.10%
Rheumatoid arthritis/collagen vascular disease	93	2.80%	54	2.90%	20	2.80%	5	2.70%
Valvular heart disease	80	2.40%	45	2.40%	17	2.40%	6	3.20%

BMI: Body mass index.

time of prosthetic treatment compared to overweight or obese stage I patients ($P < 0.001$) (Tables 3 and 4).

A correlation between anthropometric data (gender, BMI, stages of overweight/obesity) and functional scores (HHS/HSS) could be shown with the strongest negative correlation between BMI and functional scores in TKA as well as in THA. A correlation between anthropometric data and age of arthroplasty could be shown with the strongest negative correlation between BMI and age of arthroplasty in TKA and HHS and age of arthroplasty in THA (Tables 5 and 6).

In all stages of obesity, the surgeons used a similar distribution pattern of the different types of hip prostheses. In the super-obese population, more cementless alternatives were used instead of fully cemented or hybrid prostheses (Tables 7 and 8).

In the knee replacement surgery, the surgeons used a similar distribution pattern of implants in the overweight and obese stage I patients. With increasing BMI more bicondylar surface replacements and less hinge prostheses or constrained condylar knees (long stem) were used. The use of unicondylar knee replacement declined with increasing BMI (Tables 9 and 10).

The peri-and postoperative complications were similar in form and quantity to those of the normal population (Tables 11 and 12).

DISCUSSION

Our study shows that the time of primary implantation of a total hip or total knee arthroplasty is significantly influenced by the stage of obesity. In our study, patients who have had a higher BMI needed endoprosthetic joint replacement at a younger age. It is noticeable that the primary implantation was carried out at significantly lower function scores (HHS, HSS) with increasing BMI. This suggests that super-obese patients were treated much more cautiously than overweight or normal weight patients. In higher stages of obesity, more cementless total hip arthroplasties were carried out than fully cemented or hybrid alternatives. An explanation for that could be the shorter time of surgery for cementless arthroplasty. This can sometimes become necessary in this high-risk population such as multimorbid patients. Obesity is associated with multiple comorbidities such as type Ⅱ diabetes and cardiovascular disease[13].

It is known that obese patients have a high risk of formation of osteoarthritis. Due to the high weight-

Table 3 Pre-total hip arthroplasty comparison of the different study groups

BMI (kg/m^2)	25-29.9 (Overweight)	30-34.9 (Stage Ⅰ)	35-39.9 (Stage Ⅱ)	≥ 40 (Stage Ⅲ)	*P* value
Gender (percent male)	961/959 (50.0%)	445/454 (49.5%)	121/164 (42.5%)	34/36 (48.6%)	
Age at the time of Arthroplasty (years)	65.8 ± 11.0	63.7 ± 11.0	62.6 ± 10.6	58.9 ± 10.2	< 0.001
Harris Hip Score	47.1 ± 12.5	44.8 ± 12.4	42.2 ± 13.1	37.7 ± 12.2	< 0.001
Weight (kilograms)	80.7 ± 9.8	94.4 ± 11.5	107.8 ± 12.8	125.9 ± 18.2	< 0.001

BMI: Body mass index.

Table 4 Pre-total knee arthroplasty comparison of the different study groups

BMI (kg/m^2)	25-29.9 (overweight)	30-34.9 (Stage Ⅰ)	35-39.9 (Stage Ⅱ)	≥ 40 (Stage Ⅲ)	*P* value
Gender (percent male)	596/798 (42.7%)	368/593 (38.3%)	116/316 (26.8%)	33/84 (28.2%)	
Age at the time of Arthroplasty (yr)	68.2 ± 9.7	65.9 ± 9.3	64.2 ± 9.2	62.8 ± 7.0	< 0.001
Hospital for Special Surgery Score	55.7 ± 13.1	54.2 ± 13.3	50.6 ± 12.9	49.3 ± 13.8	< 0.001
Weight (kg)	79.9 ± 9.9	92.9 ± 11.5	103.7 ± 13.3	119.6 ± 16.5	< 0.001

BMI: Body mass index.

Table 5 Relationships between age at total hip arthroplasty, Harris Hip Score, body mass index, stages of overweight/obesity and gender

	Age at THA Regression coefficient	*P* value	HHS Regression Coefficient	*P* value
BMI	-0.178 (-0.226 to -0.13)	< 0.001	-0.201 (-0.256 to -0.146)	< 0.001
HHS	-0.217 (-0.232 to -0.202)	< 0.001		
Gender	0.112 (-0.268 to 0.492)	< 0.001	-0.099 (-0.537 to 0.339)	< 0.001
Overweight	0.139 (-0.251 to 0.529)	< 0.001	0.148 (-0.301 to 0.597)	< 0.001
Stage Ⅰ	-0.098 (-0.529 to 0.333)	< 0.001	-0.099 (-0.594 to 0.396)	< 0.001
Stage Ⅱ	-0.110 (-0.786 to 0.566)	< 0.001	-0.125 (-0.901 to 0.651)	< 0.001
Stage Ⅲ	-0.116 (-1.427 to 1.195)	< 0.001	-0.127 (-1.631 to 1.377)	< 0.001
Age at THA			-0.215 (-0.415 to -0.195)	< 0.001

BMI: Body mass index; THA: Total hip arthroplasty; HHS: Harris Hip Score.

Table 6 Relationships between age at total knee arthroplasty, Harris Hip Score, body mass index, stages of overweight/obesity and gender

	Age at TKA Regression coefficient	*P* value	HSS Regression coefficient	*P* value
BMI	-0.224 (-0.263 to 0.185)	< 0.001	-0.152 (-0.208 to 0.096)	< 0.001
HSS	-0.118 (-0.132 to -0.104)	< 0.001		
Gender	0.076 (-0.294 to 0.446)	< 0.001	-0.128 (-0.641 to 0.385)	< 0.001
Overweight	0.184 (-0.175 to 0.543)	< 0.001	0.115 (-0.39 to 0.62)	< 0.001
Stage Ⅰ	-0.129 (-0.529 to 0.271)	< 0.001	-0.063 (-0.623 to 0.497)	< 0.001
Stage Ⅱ	-0.181 (-0.715 to 0.353)	< 0.001	-0.138 (-0.885 to 0.609)	< 0.001
Stage Ⅲ	-0.130 (-1.051 to 0.791)	< 0.001	-0.100 (-1.386 to 1.186)	< 0.001
Age at TKA			-0.118 (-0.144 to 0.092)	< 0.001

BMI: Body mass index; TKA: Total knee arthroplasty; HHS: Harris Hip Score.

Table 7 Distribution pattern of implanted total hip arthroplasty

BMI (kg/m^2)	25-29.9 total	(Overweight) %	30-34.9 total	(Stage Ⅰ) %	35-39.9 total	(Stage Ⅱ) %	≥ 40 total	(Stage Ⅲ) %
Cementless short stem	535	27.9	253	28.10	76	26.7	20	28.6
Cementless standard stem	585	30.5	297	33.00	109	38.2	27	38.6
Hybrid (cemented/cementless)	43	2.2	22	2.40	8	2.8	3	4.3
Cemented THA	757	39.4	327	36.40	92	32.3	20	28.6
Total amount	1920		899		285		70	

THA: Total hip arthroplasty; BMI: Body mass index.

Table 8 Relationships between preferred prosthesis type, age at total hip arthroplasty, Harris Hip Score, body mass index, stages of overweight/obesity and gender

	Cementless short stem (Reference)		Cementless standard stem (Reference)		Hybrid (cemented/cementless) (Reference)		Cemented THA (Reference)	
	Regression coefficient B	*P* value	Regression coefficient B	*P* value	Regression coefficient B	*P* value	Regression coefficient B	*P* value
Cementless short stem								
BMI			-0.003 (-0.015 to 0.009)	0.826	-0.025 (-0.054 to 0.004)	0.389	0.002 (-0.013 to 0.017)	0.898
Age at THA			0.007 (0.002 to 0.012)	0.132	-0.061 (-0.075 to -0.047)	< 0.001	-0.171 (-0.179 to -0.163)	< 0.001
Gender			0.609 (0.513 to 0.705)	< 0.001	0.989 (0.737 to 1.241)	< 0.001	1.134 (1.023 to 1.245)	< 0.001
HHS			0.019 (0.015 to 0.023)	< 0.001	0.043 (0.033 to 0.053)	< 0.001	0.042 (0.037 to 0.047)	< 0.001
Cementless standard stem								
BMI	0.003 (-0.117 to 0.015)	0.826			-0.023 (-0.052 to 0.006)	0.432	0.004 (-0.010 to 0.018)	0.746
Age at THA	-0.007 (-0.012 to -0.002)	0.132			-0.068 (-0.082 to -0.054)	< 0.001	-0.178 (-0.185 to -0.171)	< 0.001
Gender	-0.609 (-0.705 to -0.513)	< 0.001			0.380 (0.13 to 0.63)	0.128	0.525 (0.419 to 0.631)	< 0.001
HHS	-0.019 (-0.023 to -0.015)	< 0.001			0.024 (0.014 to 0.034)	< 0.05	0.023 (0.019 to 0.027)	< 0.001
Hybrid (cemented/cementless)								
BMI	0.025 (-0.004 to 0.054)	0.389	0.023 (-0.006 to 0.052)	0.432			0.027 (-0.002 to 0.056)	0.353
Age at THA	0.061 (0.047 to 0.075)	< 0.001	0.068 (0.054 to 0.082)	< 0.001			-0.110 (-0.125 to -0.095)	< 0.001
Gender	-0.989 (-1.241 to -0.737)	< 0.001	-0.380 (-0.63 to -0.13)	0.128			0.145 (-0.105 to 0.395)	0.561
HHS	-0.043 (-0.053 to -0.033)	< 0.001	-0.024 (-0.034 to -0.014)	< 0.05			-0.001 (-0.011 to 0.009)	0.926
Cemented THA								
BMI	-0.002 (-0.017 to 0.013)	0.898	-0.004 (-0.018 to 0.010)	0.746	-0.027 (-0.056 to 0.002)	0.353		
Age at THA	0.171 (0.163 to 0.179)	< 0.001	0.178 (0.171 to 0.185)	< 0.001	0.110 (0.095 to 0.125)	< 0.001		
Gender	-1.134 (-1.245 to -1.023)	< 0.001	-0.525 (-0.631 to -0.419)	< 0.001	-0.145 (-0.395 to 0.105)	0.561		
HHS	-0.042 (-0.047 to -0.037)	< 0.001	-0.023 (-0.027 to -0.019)	< 0.001	0.001 (-0.009 to 0.011)	0.926		

TKA: Total knee arthroplasty; HHS: Harris Hip Score; BMI: Body mass index.

Table 9 Distribution pattern of implanted total knee arthroplasty

BMI (kg/m^2)	25-29.9 total	(Overweight) percent	30-34.9 total	(Stage Ⅰ) percent	35-39.9 total	(Stage Ⅱ) percent	≥ 40 total	(Stage Ⅲ) percent
Bicondylar surface replacement	1246	89.40%	878	91.40%	403	93.30	116	99.10%
Long stem	60	4.30%	43	4.50%	22	5.00	1	0.90%
PFJ	10	0.70%	5	0.50%	3	0.70	0	0.00%
Unicondylar knee replacement	78	5.60%	35	3.60%	4	0.90	0	0.00%
Total amount	1394		961		432		117	

BMI: Body mass index.

related load on the skeleton, obese patients often have good bone quality. Yet in obese patients who have a lack of physical activity and sometimes hormonal disbalances, a poorer bone quality is frequently found. However, these patients often do not manifest complaints due to their low level of activity[14].

In the knee replacement surgery in stage Ⅲ obese patients, surgeons used almost no hinge prostheses or constrained condylar knees. Super-obese patients with a distribution pattern of pitfalls such as severe axis deviations and ligamentous instabilities are often preoperatively convinced to lose weight. Studies have shown that weight loss is effective for symptomatic relief in obese subjects with knee osteoarthritis independently of joint damage severity[15]. In this patient group, the risk of complications following joint replacement appears to be lower if bariatric surgery is performed first[16].

Isolated medial gonarthrosis seems to be much less common in this group of patients. Due to this fact, unicondylar knee replacements or osteotomies have not been performed at all in the super-obese population at our institution in this time period. Some studies mention that there is a significant increased risk for complications in the super-obese population[17,18]. Some authors determined that there is no increased risk in this population[19,20]. In our institution the peri-and postoperative complication rate was not increased significantly by increasing BMI. Sometimes total hip arthroplasties in obese patients were perceived by the surgeon to be significantly more difficult. However, in this cases neither increased risk of complications, operation time, or blood loss, nor suboptimal implant placements have been observed[21].

We have to mention that good preparation is indispensable. Co-morbities should be assessed and the set-up should be related to high weight. Sometimes special operation-tables, beds, and crutches are required. The long-time outcome after the duration of years will be interesting. Obese patients showed greater improvement according to functional outcome compared with non-morbidly obese patients. Morbid obesity does not affect 1-year outcomes in patients who have had a total knee arthroplasty[22]. TKA benefits were realized at all stages

Table 10 Relationships between preferred prosthesis type, age at total hip arthroplasty, Harris Hip Score, body mass index, stages of overweight/obesity and gender

	Bicondylar surface replacement (Reference)		Long stem (Reference)		PFJ (Reference)		Unicondylar knee replacement (Reference)	
	Regression coefficient B	*P* value	Regression coefficient B	*P* value	Regression coefficient B	*P* value	Regression coefficient B	*P* value
Bicondylar surface replacement								
BMI			0.023 (0.001 to 0.045)	0.299	0.085 (0.023 to 0.147)	0.172	0.133 (0.104 to 0.162)	< 0.001
Age at THA			-0.046 (-0.057 to -0.035)	< 0.001	0.158 (0.131 to 0.185)	< 0.001	0.043 (0.033 to 0.053)	< 0.001
Gender			-0.097 (-0.307 to 0.113)	0.642	0.447 (-0.06 to 0.954)	0.378	-0.277 (-0.477 to -0.077)	0.167
HSS			0.070 (0.063 to 0.077)	< 0.001	-0.056 (-0.077 to -0.035)	< 0.001	-0.047 (-0.056 to -0.038)	< 0.001
Long stem								
BMI	-0.023 (-0.045 to -0.001)	0.299			0.062 (-0.004 to 0.128)	0.348	0.110 (0.074 to 0.146)	< 0.05
Age at THA	0.046 (0.035 to 0.057)	< 0.001			0.204 (0.175 to 0.233)	< 0.001	0.089 (0.074 to 0.104)	< 0.001
Gender	0.097 (-0.113 to 0.307)	0.642			0.545 (-0.002 to 1.092)	0.320	-0.179 (-0.466 to 0.108)	0.532
HSS	-0.070 (-0.077 to -0.063)	< 0.001			-0.125 (-0.148 to -0.102)	< 0.001	-0.117 (-0.128 to -0.106)	< 0.001
PFJ								
BMI	-0.085 (-0.147 to -0.023)	0.172	-0.062 (-0.128 to 0.004)	0.348			0.049 (-0.019 to 0.117)	0.472
Age at THA	-0.158 (-0.185 to -0.131)	< 0.001	-0.204 (-0.233 to -0.175)	< 0.001			-0.115 (-0.143 to -0.087)	< 0.001
Gender	-0.447 (-0.954 to 0.06)	0.378	-0.545 (-1.092 to 0.002)	0.320			-0.724 (-0.1262 to -0.186)	0.178
HSS	0.056 (0.035 to 0.077)	< 0.001	0.125 (0.102 to 0.148)	< 0.001			0.008 (-0.015 to 0.031)	0.711
Unicondylar knee replacement								
BMI	-0.133 (-0.162 to -0.104)	< 0.001	-0.110 (-0.146 to -0.074)	< 0.05	-0.049 (-0.117 to 0.019)	0.472		
Age at THA	-0.043 (-0.053 to -0.033)	< 0.001	-0.089 (-0.104 to -0.074)	< 0.001	0.115 (0.087 to 0.143)	< 0.001		
Gender	0.277 (0.077 to 0.477)	0.167	0.179 (-0.108 to 0.466)	0.532	0.724 (0.186 to 1.262)	0.178		
HSS	0.047 (0.038 to 0.056)	< 0.001	0.117 (0.106 to 0.128)	< 0.001	-0.008 (-0.031 to 0.015)	0.711		

THA: Total hip arthroplasty; HHS: Harris Hip Score; BMI: Body mass index; PFJ: Patello-femoral joint.

Table 11 Surgical complications in total hip arthroplasty

BMI (kg/m²)	25-29.9 total	(Overweight) percent	30-34.9 total	(Stage Ⅰ) percent	35-39.9 total	(Stage Ⅱ) percent	≥ 40 total	(Stage Ⅲ) percent
Femoral fracture	8	0.2%	1	0.1%				
Femoral perforation	2	0.1%						
Trochanteric fracture	4	0.1%			2	0.3%		
Acetabular fracture					1	0.1%		
Acetabular perforation	11	0.3%	6	0.3%	3	0.4%	1	0.5%
Vascular leasion	1	0.0%						
Other complications	1	0.0%	2	0.1%				

BMI: Body mass index.

Table 12 Surgical complications in total knee arthroplasty

BMI (kg/m²)	25-29.9 total	(Overweight) percent	30-34.9 total	(Stage Ⅰ) percent	35-39.9 total	(Stage Ⅱ) percent	≥ 40 total	(Stage Ⅲ) percent
Femoral fracture			1	0.1%				
Femoral perforation	4	0.1%	2	0.1%	2	0.3%	1	0.5%
Condylar fracture	3	0.1%	1	0.1%				
Rupture of the patellar tendon					1	0.1%	1	0.5%
Vascular leasion	2	0.1%						
Nerval leasion	1	0.0%						
Wound healing disorders			1	0.1%				
Other complications	3	0.1%	4	0.2%	2	0.3%		

BMI: Body mass index.

of BMI, but at BMI ≥ 40 kg/m^2, more rehabilitation and monitoring are recommended because of more patellar radiolucencies, poorer hamstring and quadriceps conditioning, and more patellofemoral symptoms[23].

There are limitations of this study. The multivariate analysis is limited by a limited availability of information on potential confounding factors and by a cross-sectional nature of the sample. Furthermore, there should be a long-time follow-up of our study population. The associated data should also be part of future publications.

We conclude that both the primary hip and knee arthroplasty can be performed in all stages of obesity with a relatively low perioperative risk. A higher BMI leads to an endoprosthetic joint replacement at earlier times, which, however, is only carried out at significantly lower levels of joint function.

COMMENTS

Background

The prevalence of overweight patients is steadily increasing in the general population. It is known that obesity has a negative influence on the formation of osteoarthritis. An increased body mass index leads to an increased risk of needing a joint replacement.

Research frontiers

To the knowledge, there is no study that evaluated the influence of the respective stage of obesity in a monocentric setting with large number of cases.

Innovations and breakthroughs

Six thousand and seventy-eight patients with a body mass index (BMI) ≥ 25 kg/m^2 were treated with a primary total hip arthroplasty (THA) or total knee arthroplasty (TKA). Age decreased significantly (P < 0.001) by increasing obesity in both the THA and TKA. Harris Hip Score (HHS) and Hospital for Special Surgery Score (HSS) were at significantly lower levels at the time of treatment in the super-obese population (P < 0.001). Distribution patterns of the type of endoprostheses used changed with an increasing BMI. Peri- and postoperative complications were similar in form and quantity to those of the normal population.

Applications

We conclude that both the primary hip and knee arthroplasty can be performed in all stages of obesity with a relatively low perioperative risk. A higher BMI leads to an endoprosthetic joint replacement at earlier times, which, however, is only carried out at significantly lower levels of joint function. Good preparation is indispensable.

Terminology

According to the classification of the World Health Organization overweight is defined as BMI 25-29.9 kg/m^2, stage I obesity is defined as BMI 30-34.9 kg/m^2, stage II obesity is defined as 35-39.9 kg/m^2 and stage III obesity is defined as BMI ≥ 40 kg/m^2. HHS and Hospital for HSS are used to measure function in patients suffering from osteoarthritis of the hip or the knee, respectively.

Peer review

This retrospective study, conducted at a single medical center with high volume of total joint arthroplasty, showed some interesting findings. The study was well conducted with detailed data analysis. The conclusion is validated.

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