Possible risk factors for acute and chronic deep periprosthetic joint infections in primary total knee arthroplasty. Do BMI, smoking, urinary tract infections, gender, and ASA classification have an impact?

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ABSTRACT

Purpose: Aim of this retrospective study was to evaluate the impact of the patient related factors body mass index (BMI), urinary tract infection, current smoking, gender, and American Society of Anesthesiologists (ASA) classification on the incidence of acute and chronic deep periprosthetic joint infections (PJI) in total knee arthroplasty (TKA).

Methods: All patients undergoing revision surgery for a deep PJI of primary TKA between July 2012 and December 2016 were included in this study. All relevant data was collected from the medical records. Acute deep PJI was defined when PJI was diagnosed within the first 6 weeks after primary TKA, chronic PJI was defined when patients demonstrated PJI later than 6 weeks after primary TKA.

Results: A total of 57 patients was included in this study with 13 cases of acute PJI and 44 of chronic PJI. Overweight patients (BMI > 25 kg/m^2) represent a significantly larger proportion in both PJI groups ($p < 0.05$). Current smokers had an significantly increased risk for acute and chronic PJI ($p < 0.05$). In the acute PJI group 46.2% patients had an postoperative urinary tract infection.

Conclusion: An elevated BMI (> 25 kg/m^2), current smoking and urinary tract infection are possible risk factors for acute and chronic deep PJI. After primary TKA screening for urinary tract infection is recommendable to prevent predominantly acute deep PJI.

1. Introduction

Total Knee Arthroplasty (TKA) is one of the most common elective orthopedic surgical procedures.[1] In some cases complications necessitate revision surgery and among these cases many overweight patients are included.[2,3] The exact relationship between patient related factors and the outcome of TKA remains unclear, however an association of lower functional scores in patients with BMI > 30 kg/m^2 has been presented.[3] The association between obesity and an increase in the risk for periprosthetic joint infections (PJI) after primary TKA has been displayed in various studies[2–4] and some studies have defined a BMI cutoff that divides Low-risk from High-risk patient for PJI after TKA.[3] Si et al. found higher incidences of PJI in patients with BMI > 40 kg/m^2.[3]

PJI is a deleterious complication of TKA that may be influenced by numerous patient related factors.[4] Besides others, male gender is related with an increased risk for PJI.[1,5] In a meta-analysis Kunutsor et al.

demonstrated[1] an increased risk in smokers and Claus et al.[6] found a relationship between ASA grading and postoperative risk for PJI in TKA.

Aim of this study was to evaluate the impact of the patient related factors BMI, history of current smoking, gender, history of current urinary tract infection, and ASA grading on the risk of PJI after primary TKA.

2. Material and methods

The local ethics committee approved this retrospective study. All patients undergoing revision surgery for a deep PJI of primary TKA at a single institution between July 2012 and December 2016 were included in this study. Preoperatively, in all patients blood testing and a joint fluid aspiration were performed. According to the classification of the Musculoskeletal Infection Society and as reported by Schiffner et al.[7] a

deep PJI was assumed when three of the following four abnormalities were present: elevated CRP (> 1 mg/dl), synovial WBC count greater than 3000 cells/μl, synovial neutrophil percentage above 65%, or bacterial growth from two synovial aspirate cultures.[8] Additionally, blood testing for WBC count was performed. Joint fluid aspiration was achieved under aseptic conditions in an operating room and incubated in aerobic and anaerobic blood culture bottles. In cases of negative joint fluid aspiration in combination with two positive other findings a repeat aspiration was performed one month later. As a retrospective control, five periprosthetic soft tissue samples were obtained in all cases during the initial revision surgery for microbiological analysis. For each patient included in this study the following data was collected from the medical record: gender, body mass index (BMI), ASA grading, history of current urinary infection, time between the primary arthroplasty and revision surgery, CRP (mg/dl), results from synovial fluid analysis (WBC, neutrophil %), results from the synovial fluid cultures, and microbiological analysis of the intraoperative tissue. Acute deep PJI was stated for patients with diagnosis PJI within the first 6 weeks after primary TKA according to Tsukuiama.[9] An Infection was classified chronic deep when PJI occurred later than 6 weeks after primary TKA.[9] For statistical analysis Kruskal-Wallis non-parametric test followed by the post-hoc Dunn's test and the chi-squared test was used to compare categorical variables using SPSS software pack (version 23, IBM, New York, USA). P value < 0.05 was considered for statistic significance.

3. Results

A total of 57 patients with diagnosis of PJI in primary TKA were included in this study. This involved 13 acute deep PJI and 44 chronic deep PJI. The demographic data is presented in Table 1.

There were no significant differences in gender distribution in either group ($p > 0.05$). Furthermore, no significant difference in the mean BMI and age were seen between the acute and chronic groups ($p > 0.05$). In both groups the majority of patients had a history of current smoking without significant differences between the groups ($p > 0.05$). The mean time between primary TKA and revision surgery was 28.2 (± 5.8) days in acute PJI and 5.38 (± 2.4) years in chronic PJI. Patients diagnosed with acute PJI had a significantly higher CRP compared to the chronic PJI group ($p < 0.05$). In both groups the majority of patients had an abnormal weight (BMI > 25 kg/m^2). The percentage of normal weight patients was significantly lower and the rate of obese patients significantly higher in the acute group ($p < 0.05$, Table 2.). No patient in either groups exhibited a BMI > 35 kg/m^2. In the acute group 6 patients (46.2%) had an postoperative urinary tract infection.

A further evaluation of the ASA grading in acute deep PJI and chronic deep PJI following TKA was carried out in Table 3. There were no significant impact of the ASA grading in either groups. ($p > 0.05$).

Table 1
Patients characteristics, $\pm$ SD.

	acute	chronic
n	13	44
age (years)	67.07 ± 7.9	73.8 ± 10.8
BMI (kg/m^2)	27.1 ± 2.6	28.2 ± 3.1
women	5	21
men	8	23
Current smokers	9 (69.2%)	35 (79.5%)
whitebloodcells	30164 (range	12466 (range
(synovialfluid)	3865–67625)	3273–25527)
CRP (mg/dl)	8.4 (± 2.8)	1.8(± 1.7)
Urinary tract infection	6 (46.2%)	3 (6.8%)

Table 2
BMI distribution.

	acute PJI	chronic PJI
	13	44
normal	1(7.7%)	14(31.8%)
BMI (19–24.9 kg/m^2)		
Overweight	8(61.5%)	22(50%)
BMI (25–29.9 kg/m^2)		
Obese I	4 (30.8%)	8(18.2%)
BMI (30–34.9 kg/m^2)		

Table 3
ASA score distribution.

ASA score	acute PJI	chronic PJI
	13	44
I	3(23%)	12(27%)
II	7(54%)	23(52%)
III	3(23%)	9(20%)

4. Discussion

PJI is a major complication in TKA implying deleterious consequences for affected patients.[10] Reducing the incidence of PJI following TKA necessitates detailed understanding of the influencing patient related factors Previous studies have shown higher rates of PJI after TKA in obese patients.[2–4] The current analysis demonstrates significant differences in the occurrence of deep PJI in TKA between normal weight patients BMI (< 25 kg/m^2) with PJI and patients with PJI with elevated BMI (BMI > 25 kg/m^2). In accordance to these results Electricwala et al.[2] displayed an increase in the risk of deep PJI after TKA at a BMI higher than 25 kg/m^2. In the current study patients with a BMI > 25 kg/m^2 represent a significantly larger proportion in both the acute and chronic group ($p < 0.05$). In a meta-analysis performed by Si et al.[3] patients with a BMI above 30 kg/m^2 suffered higher revision rate after TKA. However, with a cut-off level of 40 kg/m^2 the authors define a threshold from which patients are at higher risk of developing a deep infection. Also, Chen et al.[11] reported a BMI above 30 kg/m^2 being associated with higher incidences of deep infections after TKA. The current analysis shows an increased possibility of acute and chronic deep PJI of a BMI threshold level of 25 kg/m^2. In Germany the average preoperative BMI in patients with knee osteoarthritis receiving TKA was 30 kg/m^2 in 2017.[12]

It has previously reported that male gender is related to an increase in the risk of PJI in primary TKA.[4,5,13] However, this study does not show an impact of gender on acute and chronic PJI. One possible reason for this discrepancy could be the relatively small sample size of this study.

We found a significantly higher rate of current smokers compared to non-smokers ($p < 0.05$) in the acute as well as the chronic group. These findings are in line with results from a meta-analysis by Kunutsor et al.[1] in which smokers had an increased risk of PJI in primary TKA compared to non-smokers. The most likely explanation for this correlation is the vasoconstriction effectuated by nicotin that delaying wound healing.[1] Also, smoking diminishes local perfusion by its promotion of artherosclerosis.[1] The resulting tissue hypoxia increases the risk for deep PJI in TKA.

When analyzing the ASA grading as a possible risk factor for PJI in our study no statistically significant differences ($p > 0.05$) were found in either group. These results are in line with Jung et al.,[4] who reported the ASA grading not to be of influence on the risk of PJI in primary TKA. However, in our study postoperative urinary tract infection was found to be a risk factor for acute deep PJI in primary TKA. In the acute group 46.2% patients had an postoperative urinary tract infection. In an analysis by Pulido et al.[14] urinary tract infection were associated with

an increased risk of the development of PJI within the first year after TKA.

There are limitations of this study, such as the small sample size and the retrospective study design. Finally, a limitation of this study is the lack of a control group. Further studies in Germany are needed to show the impact of patient related risk factors.

5. Conclusion

An elevated BMI and current smoking are risk factors for acute and chronic deep PJI. We have seen a BMI threshold level of 25 kg/m^2 of which the risk for PJI increases. Also urinary tract infection was found to be a possible risk factor for PJI in primary TKA. This mandates frequent screening and appropriate treatment for urinary tract infection after primary TKA. These findings are important for the development of prevention strategies for PJI after TKA.

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Declaration of competing interest

None.

Acknowledgment

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