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Complications - Other

Vascular Calcifications on the Preoperative Radiograph: Predictor of Ischemic Complications in Total Knee Arthroplasty?

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ABSTRACT

Background: Vascular calcifications seen on the preoperative radiograph of patients scheduled for total knee arthroplasty (TKA) are intuitively seen as a risk factor for ischemic complications though there is no empiric evidence to support this assumption. The aim of this study was the correlation of perioperative ischemic complications and vascular calcifications of patients undergoing TKA.
Methods: In this retrospective analysis, all 825 patients who had undergone primary TKA in the period 2009-2011 with intraoperative use of a tourniquet were included. Patients with pathologic pulse status and history of vascular intervention were excluded. Vascular calcifications seen on the preoperative radiograph were classified as intimal-type and medial-type calcifications and were correlated to perioperative ischemic complications.
Results: Vascular calcifications were seen in 268 patients (medial type: n = 54, intimal type: n = 214). Major ischemic complications such as arterial thrombosis were seen in 2 patients, one of them with intimal-type calcifications and one without (complication rate 0.5% vs 0.2%, $P = .715$). The rate of minor ischemic complications such as protracted wound healing was significantly elevated in patients with intimal-type calcifications (6.1%) when compared to patients with medial-type calcifications (1.9%) and those without (1.6%, $P = .003$) even when multiple regression analysis was performed taking into account 2 potential influencing factors "age" and "diabetes mellitus" ($P = .008$).
Conclusion: Owing to the significantly increased risk of ischemic complications in patients with intimal-type calcifications undergoing TKA, we recommend high alertness to the presence of calcifications on preoperative radiographs, careful intraoperative soft tissue management, and postoperative monitoring of the vascular status.

Vascular perioperative complications in total knee arthroplasty (TKA) are rare; the incidence ranges between 0.08% [1] and 0.2 % [2,3]. Ischemic complications are both the most common vascular complications (56%-60% of total complication rate [2,4]) and the most dangerous. Acute ischemic complications may lead to compartment syndrome in up to 33% [2] and limb amputation in up to 22% [5] and may even prove fatal [4]. Although cases of acute arterial occlusion in patients without preexisting occlusive disease have been reported in literature [6], the most common cause of ischemic complications is thought to be acute exacerbation of chronic limb ischemia due to blunt pressure of retractors or reduced blood flow during surgery. Thus, several algorithms of vascular diagnostic workup before performing TKA have been developed mainly based on expert opinion to prevent ischemic complications [3,7,8]. There is general agreement that the intraoperative use of a tourniquet should be dispensed with if calcifications of the femoral artery are seen on preoperative radiographs [3,7,8]. These recommendations do not distinguish between intimal or medial artery calcifications.

The use of a tourniquet is controversially discussed in TKA: Although the risk of thromboembolism is significantly higher when a tourniquet is used [9], recent meta-analysis studies have shown

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that intraoperative blood loss and operating time is significantly lower [9-12]. Apart from that, the bloodless intraoperative field caused by the tourniquet considerably facilitates cement application [13] which is considered a crucial factor in long-term stability of TKA. Owing to this advantage of the tourniquet in TKA, the recommendation mentioned previously is frequently disregarded in clinical practice: In a survey among 107 surgeons of the British Association for the Surgery of the Knee, only 55% claim that they dispense with a tourniquet if calcifications of the femoral artery are seen on preoperative radiographs [14].

In an attempt to overcome this uncertainty concerning the significance of intimal or medial artery calcifications seen on the preoperative radiograph, we performed a retrospective statistical analysis of ischemic complications of 825 consecutive patients with or without calcifications of the femoral artery who had undergone TKA with intraoperative use of a tourniquet in our institution.

Material and Methods

We analyzed the perioperative course of all 848 patients who had undergone primary TKA with a standard, unconstrained implant in our institution between 01/2009 and 12/2011. Surgery was performed by one of five experienced orthopedic surgeons or under their direct supervision. Patients were excluded from the study if they had had previous vascular surgery or intervention (n = 7), if they had no palpable peripheral pulse (n = 1), if axis deviation or flexion contracture exceeded 10° (n = 6), or if TKA had been performed without using a tourniquet (n = 10). According to these criteria, 825 patients were included in our study.

Mean age was 70.0 ± 8.6 years; 272 patients were male and 553 patients female. Surgery was performed on the right side in 423 cases and on the left side in 402 cases. A history of diabetes was noted in 171 patients, 427 patients were obese (body mass index >30), and 149 patients had a history of coronary or cerebral occlusive disease.

Preoperative radiographs of the knee were available in all cases and were screened for calcifications of the femoral and/or popliteal artery. Calcifications were classified according to Lehto et al [15] and Orr et al [16] as medial or intimal: Medial artery calcifications are characterized by 2 uniform fine-grained parallel lines similar to railroad tracks, whereas intimal artery calcifications typically present as irregular, patchy, or plaque-like dense clumps [15,16]. Radiographic evaluation was performed by an orthopedic surgeon blinded to the clinical course of the patients.

Ischemic complications occurring intraoperatively and postoperatively within the patients' hospital stay - i.e. the postoperative period of observation - were noted. “Minor ischemic complications” were defined as complications such as protracted wound healing, wound necrosis, or pressure-induced necrosis of toes, heel, or foot without threat for the patients' life or limb. Protracted wound healing was classified as “ischemic complication” as a pathologic vascular status is one of the reasons for impaired wound healing or soft tissue defects after TKA [17]. The term “major ischemic complications” included more severe complications such as compartment syndrome or acute limb ischemia that might result in amputation of the lower limb and even prove lethal.

For statistical analysis, the Statistical Package for Social Sciences (SPSS Inc, IBM, version 19) was used. Statistical advice was gained before the planning of the study. Continuous variables were summarized as mean ± standard deviation. Percentages were rounded off to the first decimal. For the analysis of nominal variables, crosstables and Pearson's chi-square test or, if applicable, Fisher's exact test was used, and for the analysis of continuous variables, analysis of variance was used. Probability value of <.05 was considered to indicate statistical significance. For analysis of statistical power and of the required sample size, we used the free software G*Power, version 3.1.3.

Results

Calcifications of the femoral and/or popliteal artery were seen in 268 out of 825 cases (medial: n = 54, intimal: n = 214, see Fig. 1); 106 out of 214 patients with intimal lesions had very small lesions consisting of only 1 or 2 plaques that might easily be overlooked on the preoperative radiograph. Demographic data of all 3 groups are shown in Table 1. We did not find a statistically significant difference of intraoperative blood loss and operating time when comparing all 3 groups. However, there was a significant difference between the groups with regard to the patients' age, the percentage of male patients, the duration of their hospital stay, the presence of diabetes mellitus, obesity, and history of coronary or cerebral occlusive disease.

We found major ischemic complications in 2 cases (0.2 %): The first case was a 50-year-old female without calcifications of the femoral artery who had undergone several attempts at anterior cruciate ligament reconstruction before TKA. Occlusion of the popliteal artery and compartment syndrome were seen on the first postoperative day and resulted in immediate thrombectomy of the popliteal artery and fasciotomy as well as partial peroneal palsy. The second case was a 75-year-old male patient with 10° varus deformity and 10° flexion contracture of the knee; intimal artery calcifications of the femoral artery were seen on preoperative radiographs. Occlusion of the popliteal artery was seen few hours after surgery and was treated immediately by thrombectomy and fasciotomy. Nevertheless, persisting peroneal palsy and hallux amputation for gangrena could not be avoided. Although the rate of major ischemic complications was elevated in the patient group with intimal artery calcifications (1 of 214 = 0.5%) when compared to those with medial-type calcifications (0 of 54 = 0%) or those without calcifications (1 of 557 = 0.2%), on statistical analysis, we found no significant difference between these groups on Pearson's chi-square test ($P = .715$, see Table 2). Post hoc power analysis showed a β error of 0.94; on sample size analysis, we found that a study group of 35,256 patients would have been needed to achieve a sufficient statistical power $1 - \beta > 0.8$.

Minor complications were seen in 23 patients (2.8%) and included protracted wound healing and necrosis of the wound of varying size with need for further surgical intervention in 7 cases. In 6 cases, revision surgery included excision of the necrosis and suture, whereas in 1 case, a gastrocnemius muscle transfer was necessary to cover the soft tissue defect. The rate of minor ischemic complications was considerably elevated in the patient group with intimal artery calcifications (13 of 214 = 6.1%) when compared to those with medial artery calcifications (1 of 54 = 1.9%) or those without calcifications (9 of 557 = 1.6%); on statistical analysis, we found a highly significant difference between these groups on Pearson's chi-square test ($P = .003$, see Table 3). Even among those patients with minimal intimal artery calcifications with only 1 or 2 plaques, complication rate was significantly elevated (5 of 106 = 4.7%) when compared to those with medial artery calcifications or those without ($P = .005$, Pearson's chi square).

We conducted multiple logistic regression analysis to determine if this association between minor complications and calcifications was independent of age and the presence of diabetes mellitus. Again, we found a significantly higher risk of minor ischemic complications in the patients with intimal artery calcifications when compared to those without calcifications ($P = .008$, see Table 4).