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Original Article

The use of tourniquet during total knee replacement in patients with and without popliteal artery calcification☆

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ABSTRACT

Objective: Identify the clinical and surgical complications associated with the use of a tourniquet in total knee arthroplasty in patients with or without calcification of the popliteal artery.

Methods: The study was performed retrospectively, analyzing 58 patients with calcification of the popliteal artery and 57 patients as a control group.

Results: The case group patients were significantly older than patients in the control group; however, this had no impact on the clinical outcome in the analyzed period.

There were no complications during surgery in the groups studied, as there were no statistically significant differences between the incidence of local or systemic intercurrences in the analyzed period.

Conclusion: This study found low rates of complications in patients undergoing total knee arthroplasties with use of a tourniquet, with or without calcification of the popliteal artery.

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O uso do manguito pneumático em pacientes submetidos a artroplastia total do joelho com ou sem calcificação da artéria poplítea

Palavras-chave:
Artroplastia do joelho
Complicações pós-operatórias
Torniquetes
Artéria poplítea

RESUMO

Objetivo: Identificar as complicações clínicas e cirúrgicas associadas ao uso de torniquete na artroplastia total de joelho em pacientes com ou sem calcificação da artéria poplítea.

Métodos: O estudo foi feito de modo retrospectivo, analisou 64 pacientes com calcificação da artéria poplítea e 57 pacientes como grupo controle.

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Resultados: Os pacientes do grupo de casos eram significativamente mais velhos do que os pacientes do grupo controle. Entretanto, tal fato não teve repercussão quanto ao desfecho clínico no período analisado. Não houve complicações durante o ato cirúrgico nos grupos estudados, bem como não houve diferenças estatisticamente significantes entre a incidência de intercorrências locais ou sistêmicas no período analisado.

Conclusão: O presente estudo observou baixos índices de complicações em pacientes submetidos a artroplastia total do joelho com uso de torniquete com ou sem calcificação da artéria poplítea.

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Introduction

Total knee arthroplasty (TKA) is a highly complex orthopedic procedure indicated in the treatment of patients with advanced knee osteoarthrosis. The primary objective of the procedure is pain relief; its secondary objectives are mechanical alignment of the lower limb promoting a significant improvement in the patient's quality of life.[1,2]

Current studies demonstrate high satisfaction and functional improvement rates in patients who undergo TKA, presenting good and excellent results in more than 90% of cases in long term results.[3,4]

Despite the high success rate of the procedure, 11–20.8% of the patients develop perioperative complications.[5,6] Among the most common complications are those related to the surgical wound, thromboembolic disease, infection, neurovascular injury, periprosthetic fracture, injury of the extensor mechanism, and joint stiffness.[7,8]

A pneumatic cuff is routinely used during knee replacement surgery. The advantages of its use are promoting a cleaner operative field, lower perioperative bleeding, better quality of implant cementation, and faster surgery[9]; it also decreases the surgeon's risk of acquiring diseases such as AIDS or hepatitis. However, its use has been associated with the incidence of neurapraxia, vascular injury, muscle damage, postoperative pain, cardiovascular alterations, and wound healing complications.[9]

In TKA, the tourniquet is applied on the thigh to occlude the femoral artery. Typically, the pneumatic cuff on the lower limb is inflated to 100 mmHg above systolic pressure.[10] The literature tends not to recommend the use of a pneumatic cuff in patients with popliteal artery calcification.[11–14]

Atherosclerosis would be the most plausible explanation for artery calcification. Calcium deposits in the intima layers of the arteries could lead to this alteration.[9,14] The artery is elastic and calcification can make the vessel less compliant and more vulnerable to acute occlusion or rupture of its wall.[9,13,15–17]

Radiographic examination of the knee is a simple, inexpensive imaging method required for every TKA candidate. By this exam, the degree of joint degeneration can be measured, and the presence or absence of popliteal artery calcification can be verified.[13,17]

This study is aimed at identifying the clinical and surgical complications in patients with or without popliteal artery calcification who underwent TKA with the use of a tourniquet.

Material and methods

After approval of the study protocol by the research ethics committee of the institution (CAAE 44349315.1.0000.5273), a retrospective observational study was conducted and data were collected through the review of medical documents (medical records and radiographs). The analysis was performed in the database of the institution by a physician specialized in orthopedics and traumatology.

The study included all patients who underwent TKA between January and December 2013 and presented calcification at the knee joint identified on preoperative X-ray films (64 patients; Fig. 1). Exclusion criteria were the need for a more constricted implant, a follow-up time of less than six months, or incomplete medical records; six patients were excluded from the study.

Fig. 1 – Lateal view preoperative radiograph.

The control group consisted of 57 patients who were operated on during the same period and who did not present arterial calcification at the knee.

This hospital uses the following views as radiographic standard for knee osteoarthrosis: lower limb panoramic, bipodal weight-bearing anteroposterior view, and lateral view with 30° of flexion without weight-bearing. At the time of hospitalization, these radiographic images are evaluated and classified by the Ahlback criteria.

The joint replacement procedure was performed using the posterior stabilized Press Fit Condylar Sigma implant (DePuy-Synthes, Warsaw, IN). The surgical technique was performed through a medial parapatellar access, using a pneumatic cuff inflated at 100 mmHg above the systolic pressure minutes before the skin incision. The cuff was maintained until the implant was cemented, not exceeding the maximum period of two hours, when the cuff was deflated to reassess hemostasis. A subcutaneous suction drain was routinely used. All patients underwent the same infection and deep venous thrombosis prophylaxis protocol.

Quantitative variables related to age, time of surgery, and time of arterial occlusion by the pneumatic cuff were analyzed, as well as the anesthetic risk score and the presence of comorbidities documented in the medical record.

The complications or outcomes analyzed were stratified as systemic or local events, identified, and registered in the medical record. Their frequency was analyzed from the intraoperative period to the first six months after surgery. Systemic events were subdivided into pulmonary – pulmonary embolism; cardiac disorders – acute myocardial infarction; and others. Local complications were subdivided into acute arterial occlusion, deep venous thrombosis, skin necrosis, superficial or deep infection of the surgical site, and amputation.

The database constructed from the collected data was analyzed using SPSS, version 23.0, and Microsoft Excel 2007.

In the descriptive analysis, the data were synthesized using descriptive statistics, odds ratios, graphs, and distributions of frequencies and proportions to characterize the global sample and the case and control groups.

In the inferential analysis of qualitative variables, the relationship between calcification and complications or diagnoses was assessed using the chi-squared test. When the chi-squared test was inconclusive, if feasible, Fisher's exact test was used to assess said association. For the analysis of the significance of the odds ratio, its confidence interval was calculated at the 95% confidence level.

In the inferential analysis of quantitative variables (age, ischemia time, and surgery time), the normal distribution hypothesis was assessed using the Kolmogorov–Smirnov test and the Shapiro–Wilk test. The variable was considered to have a normal distribution if both tests did not reject the null hypothesis of normality of the distribution. As the variables did not follow normal distribution, the measurements in the case and control groups were compared using the non-parametric Mann–Whitney test.

All significance tests were discussed considering the maximum significance level of 5% (0.05), *i.e.*, the following decision rule was adopted in the tests: the null hypothesis was rejected whenever the p-value associated with the test was less than 0.05. In the tests with asymptotic and exact p-values, the exact p-values were considered.

Results

The mean age of the group without arterial calcification was 67.5 years, *versus* 72 years in the case group. Using the Mann–Whitney test, it was possible to conclude that the differences in patients' age in the two groups were statistically significant (p-value = 0.000).

The ischemia time ranged from 70 to 180 min in the control group and from 36 to 145 min in the case group (median: 90 and 104 min, respectively). These differences were not statistically significant (p-value = 0.161, Mann–Whitney test).

The mean surgery time was 124.9 min in the group with arterial calcification and 119.5 min in the control group. The differences in the observed distributions were not statistically significant (p-value = 0.192, Mann–Whitney test).

Using the chi-squared test, it was observed that the distribution of ASA surgical risk scores was significantly different in the case and control groups. In fact, the frequency of patients with ASA I risk was higher in the case group (23.2%), while the frequency of patients with ASA II risk was higher in the control group (91.2).

Table 1 presents the incidence of complications during or after surgery in the case and control groups. Such data were assessed using the chi-squared test, or Fisher's exact test when the chi-squared test was inconclusive.

Despite a higher incidence of deep venous thrombosis and one case of pulmonary thromboembolism in patients with calcification at knee level, these differences were not statistically significant. No case of acute arterial occlusion was reported in both of the groups evaluated.

The incidence of skin necrosis was 8.9% in the case group and 10.5% in the control group, with no statistical significance.

The incidence of clinical complications was low in both groups; one case of acute myocardial infarction was observed in one patient from the case group, but without statistical significance. Knee cellulitis was observed in another patient from the case group, and was treated with oral antibiotic therapy.

Based on the p-values observed, all higher than 5%, it can be concluded that there was no significant difference between the incidence of complications in the case and control groups. The odds ratios that could be calculated are also shown in Table 1, but they are not statistically significant, since all the confidence intervals had a value of 1.

Discussion

Some authors contraindicate the use of a pneumatic cuff in patients with calcification of the popliteal artery who undergo TKA. They state that this use could lead to an increased risk of vascular complications.[12–15,18–21]

Tourniquet use is associated with risks such as neurological injury, rhabdomyolysis, and pulmonary embolism.[9] The use of a pneumatic cuff in calcified arteries may lead to other complications, such as ineffective arterial occlusion (continuous bleeding during surgery), rupture of the vessel wall, acute arterial occlusion, aneurysm formation, and displacement of an

Table 1 – Absolute and percentage frequencies of complications in the case and control groups, and their respective statistical significance.

Complication	Incidence			p-Value of the test χ^2	Odds ratio (OR)	OR confidence interval	Power of the test (%)
	Control group	Case group	Global				
Deep venous thrombosis (gastrocnemius vein) (%)	1 1.8	3 5.4	4 3.5	0.364[a]	3.17	0.32–31.43	82.08
Pulmonary thromboembolism (%)	0 0.0	1 1.8	1 0.9	0.496[a]	–	–	–
Pulmonary thromboembolism (%)	0 0.0	1 1.8	1 0.9	0.496[a]	–	–	–
Acute arterial occlusion (%)	0 0	0 0	0 0	1.000	–	–	–
Surgical wound complication							
Skin necrosis (%)	6 10.5	5 8.9	11 9.7	0.579	–	–	8.59
Cellulitis (%)	0 0	1 1.8	1 0.9				–
Varied complications (overall) (%)	6 10.53	8 14.29	14 12.39	0.544	1.417	0.46–4.39	25.59
Acute (superficial) infection (%)	1 1.8	0 0.0	1 0.9	1.000[a]	–	–	–
Anemia (%)	0 0.0	1 1.8	1 0.9	0.496[a]	–	–	–
Thigh ecchymosis/ thrombocytopenia (%)	1 1.8	0 0.0	1 0.9	1.000[a]	–	–	–
Hyperkalemia (%)	0 0.0	1 1.8	1 0.9	0.496[a]	–	–	–
Hypokalemia (%)	1 1.8	1 1.8	2 1.8	1.000[a]	1.02	0.06–16.69	5.0
AMI (%)	0 0.0	1 1.8	1 0.9	0.496[a]	–	–	–
Urinary tract infection (%)	0 0.0	1 1.8	1 0.9	0.496[a]	–	–	–
UTI/disorientation (%)	0 0.0	1 1.8	1 0.9	0.496[a]	–	–	–
Fibular neuropathy (%)	1 1.8	0 0.0	1 0.9	1.000[a]	–	–	–
Thrombocytopenia (%)	0 0.0	2 3.6	2 3.6	0.125[a]	–	–	–
Anaphylactic reaction (%)	1 1.8	0 0.0	1 0.9	1.000[a]	–	–	–
Joint stiffness (%)	1 1.8	0 0.0	1 0.9	1.000[a]	–	–	–
Late surgical wound secretion (%)	1 1.8	0 0.0	1 0.9	1.000[a]	–	–	–

[a] Without statistical significance, $p > 0.05$.

atheromatous plaque causing distal arterial occlusion.[9] The persistence of venous bleeding after the pneumatic cuff is inflated may be related to inadequate positioning at the upper end of the thigh, and cannot be attributed solely to the presence of arterial calcification.

In the authors' opinion, surgeons do not like to change their routine during surgery, and most orthopedic surgeons do not give the appropriate importance to popliteal artery calcification. This fact raised the interest of the present authors; this subject had never been researched in Brazil.

Kobayashi et al.[14] reported that a tourniquet should not be used in patients with popliteal artery calcification undergoing TKA; moreover, surgeons should be extremely careful during intraoperative knee manipulation. According to these authors, the calcified vessel loses elasticity, and plaque embolization may occur in the intima layer of the artery, especially during knee extension. The present authors agree that surgeons should be careful during knee manipulation, regardless of the presence or not of arterial calcification.

Julia et al.[11] retrospectively evaluated 268 patients with arterial calcification who underwent TKA using a pneumatic cuff, and found a three-fold increased risk of complications associated with the surgical wound in patients with intima layer calcifications. In the present study, a 9.7% overall incidence of skin necrosis was observed, with no significant variation between groups.

In the present study, skin necrosis was considered a local complication. The use of the pneumatic cuff may be related to this alteration due to perioperative hypoxia and a reduction of postoperative perfusion tissue.[19] However, it is known

that inadequate care with soft tissues or a very tight skin closure can cause this complication. As a result, this local complication cannot be attributed to the use of the pneumatic cuff alone.

Hozack et al.[22] reported that popliteal calcification radiography and family history of arteriosclerotic vascular disease provide additional information on possible vascular complications. Therefore, for TKA candidates, the present authors recommend a thorough patient's medical history, a peripheral vascular physical examination routine, and a higher consideration of his family history.

Jeyaseelan et al.[17] reported a higher rate of popliteal artery calcification at the knee in diabetic patients. This association was not observed in the present study. Of the 58 patients in the present study, only 19 were diabetic; this comorbidity was not associated with major postoperative complications when compared with the control group without arterial calcification.

In some cases, the nonuse of the pneumatic cuff with calcified artery may pose a risk to the patient. Some patients with arterial calcification at the knee may have undetected cardiac disease, which might manifest itself after increased blood loss associated with the nonuse of the tourniquet in the surgical procedure.[9] Therefore, caution is required in such situations to minimize the risk of this complication, with measures such as a blood transfusion or the use of antifibrinolytic agents (*e.g.*, tranexamic acid).[17] The authors believe that a careful preoperative evaluation by the clinical and anesthetic team is indispensable to determine the safety of the surgeon's conduct.

DeLaurentis et al.[13] observed a low rate of complications with the use of pneumatic cuff during TKA in patients with arterial calcification. The present results validate this conclusion. In the present study, patients in the case group were significantly older than those in the control group. However, this fact did not have repercussions regarding the clinical outcome in the analyzed period. The differences between ischemia time, surgical time, anesthetic risk, surgical complications, and skin necrosis between the groups were not statistically significant.

Koehler et al.[23] recommended the use of the pneumatic cuff in patients with knee artery calcification who undergo TKA. Their findings corroborate the low rates of complications with tourniquet use observed in the present study. Those authors stated that most complications occur in the first three months after surgery. The present authors believe that the period of six months postoperatively was adequate to observe complications related to the use of the pneumatic cuff.

The present study had limitations, as it was conducted retrospectively; it was also subject to the bias of error in the completeness of data in the medical records. In order to reduce this possibility, patients whose outpatient follow-ups were poorly documented were excluded.

This was a pilot study, in which a small rate of postoperative complications was observed. This research serves as the basis for a future Level 1 study, without generating risks to the patients.

It can be concluded that TKA in the presence of arterial calcification at the joint level was not associated with an increase in the complications rate in the acute postoperative period.

Conclusion

This study presented low complication rates in patients with or without calcification of the popliteal artery who underwent TKA with the use of the tourniquet, demonstrating that the joint replacement procedure can be performed with the aid of a tourniquet without posing risks to the patients.

Conflicts of interest

The authors declare no conflicts of interest.

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