

ARTERIAL THROMBOSIS IN TOTAL KNEE ARTHROPLASTY: A LITERATURE REVIEW.

RONALD FIDELIS JÚNIOR¹, MARCO MARTINS AMATUZZI², PEDRO PUECH LEÃO³, LUIZ EUGÊNIO GARCEZ LEME⁴.

SUMMARY

Arterial complications after Total Knee Arthroplasty (TKA) are quite rare, however, the arterial occlusive disease (AOD) associated with chronic knee osteoarthritis may represent a problem. Since the sequels can be disastrous, the surgical TKA approach should be different when AOD is present. Most of the cases reported have been attributed to the following factors: use of tourniquet; excessive intraoperative manipulation; or the correction of a flexion contracture. AOD is underestimated among people with osteoarthritis and most of cases occur among patients with previous clinical or radiological evidences of arterial disease. A vascular evaluation should be considered in those situations.

Furthermore, it's difficult to recognize and promptly deal with an ischemic leg in the post-operative TKA period. In spite of the small incidence of arterial thrombosis, a high amputation risk is reported. We have made a literature review, which showed the reported AOD incidence among patients presenting degenerative knee osteoarthritis and post-TKA arterial thrombosis aspects. Also, the predictive factors for ischemic atherosclerotic complications in TKA were identified. Lesions due to direct trauma of normal arteries, leading to pseudoaneurysms, arteriovenous fistulas and bleeding weren't studied.

Keywords: Thrombosis; Ischemia; Arthroplasty; Knee.

1-INTRODUCTION

The high prevalence of Peripheral Obliterating Arterial Disease (POAD)⁽¹⁾ in individuals above the sixth decade of life has created an increasing number of evaluations being requested by vascular surgeons in patients scheduled for orthopaedic procedures for treating joint degenerative diseases of the lower limbs, those with a significant incidence among this age group, as well^(2,3).

Among those procedures we found the Knee Total Arthroplasty (KTA)⁽⁴⁾, which, despite presenting a low incidence of complications, is a surgery that has been increasingly performed (estimated as 45,000/ year in the USA and 28,000/ year in the United Kingdom)⁽⁵⁾, and presents a potential for arterial decompensation and ischemia, which, if not consistently treated, may evolve to difficult healing, infections, neurological injuries, or even limb necrosis. Pertinent literature is composed, most of cases, by reports of isolated cases or by small case series, where the mechanisms mostly associated to thrombosis are: temporary hemostasis usually achieved with a pneumatic cuff or with elastic bands; arterial compression between osteotendinous structures after knee angulation (flexion) correction; or, the very intraoperative manipulation⁽⁶⁻¹⁹⁾.

The orthopaedist is interested in quantifying the risk of per-operative arterial decompensation, as well as in prophylactic or therapeutic actions aiming to improve outcomes in cases of ischemia that may impose a risk to the functionality and the availability of

the limb. Nevertheless, no consensus exists regarding how to stratify the pre-operative risk of thrombosis, or an algorithm of prophylactic or therapeutic approach for those cases.

Thus, we consider as important to review data available in literature concerning the prevalence of POAD in the overall population, and among the KTA-candidate patients, description and analysis of thrombosis cases associated to that surgery and, if possible, the identification of common preoperative characteristics that could serve as predictive factors of arterial decompensation, suggesting prophylactic or therapeutic approaches.

2-Obstructive Arterial Disease of LLLL in the Elderly (DAOP)
The prevalence of POAD has been evaluated based on its major clinical evidence (Table 1): Intermittent Claudication (IC). Thus, its annual incidence is:

Decade	Percentage
5 th	2%
6 th	4%
7 th	6.8%
8 th	9.2%

Table 1 – Percentage of intermittent claudication by age group.

Study conducted by: Department of Orthopaedics and Traumatology, Discipline of Vascular Surgery - Medical College, University of São Paulo - FMUSP

Correspondences to: Prof. Dr. Luiz Eugênio Garcez Leme - Avenida Angélica, 1071, apto 112. - CEP 01227-100, São Paulo, SP.
E-mail: lueglem@usp.br

1. Doctor Orthopaedics. Post-graduation student, FMUSP

2. Emeritus Professor, FMUSP

3. Chairman of the Discipline of Vascular Surgery, FMUSP

4. Full Professor and Associate Professor, Department of Orthopaedics and Traumatology, FMUSP

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However, if we consider a change in the ankle-arm index (AAI) as indicative of POAD, its prevalence reaches three to four times the one noticed by the IC. Among individuals within 55 to 74 years old, IC is found in about 4%, whereas the AAI < 0.9 in this population is 17%. An AAI < 0.9 means arteriographically proved stenosis or occlusions, with 96-97% sensitiveness and 94-100% specificity⁽⁶⁾.

Even in patients without LLLL arthrosis, a minority spontaneously complain of IC. Approximately 50 to 90% of those patients do not mention ambulation restraints, and, when specifically inquired, they consider this increasing difficulty as normal in aging process. In a cohort of 5,209 individuals, it was found that the POAD incidence notably increases up to 75 years old.

In clinical evaluation of POAD, the research is oriented to pain in muscle groups, deflagrated by walking. The evolution time, progression and continuous gait actual distance (gait autonomy) must be characterized. This distance may be grossly estimated in blocks, presuming an approximate 100m relation for each block. Special situations make vascular limping elucidation difficult, among them, the presence of diabetic neuropathy and even the knee arthrosis. History of limbs injuries, especially those spontaneous, with difficult healing, must be considered.

In the physical test, before palpation of vascular paths, a limb inspection can evidence signs of chronic arterial failure. Reduction in the amount of hair, changes on nails color and shape, disproportional muscle atrophy, and skin dryness. Hair replenishment, evaluated by digital pressure, may be slowed (less than 2 seconds). An excessively hyperemic foot at pending position, becoming pale when lifted up, indicates an ischemic end (this sign is known as reactive hyperemia). Finally, a thorough palpation and auscultation of all vascular paths must be performed, with all findings, either positive or negative, recorded in patients' files.

The site most often affected by atherosclerotic POAD is the femoropopliteal, aortoiliac, or both. The occlusion of infrapopliteal arterial segments is more characteristic of diabetic and inflammatory arteriopathy. It is worthy to remember that the pedal pulse can be congenitally absent in up to 2% of the population, and the tibial posterior in 0.1%, noting that, in general, when one pulse is absent, the other is widely and easily palpable⁽¹⁹⁾.

In spite of being an early stage of the evaluation, clinical tests have their limitations⁽²³⁾, in some cases being indicated the aid of vascular laboratory. The main methods available are⁽¹¹⁾:

2.1-Doppler

It detects the blood flow through the skin, generating a characteristically 3-phase sound in normal arteries. This flow wave may be plotted in a graph. The AAI is a derived measure that, as mentioned above, is widely clinically used⁽¹²⁾.

2.2-Plethysmography

Air Plethysmography captures volume changes of a systole/diastole end, which reflects blood flow pulsation ability. Photo-plethysmography captures blood concentration in the microflow, through the reflection of the emitted infrared light.

2.3-Color scan with Doppler (Duplex Scan):

It consists on the association of ultrasound B mode, with color representation of flow, complemented by spectral analysis of the Doppler. It provides both anatomical and physiological data about the arterial system, being its accuracy strongly dependent on operator's experience.

2.4-Oxygen transcutaneous tension (TcO2)

Measurement of intra-skin oxygen content, which is directly correlated to local arterial flow (normal value = 40 to 70 mmHg)⁽¹³⁾.

2.5-Arteriography

Angiographic study⁽¹⁴⁾ of the POAD. It is usually restricted to cases already recommended to surgery, aiming to plan the procedure. This is an invasive procedure, using intra-arterial contrast.

Although not usually mentioned as a method for vascular evaluation, simple x-ray of limbs (essential test for osteoarticular diseases diagnosis) can detect calcifications along arteries, meaning atherosclerotic degeneration.

3-Arterial thrombosis on knee arthroplasty:

3.1- Literature review

Literature addressing arterial complications is composed by some case reports, and a few series reports. Acute ischemia associated to KTA is due mainly to thrombosis rather than arterial laceration. In the majority of cases, arterial occlusion was related to the use of a garrote for temporary hemostasis. Nonetheless, other factors must be considered⁽²⁶⁾.

Robson et al.⁽⁶⁾ reported the first case of arterial occlusion in KTA post-operative period in a 24-year old patient, presenting with rheumatoid arthritis since the age of 7. Obviously, in this case, there were no atherosclerotic injuries, with obstruction being attributed to an excessive arterial stretching after the correction of a knee chronic flex, of 52°, plus compression by musculotendinous structures.

Many years later, Giannestras⁽⁷⁾ documented a case of superficial femoral artery thrombosis at the point in which the pneumatic tourniquet had been applied, insufflated at 500 mmHg for 70 minutes. Surgery aimed the correction of foot deformities. The patient, a 43-year old woman, had no previous sign or symptom suggestive of vascular disease, except for a history of thrombophlebitis during pregnancy. The case was treated with autologous femoropopliteal venous graft, since the member seemed to be ischemic and thrombectomy wasn't effective.

McAuley et al.⁽⁸⁾ documented two cases; in the first, the mechanism of arterial injury put forth was the rupture of atherosclerotic plaque at compression site, with embolization of fragments to distal vessels; in the second, a late stenosis (16 months after surgery), evolved to a symptomatic occlusion in the 17th month. This lesion was also a result of plaque fracture, but due to joint hyperextension. In this study, authors have called the attention exactly to the risks of using a tourniquet in patients with POAD. Also, excessive intra-operative manipulation and hyperextension may cause chronic arterial lesions instability.

Irvine⁽⁹⁾ described a case where, although artery calcification was evident at the level of the knee, as showed by x-ray studies, the tourniquet was used and the intra-operative occlusion of the popliteal resulted in transfemoral amputation of the limb.

Worried about the case of a patient having IC, in whom arthroplasty led to a decompensation of arterial disease, Rush⁽¹⁰⁾ performed, in 1987, a research in the major Australian medical centers, obtaining answers from 470 orthopaedic doctors. In the 10 previous years, 12 arterial lesions in the course of TKA had occurred. Five resulted in direct trauma to the artery, with bleeding events. In the seven cases of thrombosis, five resulted in amputation, one died, and one lost follow-up.

In 1990, Hagan and Kaufman⁽¹¹⁾ attributed a popliteal artery thrombosis post-KTA to a probable hypercoagulable state of a patient who had been smoking for 60 years (he was 80 years old

*AAI is the ratio of systolic pressure measured by Doppler in the LLLL, with the same systolic pressure in the upper limb. Normal value is >0.9. It indicates absence of significant arterial obstructions or stenosis

by occasion of arthroplasty), in estrogen hormonal treatment for a prostate malign neoplasia. Some contraindications related to the use of the tourniquet are mentioned, namely: atherosclerotic disease (in any vascular region); diabetes mellitus; venous thrombosis (even if suspected); presence of arterial calcifications on x-rays; rheumatoid arthritis and other collagen diseases associated to vasculitis. It is interesting to mention that at least one of those situations is present in virtually all TKA candidates.

DeLaurentis et al.⁽¹²⁾ are responsible for the first and only arthroplasty series assessed with the objective of determining the POAD incidence in individuals submitted to TKA and the real meaning of this association. The arterial disease was clinically evaluated, using the AAI and the plethysmography. A total of 1,182 patients were included, being 975 retrospectively and 207 prospectively. Mean age was 70 years old, with 93% of KTA indications due to osteoarthritis. The overall prevalence of POAD was 2% – 24/1182 – (probably underestimated due to sub-notification on retrospective group). The rate of arterial complications (thrombosis) was 0.5% – 6/1182. The major information in those numbers is in the fact that all arterial complications occurred among POAD carriers (6/24=25%). Two vascular grafts were required. The following risk factors were considered as significant:

- History of arterial failure (IC; ischemic ulcers, previous vascular procedures)
- Absence of pedal pulse (pd)
- Absence of posterior tibial pulse (tp)
- Absence of pd and tp pulses
- Arterial calcification (upon x-ray)

In patients without POAD, the tourniquet did not change Doppler and plethysmography patterns on post-operative period, and there are no conclusive information concerning their use in patients with POAD. The AAI ranged from 0.39 to 0.89 among those with arterial disease.

Calligaro et al.⁽¹³⁾ studied the best approach to the 0.17% cases of arterial thrombosis post-KTA, concluding that an aggressive approach to ischemic cases should be the first choice. From a total of 20 cases, 10 were submitted to grafts and 10 to minor procedures (thrombectomies, sympathectomies, or fasciotomies). In the first group, no deaths occurred within the period of study, with 100% of the limbs being saved. In the second group, seven amputations were required (three above the knee, one below the knee, one transmetatarsal, and two non-specified). Furthermore, in this group, one patient died in the seventh post-operative period of a thrombectomy.

More recently, Holmberg⁽¹⁴⁾ published other 4 cases of arterial complications in TKA. Two lesions were resultant of direct trauma, with perforation and bleeding, and two cases of thrombosis. The incidence of thrombosis was 0.1% among the TKAs (4/1483). In this report, the case series from Clinica Mayo was mentioned, where among 9,022 KTAs, 0.03% of arterial complications were described. It is also worthy to mention the difficulties to diagnose ischemia post-operatively, due to occlusive dressings and to the

residual effect of the anesthetic blockages.

In 1997, Ohira⁽¹⁵⁾ documented another case in which ischemia was detected intra-operatively, after the garrote was removed. Upon confirming the absence of distal pulses, an arteriography showed total occlusion of the popliteal artery. Through the very angiography catheter, a thrombolytic infusion (urokinase) was initiated. By this technique, a good reperfusion of the limb and anterior and posterior tibial arteries clots lysis were achieved. The patient evolved without deficits, and oral anti-platelet agglutination drugs prescribed for two months.

A new therapeutic potential was described by Bellemans et al.⁽¹⁶⁾, when they performed an aspiration of an arterial thrombus found in arteriography. In the two cases reported here, the onset of ischemia occurred hours after the conclusion of TKA (one within 24 hours, and the other, within 48 hours). Time elapsed from the onset of pain and reperfusion was, respectively, four and five hours. To give an idea of the severity of this kind of acute ischemia, both patients evolved to footdrop.

A third case of post-KTA thrombosis treated with thrombus aspiration was documented by Berger et al.⁽¹⁹⁾ in 2002. In that case, a popliteal angioplasty was added due to a stenosis estimated to 75%, at the level of knee joint interline. Ischemia lasted 3 hours, and the patient progressed with no sequels.

Table 2 shows a summary of the mentioned series, with approach and evolution.

Although post-KTA chances of thrombosis are small, a significant part of the patients showing this kind of complication present signs of previous arterial disease. However, it is unclear when a limb revascularization indicative exists before arthroplasty. By adding elements to this issue, Turner and cols⁽¹⁵⁾ published a research made in Clinica Mayo gathering data regarding the evolution of patients with previous revascularization of the limb when KTA was determined. In 27 years, from the 19,808 arthroplasties, 9 patients had grafts, one of them being bilateral. The mean duration of grafts was 4.45 years. From 10 limbs, garrote was used on orthopaedic surgery in seven. The incidence of thrombosis was 20%^(2/10), which is notably higher than the 0.5% previously reported. Thus, it seems that a vascular graft is not recommended prior to KTA, except in specific situations, at vascular surgeon's discretion, such as severe ischemia, femoropopliteal calcifications or popliteal aneurysms. For those cases, some authors recommend an intermediate

approach, which would be a pre-operative arteriography, with the objective of hastening a potential vascular procedure after arthroplasty. It is interesting to note that, in this study, thrombosis occurred regardless of the garrote. The use of this device for obtaining a bloodless operative field seems to be related to thrombosis in most of the other studies. Klenerman even suggested a systematic vascular evaluation of all KTA candidate patients with the garrote, being the pneumatic cuff preferable to the elastic band (Esmarch)⁽²⁸⁾ because of the possibility of measuring pressure, which should be, at most, twice the systolic pressure.

Author	Year	# of Cases	Evolution
Robson	1975	01	Limb salvation with fasciotomy
Giannestras	1975	01	Limb salvation with revascularization
McAuley	1984	02	Transfemoral amputation/ Salvation with revascularization
Irvine	1986	01	Transfemoral amputation
Rush	1987	07	05 amputations / 01 death / 01 lost follow-up
Hagan	1990	01	Salvation with thrombectomy
DeLaurentis	1992	06	Salvation with: 02 grafts/ 04 clinical treatment
Calligaro	1994	20	07 amputations / 01 death
Holmberg	1996	02	Salvation with revascularization
Ohioan	1997	01	Limb salvation with thrombolysis
Bellemans	1999	02	Salvation with thrombus aspiration/ neurological sequel
Berger	2002	01	Salvation with thrombus aspiration/ no sequel

Table 2 - Reports of non-traumatic occlusive arterial complications in patients submitted to knee total arthroplasty.

One alternative to the garrote is the temporary occlusion of the iliac or femoral artery by means of intravascular balloons. With this technique, a bleeding is reduced by half, showing low rates of complications.

CONCLUSION

Total knee arthroplasty is accompanied by a small potential of occlusive arterial complications (0.03 to 0.5%), when we consider the overall population submitted to this procedure. However, considering the identifiable subgroup of patients with associated arterial disease, an incidence of up to 25% is found. Factors increasing vascular risks of the orthopaedic surgery are listed on Table 3.

The use of the garrote must be avoided in patients at risk. When indispensable, pneumatic cuffs are preferable.

Complaints of intermittent claudication
Previous ulcers (ischemic)
Absence of pulses (pd and/or tp)
Ankle-arm index < 0,9
Arterial calcifications on x-ray
Atherosclerotic disease (in any vascular site)
Popliteal aneurysm

Table 3: Predisposing factors to arterial complications in KTA

According to literature, there are no reasons for contraindicating KTA in cases of absent arterial pulses in LLLL. Also, there are no criteria established for indicating revascularization in a compensated limb, pre-operatively, because the use of the tourniquet increases the chances of occlusion of the arterial repair.

A visit to the vascular surgeon should be considered, and the risks of the procedure should be interdisciplinarily assessed for each case, due to the bad prognosis of this kind of complication, indicating the severity of ischemic pictures triggered by an orthopaedic surgery. The objective is the prompt reperfusion of the affected limb. Alternative techniques, such as fibrinolysis and thrombus aspiration seem to be promising, but studies are incipient. A surgical revascularization, even meaning a distal graft, should not be postponed.

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