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Original article

Vascular injuries during closing-wedge high tibial osteotomy: A cadaveric angiographic study

A. Darnis[a,b,*], V. Villa[a], C. Debette[a], S. Lustig[a], E. Servien[a], P. Neyret[a]

[a] Service de chirurgie orthopédique, centre Albert-Trillat, université Claude-Bernard Lyon 1, hôpital de la Croix-Rousse, hospices civils de Lyon, 103, Grande-Rue-de-la-Croix-Rousse, 69004 Lyon, France
[b] Laboratoire d'anatomie, faculté de médecine Rockefeller, université Claude-Bernard Lyon 1, 8, avenue Rockefeller, 69003 Lyon, France

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ABSTRACT

Introduction: Closing-wedge high tibial osteotomy is a surgical option for patients with isolated medial compartment osteoarthritis and varus knee alignment. Vascular complications are rare, but incriminate the use of oscillating saw or osteotome. It is important to know the steps of this surgery that involve risk of vascular injury and what to do to decrease that risk.
Hypothesis: Performing the distal osteotomy cut using an oscillating saw is a step with high risk of vascular injury. A protective device behind the tibia may decrease this risk.
Materials and methods: In this descriptive angiographic cadaver study, closing-wedge high tibial osteotomy was performed on 6 cadaveric knees in 90° knee flexion, and the distance between the surgical instrument and the popliteal artery was measured on fluoroscopy with artery opacification at the various steps of surgery.
Results: Tibial osteotomy with oscillating saw involves high vascular risk: the mean distance between the saw-blade and the popliteal artery is 10.6 mm in 90° knee flexion. Using a specific device placed behind the tibia protects the vascular structures.
Discussion: High tibial osteotomy is indicated in medial compartment osteoarthritis of the knee and can be performed by closing or opening-wedge. Vascular injuries in closing-wedge osteotomy exist and it is recommended to perform this surgery at 90° knee flexion, although some studies report that this does not move the artery out of the way. A risk of vascular lesion should be kept in mind. The oscillation of the saw and the direction of the osteotomy should also be taken into consideration when performing a closing-wedge high tibial osteotomy in order to protect the popliteal artery.
Study design: Descriptive cadaver study. Level IV.

1. Introduction

High tibial osteotomy (HTO) is a surgical option in isolated medial compartment osteoarthritis with varus knee. The procedure is not free of possible complications, and the risk of lesion to the nearby popliteal artery ranges in the literature between 0.4% and 9.8% [1,2]. The steps in the procedure that involve such risk need to be known, as do the anatomic variants liable to increase it. Following a case of popliteal artery branch lesion sustained during closing-wedge HTO, an angiographic cadaver study was performed to identify the risks in the procedure by measuring the distance between instruments and artery during the various steps. The study hypothesis was that performing the distal osteotomy cut using an oscillating saw is a step with high risk of vascular injury and that a protective device behind the tibia may decrease this risk.

2. Material and method

The study was performed on 6 lower limbs from 3 whole fresh cadavers: 3 right and 3 left knees (Anatomy Laboratory, Rockefeller Medical Faculty, Claude-Bernard University, Lyon, France). The cadavers were stored at 4 °C and exposed to room temperature (18 °C) for 12 hours before examination. Specimens with scarred skin over the knee were excluded, and AP and lateral fluoroscopy ruled out any obvious abnormality (trauma, tumor, material). The cadavers were positioned in dorsal decubitus, with a support holding the knee in 90° flexion. The fluoroscope was positioned so as to obtain the lateral view. The femoral artery was approached via the

* Corresponding author. Service de chirurgie orthopédique, centre Albert-Trillat, université Claude-Bernard Lyon 1, hôpital de la Croix-Rousse, hospices civils de Lyon, 103, Grande-Rue-de-la-Croix-Rousse, 69004 Lyon, France. Tel.: +33 6 76 82 45 29.
E-mail addresses: alice.darnis@icloud.com, alice.darnis@chu-lyon.fr (A. Darnis).

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femoral triangle with the limb in extension, and a 16-gauge latex probe was introduced into the artery and held in place by suture. The posterior tibial artery was identified behind the medial malleolus and an opening allowed the substance injected into the femoral artery to be evacuated. Physiological saline was then injected via a femoral catheter to remove any clots and to check permeability. The arterial opacifier used was Telebrix (Guerbet, France) in a 50% physiological saline solution. The various steps of closing-wedge HTO were performed following the procedure adopted in the authors' surgery department [3].

2.1. Closing-wedge high tibial osteotomy technique

The entire procedure was performed with the knee in 90° flexion. The skin incision was oblique, on the anterolateral side of the tibia, 1 cm above the anterior tibial tuberosity and 1 cm under the fibular head. The anterior tibial aponeurosis was opened, conserving a small superior "skirt", and the anterior tibial and extensor digitorum muscles were released downward by raspatory. Fibular neck osteotomy was performed with 4 holes drilled in the neck with a 3.2-mm bit then cutting with a Lambotte osteotome. Tibial osteotomy used dedicated instrumentation (Tornier HTO, Saint Ismier, France). A K-wire was placed in the joint line, then a guide-wire 1 cm below, via the instrumentation. A bone chisel was slid along the wire, stopping 1 cm short of the medial cortex. A drill guide was then impacted and slid along the wire, and holes were drilled with a 6-mm bit. The blade plate was slid along the wire and impacted until the head was embedded in the bone. The inferior osteotomy line was cut using an oscillating saw, respecting the anterior tibial tuberosity and superior tibiofibular joint. A raspatory was then placed behind the tibia, to protect the popliteal artery (Fig. 1). The raspatory was introduced laterally, in direct contact with the tibia, under the periosteum and forward of the soleus, lateral gastrocnemius and popliteal muscles. The superior section was cut by oscillating saw using an 8° guide and the bone wedge was withdrawn. A temporary screw was introduced in the distal fragment 1 cm from the osteotomy line, and reduction was maintained by forceps supported by the screw and by the head of the plate, allowing two definitive bicortical screws to be introduced through the plate.

A fluoroscopic lateral view of the knee, defined by superposition of the lateral and medial condyles, was taken after contrast medium injection through the femoral catheter during the plate impaction and tibial osteotomy by oscillating saw. On each image, the scale was given by a 2-mm diameter wire in the tibia or femur. Four measurements were taken:

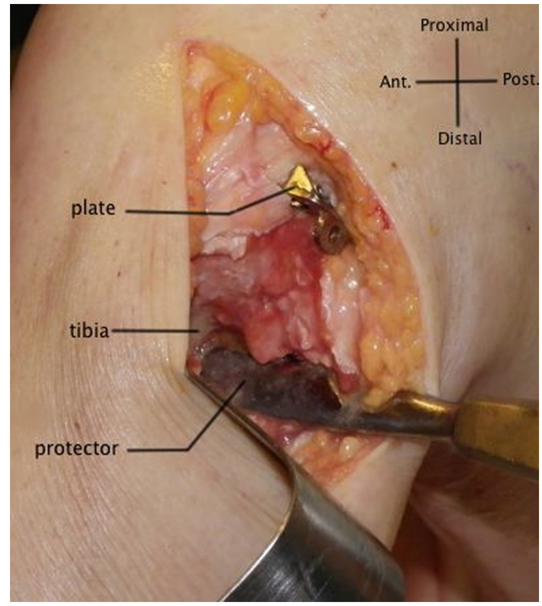

Fig. 1. Left knee tibial osteotomy. Raspatory positioned behind tibia to protect the popliteal artery.

- distance between the popliteal artery and the posterior tibial cortex 2 cm under the joint line;
- distance between the artery and the posterior edge of the plate;
- distance between the artery and the saw-blade (with the blade in stop position);
- distance between the artery and the raspatory at the time of tibial osteotomy (Fig. 2).

The study was repeated on all 6 limbs, and all measurements were taken on fluoroscopic images.

3. Results

All specimens showed a classical arrangement of the popliteal vessels. Results are presented in Table 1. The popliteal artery was 2 cm under the joint line, at a mean 11.7 mm (range, 10.2–12.8) from the posterior tibial cortex, in 90° flexion. When the blade plate was introduced, some 10 mm under the joint line, the mean distance between its posterior edge and the artery was 24.7 mm (20.1–28.1). During distal osteotomy by oscillating saw, some 30 mm under the joint line, the saw-blade was a mean 10.6 mm (7.5–11.8) from the artery, with the knee in 90° flexion. The

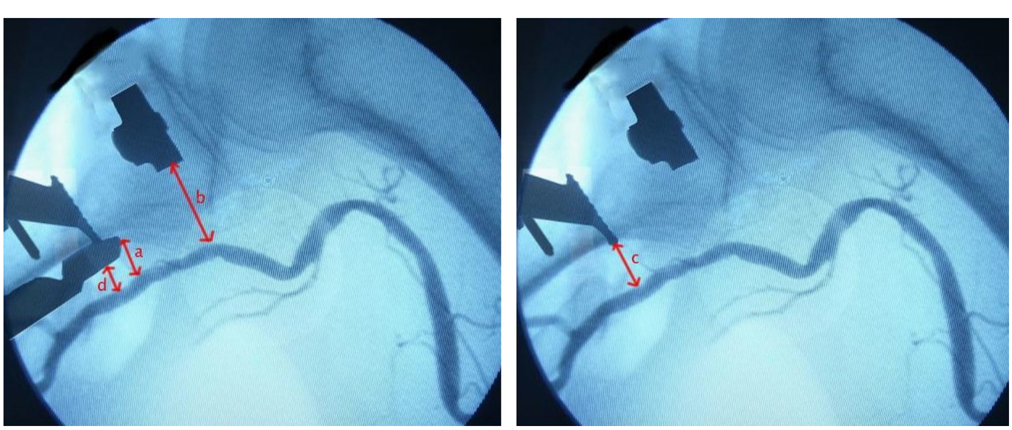

Fig. 2. Measurements on fluoroscopic view: distance between popliteal artery and (a) posterior tibial cortex, (b) blade-plate, (c) oscillating saw and (d) raspatory. 2-mm diameter tibial wire for calibration.