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Case Report

Complete rupture of the popliteal artery complicating high tibial osteotomy

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ABSTRACT

We present two cases of high tibial osteotomies performed at our institution. Both cases were complicated with the immediate postoperative occurrence of an ischaemic syndrome of the lower leg. Urgent diagnostics revealed a complete rupture of the popliteal artery that required re-operation and a vascular repair. Although neurovascular complications during high tibial osteotomies are rare the awareness of this potentially catastrophic complication should be present when performing this common procedure. All precautions to minimize the harm to the neurovascular bundle should be put into practice. A summary of the surgical precautions is presented and discussed in this paper.

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1. Introduction

High tibial osteotomy (HTO) is a common treatment option for symptomatic isolated osteoarthritis of the medial femorotibial compartment. Ideal candidates are young (40–60 years old) active non-smokers with isolated medial knee pain.¹ For a long time the classical lateral closing-wedge HTO technique has been the preferred method. Since the introduction of new implants such as locking plates that provide better fixation, the medial opening-wedge technique, described by Coventry 1965,² has become the most common technique. The main advantage of the medial open-wedge technique is an easier surgical technique without the need of lateral dissection (fibular osteotomy or tibiofibular joint release with potential

harm to the peroneal nerve), more precise angular correction and two-plane correction (coronal and sagittal). Furthermore, biplanar osteotomy below the tibial tubercle avoids the problem of a patella baja³ and preserves bone stock for future total knee replacement.⁴

The most relevant complications of the medial opening-wedge technique are infection, deep vein thrombosis, secondary loss of reduction, fracture of the lateral tibial plateau and delayed- or non-union of the tibial osteotomy.^{5,6} Rare but severe complications that have been reported only as case reports include the compartment syndrome,⁷ necrosis of the tibial head⁸ and injuries of the popliteal neurovascular bundle. Several reports of injuries of the popliteal and anterior tibial arteries exist following lateral closing-wedge HTO.^{9–14} In contrast, vascular injuries after medial opening-wedge

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osteotomy are extremely rare or maybe underreported. A case of a pseudoaneurysm of the popliteal artery after medial opening-wedge HTO was reported by Shenoy et al.¹⁵ and a case of a pseudoaneurysm after corrective HTO by Szyber et al.¹⁶

Vascular injuries after HTO for limb lengthening have been reported as a result of inappropriate pin application from the use of an external fixator. Another cause of vascular injury during limb lengthening was reported as a result of bone distraction more than two months after surgery.¹⁷ Limb lengthening either aggravated an unrecognized arterial injury during surgery or produced a de novo rupture of a scarred artery from previous trauma.

To our knowledge, a complete rupture, as a complication after a medial high tibial osteotomy, has never been reported so far. We present two cases of complete popliteal artery rupture complicating high tibial osteotomy, one after medial HTO and one after limb-lengthening anterolateral HTO. The purpose of this case report is to highlight the potentially catastrophic complication of these procedures, review the literature and present detailed surgical precautions to minimize the risk.

2. Case reports

2.1. Case 1

In a 42-year-old male patient with osteoarthritis in the medial femorotibial compartment, a corrective high tibial osteotomy was performed. The anteromedial proximal tibia was exposed and the laterally incomplete, biplanar, supratuberal medial opening-wedge osteotomy was carried out. The cut was initiated about 3.5 cm below the joint line, continued in an ascending direction towards the tip of the fibula without changing the slope. The osteotomy was completed by the use of chisels (osteotomes). The opening wedge was fixed with a locking plate (TomoFix®, Synthes™) (Fig. 1). The leg was held in slight flexion (about 30°) during the osteotomy. Tourniquet was active for the whole procedure (104 min, 350 mmHg). Before wound closure, the tourniquet was released and profuse bleeding of the osteotomy was observed intraoperatively. However, the source of the bleeding was allocated to the open cancellous bone. The foot pulses were significantly diminished immediately after surgery and the patient developed severe pain and swelling of the left lower leg within the next 12 h. Clinical assessment of the patient revealed decreased sensation of the plantar foot associated with impaired motor function of the foot. We performed an urgent CT angiogram. The diagnosis of a complete rupture of the popliteal artery at the level of the osteotomy (infragenicular part of the popliteal artery, pars III) was confirmed 24 h after surgery (Fig. 2). The vascular surgeons performed urgent revascularization with end-to-end anastomosis with a reversed ipsilateral saphenous vein interposition graft. The intraoperative findings confirmed a sharp dissection of the tibial artery caused by the osteotome. One year after surgery the interposition graft was successfully perfused. Motor function of the foot was normal. Nevertheless, the patient still suffered from sensibility disorders in the sole in combination with chronic pain.

Fig. 1 – Intraoperative anteroposterior radiograph of the knee that shows the medial opening high tibial wedge osteotomy and its fixation with a locking plate (TomoFix®, Synthes™).

2.2. Case 2

A 26-year-old female with a history of clubfoot presented with a leg length discrepancy of 4 cm. Initially, an external fixator (Monotube Triax®, Stryker™) was applied anteriorly. Through

Fig. 2 – CT angiogram of both legs immediately after surgery that shows a complete rupture of the tibial artery at the level of the osteotomy.

an anterolateral approach to the proximal tibia the posteriorly incomplete high tibial osteotomy was performed with the oscillating saw from the lateral to the medial metaphysis in a slight ascending direction. After insertion of a protecting retractor around the posterolateral cortex, the osteotomy was completed by the use of osteotomes. Through a lateral additional incision the fibula-osteotomy was carried out under protection of the peroneal nerve. The distraction was not applied yet. Throughout the procedure a tourniquet was applied (350 mmHg for 50 min). Immediately postoperatively, the foot pulses were diminished on palpation and the patient complained of severe pain during the following 24 h. Additionally, she presented with a swollen, warm leg with diminished sensation over the foot sole and a palsy of the foot extensors. An urgent MRI was performed and 48 h after surgery the diagnosis of a complete rupture of the popliteal artery (infragenicular part, pars III) was confirmed. The tibial nerve was intact on imaging. The patient was taken to urgent revision with removal of the external fixator and internal fixation of the proximal tibial osteotomy with a locking plate (NCB™ lateral proximal tibia). After that, the vascular surgeons performed an urgent revascularization with end-to-end anastomosis with a reversed ipsilateral saphenous vein interposition graft. The intraoperative findings confirmed a sharp dissection of the tibial artery caused by the osteotome. In the latest follow-up the patient still suffered from plantar hypaesthesia and paresis of the foot.

3. Discussion

We report on two cases with complete rupture of the popliteal artery after high tibial osteotomy both of which were complicated by an acute ischaemic syndrome of the lower leg and required urgent vascular surgery.

Although in HTO procedures the popliteal or the anterior tibial arteries are at risk injuries to the neurovascular bundle are rare and the literature is based only on case reports. Most of the of injuries of the popliteal and anterior tibial arteries occurred during lateral closing-wedge HTO,^{9–14} only two cases of vascular injuries were reported following medial opening-wedge HTO.^{15,16} In both cases, a pseudoaneurysm of the popliteal artery was documented but no acute complete rupture.^{9–14}

The following factors in HTOs are important and are discussed critically.

3.1. Type of osteotomy

In the first case, high tibial osteotomy was performed in a medial opening-wedge technique for the treatment of uni-compartmental lateral osteoarthritis of the knee. It was performed from an anteromedial approach to the proximal tibia. The proximal tibia was exposed as far as to the anterior border of the medial collateral ligament. The ligament itself was not released. A high frequency oscillating saw was used, starting anteromedial on the tibia continuing in an ascending direction pointing to the tip of the fibula. Laterally, the cortex of the tibia was kept intact in order to improve osteotomy gap healing.

The second case underwent lateral high tibial combined with proximal fibular osteotomy for limb lengthening. The approach was from anterolateral, stripping off the anterior tibial muscle. The osteotomy was carried out in an oblique direction in the metaphysis to increase the area of bone healing.

3.2. Technique of osteotomy

For the medial opening-wedge osteotomy in case 1, a biplanar supratuberal technique was performed whereas the limb-lengthening osteotomy in case 2 was a single plane osteotomy.

The wedge osteotomy was carried out in the same plane as the joint line in order not to change the slope. The angle of the saw blade relative to the posterior cortex seems to be relevant too. Kim et al¹⁸ compared different saw angles relative to the coronal plane in cadaver knees and found that angles greater than 30° could harm the popliteal artery and recommended keeping the saw angle as flat as possible. The limit of the flat saw angle is the integrity of the medial collateral ligament. If flatter angles need to be achieved, the ligament needs complete or at least partial release. The role of the MCL release in valgus-producing high tibial osteotomy and increased stress on the MCL with possible medial instability is controversial.¹⁹ Nevertheless, sufficient medial exposure for orientation and protection is mandatory for a safe osteotomy.

With both patients a chisel (osteotome) was used to complete the cut of the posterior tibial cortex in order to have more manual control. To protect the popliteal artery, a blunt retractor was inserted. As the popliteal artery runs posterior to the popliteus muscle the general impression is that a retractor placed anterior to the popliteus muscle would protect the vessels. According to the literature, there is an anatomical variance in the division of the popliteal artery. An aberrant high branching of the anterior tibial artery running posterior to the popliteus muscle was reported in several studies^{20–22} and prevalence ranges between 2 and 8%. If preoperative MRI imaging is available the aberrant course might be seen and careful study of the images is recommended. Mostly, preoperative MRI is not present and therefore, careful exposure of the posteromedial structures must be done to make sure the retractor lies directly on the posterior cortex.

3.3. Position of the knee

Both procedures were performed with the knee in only slightly flexed position (about 30°). The general recommendation is that the osteotomy should be performed with the knee in 90° flexion as once suggested by Coventry.³ The common understanding is that the vessels move away from the posterior cortex when the posterior soft tissues are relaxed. Most of the recent literature with MRI-, ultrasonography- or cadaver-studies underpins this suggestion. Shetty et al²³ used duplex ultrasonography of 100 knees to compare the distance of the popliteal artery to the posterior tibial cortex in full extension and 90° flexion. He found that in most cases the distance increased in flexion (76% between 1 and 1.5 cm below the joint line and 85% between 1.5 and 2 cm). Nevertheless, the remaining cases showed an opposite behaviour where the

popliteal artery still moved towards the posterior tibial cortex in 90° of flexion. The popliteal artery is relatively fixed at the origin of the anterior tibial artery and the genicular arteries²⁴ and might explain the posterior displacement of the popliteal artery during flexion. Also, the opposite behaviour might be explained if these vessels show a slight aberrant course. Kim et al¹⁸ performed cadaver studies, which showed an increase of distances in 90° of flexion (plus 6.1 mm and 4.8 mm 0.5 cm and 2 cm below the joint line).

In conclusion, the knee should be flexed in 90° during the osteotomy, although this position does not guarantee that the vessels are safe and care should be taken anyway.

3.4. Tourniquet

In both procedures a tourniquet was applied and activated throughout the procedure. Before the wound closure the pressure was released to check haemostasis. There is normally a large amount of bleeding out of the cancellous bone of the osteotomy site. Nevertheless, the experienced surgeon should have a high index of suspicion if there is profound bleeding after tourniquet release and further diagnostic work-up should not be delayed. Therefore, release of the tourniquet before wound closure is advocated in order to assess the amount of bleeding.

3.5. Postoperative surveillance

Immediately postoperatively, both our patients had diminished foot pulses, a fact that was noticed, but no further examination was performed straight away. During the following night both patients suffered from uncontrollable, severe pain and presented with a swollen lower leg, decreased foot pulses on palpation with delayed capillary refill time and increasing sensibility disorders in the sole and motor dysfunction of the foot. The lower leg was warm in both cases due to sufficient collateralisation. The swelling caused by oedema was probably more likely to be a result of a compression of the popliteal vein by the surrounding haematoma. Similarly, neurologic disorders were most likely caused by compression of the tibial nerve as the revision of the tibial nerve proved continuity. Overall, it is important to assess the foot pulses preoperatively and immediately postoperatively for comparison by the same person, best by the operating surgeon. If any difference is noted postoperatively further investigation should not be delayed.

3.6. Postoperative emergency imaging

If vascular injury is suspected urgent imaging is mandatory, ideally with duplex-sonography or CT angiogram.

In conclusion, all precautions to minimize the harm to the neurovascular bundle should be put into practice. Therefore, the knee should be held in 90° flexion during the osteotomy, the retractor should be placed deep to the posterior cortex beneath the popliteal muscle, the tourniquet should be released before wound closure assessing the amount of bleeding and the saw angle should be kept below 30°. Nevertheless, the clinical presentation of a complete popliteal rupture with uncontrollable pain, swelling and neurological

disorders should ring alarm bells. The foot pulses immediately after surgery should be checked with a high index of suspicion. Examination should be carried out without delay and with a low threshold in order to intervene as urgent as possible to prevent further damage.

Disclosure

Each author certifies that he or she has no commercial associations (eg, consultancies, stock ownership, equity interest, patent/licensing arrangements, etc) that might pose a conflict of interest in connection with the submitted article.

Conflicts of interest

All authors have none to declare.

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