CASE REPORT

Delayed compartment syndrome of leg and foot due to rupture of popliteal artery pseudoaneurysm following posterior cruciate ligament reconstruction

Ahmad Shahrulazua,¹ Mahidon Rafedon,¹ Mohd Nasir Mohd Nizlan,² James Anthony Sullivan³

¹Sports Injury Unit, Department of Orthopaedic and Traumatology, Universiti Kebangsaan Malaysia Medical Centre, Cheras, Kuala Lumpur, Malaysia

²Orthopaedic Department, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Serdang, Selangor, Malaysia

³Department of Orthopaedics, Australian School of Advanced Medicine, Macquarie University Hospital, Sydney, New South Wales, Australia

Correspondence to

Dr Shahrulazua Ahmad, drshahahmad@hotmail.com

SUMMARY

Arthroscopic posterior cruciate ligament (PCL) reconstruction carries some risk of complications, including injury to the neurovascular structures at the popliteal region. We describe a delayed presentation of the right leg and foot compartment syndrome following rupture of popliteal artery pseudoaneurysm, which presented 9 days after an arthroscopic transtibial PCL reconstructive surgery. Fasciotomy, surgical exploration, repair of an injured popliteal vein and revascularisation of the popliteal artery with autogenous great saphenous vein interposition graft were performed. Owing to the close proximity of vessels to the tibial tunnel, special care should be taken in patients who undergo arthroscopic PCL reconstruction, especially if there is extensive scarring of the posterior capsule following previous injury. Emergency fasciotomy should not be delayed and is justified when the diagnosis of compartment syndrome is clinically made.

BACKGROUND

One of the rare and most feared complications of transtibial posterior cruciate ligament (PCL) reconstruction is injury to the popliteal vessels.^{1 2} We report a case of a delayed presentation of popliteal artery pseudoaneurysm rupture following an arthroscopic transtibial PCL reconstruction. To our knowledge, this delayed presentation of compartment syndrome at 9 days has not been reported in the literature.

CASE PRESENTATION

A 28-year-old man with no previous medical illness met with a motor vehicle accident in the year 2007. He suffered multiple injuries to his right lower limb consisting of an open fracture of mid-shaft of the right femur, a close fracture of distal third of the right tibia and fibula and an avulsion fracture of the right PCL at the tibial insertion. The femur and tibia fractures were treated with intramedullary nails and the fibula fracture was fixed with a plate. The avulsed PCL insertion was treated conservatively. The patient's femoral and tibial fractures united satisfactorily and all his implants were removed in the year 2010.

He was subsequently referred to our tertiary centre (Universiti Kebangsaan Malaysia Medical Centre), with a progressive right knee pain and instability despite physiotherapy. Clinical examination of the right knee revealed a positive posterior

sagging sign with a grade-III posterior drawer test. The other ligaments were intact. His right lower limb showed normal neurovascular status. Plain radiograph showed presence of a malunited avulsion fracture of the PCL. MRI confirmed an abnormally elongated PCL while the other ligaments of the knee were normal (figure 1). The patient was advised to have surgery due to his persistent symptoms of instability.

He underwent an arthroscopic single-bundle transtibial PCL reconstruction³ with autologous hamstrings graft under combined spinal-epidural anaesthesia in March 2011. An additional posteromedial (PM) portal was used to improve visualisation. There was abundant fibrous tissue posteriorly and the posterior capsule was more adhered to the posterior tibia than normally encountered. This was released using an arthroscopic rasper. The fibrous tissue and redundant PCL were partially debrided for ease of tunnel preparation using motorised shaver and radiofrequency device. The malunited fragment of the PCL tibial footprint was smoothed by a round burr. The tibial tunnel was reamed to 8 mm size with the knee in 90° flexion, exiting about 15 mm from the articular surface. The insertion of the guide pin and reaming were performed under fluoroscopic control. A curette was inserted through the PM portal to protect the posterior knee neurovascular structures from pin penetration during pin advancement and reaming. The femoral tunnel was created using 'outside-in' technique from the anteromedial femur cortex and exited at about 6 mm deep to the articular margin at one o'clock position. The graft was passed intra-articularly and fixed at both tunnels using bio-degradable interference screws. While fixing at the tibial side, the knee was placed at 70° flexion with anterior drawer force applied to the proximal tibia. There was no abnormal bleeding observed arthroscopically at the posterior capsule. The total tourniquet time was 135 min at 300 mm Hg pressure, and the pulses of the foot were normal when examined immediately after the surgery.

Postoperatively, the patient's knee was immobilised immediately in extension with a cylinder slab. There was minimal bleeding noted from his external wounds. The swelling on his knee was moderate and consistent with the surgery. He remained comfortable while in the ward. The cylinder slab was converted to a full cast with anterior drawer force applied to the proximal tibia on postoperative

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To cite: Shahrulazua A, Rafedon M, Mohd Nizlan MN, et al. *BMJ Case Rep* Published online: [please include Day Month Year] doi:10.1136/bcr-2013-202098

Figure 1 Preoperative MRI (sagittal) showing an abnormal elongated posterior cruciate ligament (PCL) structure (chevron sign) and a malunited avulsion fracture of the PCL insertion (arrow sign).

day 3. The patient was taught to mobilise weight-bearing as tolerated, using crutches, and was discharged as per department protocol on day 4 postoperatively.

On day 9 postsurgery, the patient presented to accident and emergency (A&E) department with 2 days of increasing pain in his right leg and foot. The cylinder cast was removed. Marked tenderness and swelling was noted on his right leg, foot and toes including the popliteal fossa area. There were also multiple blisters over the leg. Multiple strong analgesia medications were given but his right leg and foot pain persisted and was exacerbated by passive movement of his ankle and toes. He also developed altered sensation over the dorsum of his foot. The right leg distal pulses were weak to palpation and the capillary refill time for toes was prolonged.

INVESTIGATIONS

An urgent Doppler ultrasound of his right leg showed no evidence of deep vein thrombosis although the popliteal vein was

Figure 2 CT angiogram (axial) image with an arrow showing pseudoaneurysm of the right popliteal artery that was filled by contrast material.

not clearly visualised. An anechoic sac was seen communicating with the right popliteal artery, which demonstrated positive colour Doppler signal. An urgent CT angiogram (CTA) of his right lower limb was performed, which demonstrated extraluminal extravasation of contrast from the mid-right popliteal artery at the level of posterior tibial plateau adjacent to the PCL tunnel site, measuring about 2.4×4×4.6 cm (anteroposterior×medial-lateral×craniocaudal) in keeping with a pseudoaneurysmal sac (figure 2). There was still opacification of the right tibioperoneal trunk and its branches with normal calibre. An early opacification of the right superficial femoral vein was seen starting approximately 1.1 cm above the level of the sac, from collateral flow through the greater saphenous vein. No evidence of arteriovenous fistula was seen. The right calf was swollen, particularly the muscles within the posterior compartment.

DIFFERENTIAL DIAGNOSIS

The features shown by the CTA were suggestive of a popliteal artery pseudoaneurysm with evidence of posterior leg compartment syndrome. The diagnosis of compartment syndrome of the right leg and foot was made clinically based on combination of patient's symptoms and physical signs. These included spontaneous onset of progressive pain that was out of proportion to that expected after a PCL surgery, increased pain on passive stretching of the affected muscle compartments, tenderness and tense swelling of the leg and foot, paraesthesia over the dorsal foot and reduced distal pulses. The altered sensation on the dorsal foot possibly signified coexisting anterior and lateral leg compartment syndrome, in addition to the posterior compartment. The development of a combined leg and foot compartment syndrome is possible since a communication between calcaneal and deep posterior leg compartments has been shown to exist.^{4 5}

Although an overlap of clinical manifestations could occur when compartment syndrome and vascular injury are present as in this patient, the symptom of disproportionate pain that is unresponsive to maximum analgesia is more characteristic of compartment syndrome.^{4 6 7} On the other hand, lack of palpable pulses is an uncommon and very late finding in compartment syndrome as the pressure that causes the compartment syndrome is often well below the arterial pressure.^{4 6} It is most likely that the vascular injury had led to reduced distal pulses and that continuous bleeding from the popliteal vessels or rupture of pseudoaneurysm had caused an increase in the intrafascial and interfascial posterior leg compartments with a subsequent pressure effect on the other compartments of the leg and foot. The presence of cast on the patient's leg might have aggravated the compartment syndrome but is unlikely to be the cause since the patient presented 6 days after the application and the removal of the cast did not improve his conditions. The patient was not prescribed any thromboprophylaxis, before or after the PCL surgery, which might greatly affect the development of his symptoms.

TREATMENT

Emergency fasciotomy of the right leg was performed via a double skin incision technique⁸ and of the right foot using two dorsal and one medial plantar skin incisions⁴ within 6 h of his presentation to the A&E department. All the four compartments of the leg and the nine compartments of the foot were decompressed. The underlying swollen muscles bulged out once the fascias were opened. A large amount of haematoma consisting of fresh and clotted blood was evacuated from the superficial and deep posterior compartments of the right leg (figure 3).

Figure 3 Intraoperative picture of the right leg fasciotomy showing medial incision and the release of haematoma from the posterior compartment containing extravasated fresh and clotted blood.

There was also necrosis of some parts of the posterior compartment muscles which were debrided (figure 3). The popliteal fossa was explored by a vascular surgeon by extending the medial leg fasciotomy incision. The popliteal artery diameter was found to be 75% transected and half of the popliteal vein diameter was also transected at the level just below the knee joint, causing pseudoaneurysm with evidence of active bleeding. Revascularisation with autogenous great saphenous vein interposition graft was performed for the artery while the popliteal vein was primarily repaired. At the end of the procedure, all the affected muscles were confirmed viable with good contractility.

OUTCOME AND FOLLOW-UP

Four days later, the distal graft anastomosis of the right popliteal artery needed revision, which was repaired successfully. At day 16 after the second operation, the right leg medial fasciotomy wound was closed with split skin graft (SSG), and all other fasciotomy wounds on the right leg and foot were closed by delayed primary suturing. The right leg was immobilised with a long-leg backslab that was then converted to a hinged-knee brace after 5 days post-SSG surgery. The patient subsequently underwent rehabilitation for his previously reconstructed PCL and recovered well with no further complication. His last follow-up review was in September 2013 (about 30 months after the PCL surgery). Apart from a slightly reduced sensation over the previously skin-grafted area, the motor and other sensory functions of the right leg and foot were normal. The range of motion of the right knee was similar to the contralateral one. The knee remained stable and the posterior drawer test showed only a grade-I laxity.

DISCUSSION

Knee arthroscopy is generally a safe procedure although rare complications such as popliteal artery and vein lacerations have been documented.^{2 9–11} On the other hand, arthroscopic PCL

reconstruction surgery is a technically demanding procedure and carries unique risks due to the close proximity of the popliteal neurovascular structures to the PCL.¹ An increased risk of injury to these vital structures may occur when there is scar tissue at the posterior knee, as illustrated in our patient, which most likely developed following the previous avulsion fracture injury. The presence of the posterior knee fibrous tissue may complicate dissection and cause aberrant position of the neurovascular structures.^{1 2 11}

Injury to the popliteal vessels has been described from distension of the scarred joint capsule by the arthroscopic fluid, during creation of PM portal, through manipulation of the posterior capsule when released from the PCL and posterior tibia, during debridement of the PCL stump or when drilling the tibial tunnel.^{2 10 11} Several recommendations have been proposed to prevent the occurrence of this complication.^{1 10 11} In our patient, intraoperative fluoroscopy was used to confirm the guidewire placement and to monitor the drilling and reaming process, which was performed with the knee in 90° flexion in an attempt to move the vessels posteriorly away from the capsule. Furthermore, a curette was used to protect the guide pin and prevent inadvertent pin advancement especially during reaming. Although the exact cause of the popliteal vessels injury in our patient is unclear, the CTA showed that the pseudoaneurysmal sac laid adjacent to the tunnel exit, suggesting that the injury was closely related to the creation of the tibial tunnel. The risk of injury to the popliteal vessels during drilling of the tibial tunnel may be reduced by using a spade tip rather than trochar tip guidewire, a tapered drill bit and oscillating drill mode.^{1 10} The use of an arthroscopic infusion pump pressure at the lowest level feasible may help to reduce the joint distension and prevent compression of the posterior capsule against the popliteal vessels.¹¹ It has been suggested that arthroscopic limited posterior release using a posterior trans-septal portal could also minimise the risk of injury to the popliteal vessels.¹ The danger associated with the PM portal placement, especially in a patient with an altered posterior anatomy, may be reduced by making a larger PM safety incision so that the surgeon's finger can bluntly access the posterior capsule for palpation and protection during creation of the tibial tunnel.¹ An open PCL reconstructive surgery using a tibial inlay technique should be seriously considered as a safer alternative.¹

Previous literatures have reported the infrequent occurrence of popliteal artery pseudoaneurysm following arthroscopic knee surgeries.^{2 9 12–16} It is more likely to develop from an unrecognised partially damaged vessel with blood dissecting into the surrounding tissues as illustrated in our patient.¹⁵ Presentation of pseudoaneurysm can occur immediately or can be as late as more than 4 years after surgery.^{2 9 13 14 16–18} In contrast to our case report, popliteal artery pseudoaneurysm usually presents with a painful pulsatile popliteal mass without signs of limb ischaemia.^{9 12 13 15} Our case is interesting because of its unusual presentation of the delayed onset of acute compartment syndrome. It may be that the progressive pain experienced by the patient over the 2 days prior to his presentation was related to the increasing size of the popliteal artery pseudoaneurysm that eventually ruptured due to further space restriction by cast application, leading to the development of compartment syndrome. Although acute compartment syndrome following an arthroscopic PCL surgery may occur due to fluid extravasation into the leg compartments or due to improper positioning of the patient during the surgery¹; to our knowledge, this is the first report describing the association of compartment syndrome with pseudoaneurysm of popliteal artery.

The measurement of compartment pressure is not essential when the diagnosis is clinically evident.^{6,7} Furthermore, the critical level of the absolute intracompartmental pressure varies between individuals and remains debatable, ranging from 30 to 50 mm Hg.⁶ More importantly, treatment with urgent fasciotomy must not be delayed to maximise the chance of neuromuscular viability and prevent long-term debilitating sequelae.^{4,6–8} The immediate intervention of fasciotomy and surgical exploration of popliteal artery pseudoaneurysm with vascular repair has led to good clinical outcomes achieved in our patient. Delay of treatment can be devastating and may result in amputation.^{5,7,17,19}

Learning points

- ▶ Malunion of tibial avulsion of posterior cruciate ligament (PCL) is likely to be associated with scarring of posterior tissues and increased risk to popliteal vessel injury in patients undergoing arthroscopic transtibial PCL reconstruction.
- ▶ Bleeding from pseudoaneurysm of popliteal artery can lead to delayed presentation of acute compartment syndrome.
- ▶ Compartment syndrome requires clinical diagnosis, and intracompartmental pressure measurement is not critical in a conscious patient with characteristic symptoms and signs.
- ▶ Early diagnosis and prompt surgical treatment, which include revascularisation and fasciotomy, are keys to success in the treatment of these limb-threatening and life-threatening complications.

Acknowledgements The authors would like to thank Dr Mohd Ikraam Ibrahim and Dr Ahmad Farihan Mohd Don for their involvement in the preparation of this manuscript.

Contributors All the authors contributed significantly to this case report. AS and MR identified and managed the case; reviewed the literature and drafted the report. AS, MNMN and JAS critically appraised and revised the report for important intellectual content. All the authors have approved the final version for submission.

Competing interests None.

Patient consent Obtained.

Provenance and peer review Not commissioned; externally peer reviewed.

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