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Case report

Compartment syndrome as reperfusion injury following thrombectomy in acute limb ischemia: A case report

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ABSTRACT

BACKGROUND: Compartment syndrome following reperfusion in acute limb ischemia represents a rare but serious complication. Thus, documenting such cases is essential to enhance comprehension and management of this condition.

CASE PRESENTATION: A 51-year-old man was referred from an urban hospital presenting with severe right leg pain persisting for 5 days prior to admission, accompanied by pulselessness, paresthesia, poikilothermia, and paralysis. The patient had underlying risk factors including uncontrolled diabetes mellitus and active smoking. Duplex ultrasound confirmed the diagnosis of acute limb ischemia, which was further supported by CT angiography revealing total occlusion from the right common iliac artery to the distal region. Intravenous heparin was administered, and the patient underwent emergency surgical thrombectomy. Following the intervention, the patient developed clinical signs of compartment syndrome as a manifestation of reperfusion injury, necessitating fasciotomy. Subsequent evaluation of the wound post-fasciotomy indicated it was not suitable for closure, and unfortunately, the patient passed away a few days later.

CONCLUSION: This case illustrates acute limb ischemia necessitating thrombectomy and surgical fasciotomy due to compartment syndrome resulting from reperfusion injury, emphasizing the importance of rigorous monitoring.

KEYWORDS: Acute limb ischemia; thrombectomy; reperfusion injury; compartment syndrome; fasciotomy.

INTRODUCTION

Acute limb ischemia is a critical cardiovascular emergency characterized by a sudden and severe reduction in blood flow to a limb, posing a substantial risk to its viability. Despite its relatively low incidence, estimated at approximately 9 to 16 cases per 100,000 individuals annually for the lower extremities and 1 to 3 cases per 100,000 overall, the condition has profound implications for patient health.[1] The mortality rate within 30 days is reported to be between 15% and 20%, with a high associated amputation rate ranging from 10% to 15%.[2] Therefore, the management of acute limb ischemia is paramount, emphasizing the urgent need for early revascularization interventions to halt thrombus propagation and prevent irreversible ischemic damage.[3] However, these interventions are not without significant risks. Complications such as compartment syndrome can arise, potentially leading to further

challenges in patient recovery.[4] Thus, while early revascularization is crucial for improving outcomes, careful consideration of associated risks is essential in guiding clinical decision-making and optimizing patient care.

Compartment syndrome is characterized by increased pressure within an anatomical compartment of the body, leading to inadequate blood supply to the tissues within that space.[5] The prevalence of compartment syndrome following reperfusion in cases of acute limb ischemia is relatively low but represents a serious complication that can occur after revascularization procedures. According to one study, compartment syndrome was observed in 5 out of 22 patients with non-traumatic acute limb ischemia, accounting for approximately 23% of cases.[6] Another study reported a 30% incidence of compartment syndrome in patients with traumatic limb injuries, indicating a higher prevalence compared to non-traumatic cases of acute limb ischemia.[7] Compartment syndrome manifests with severe swelling of the affected limb, typically the calf, necessitating fasciotomy to alleviate compartment pressure. Tissue ischemia can develop due to increased intra-compartment pressure. Neuropraxia is reversible with as little as one hour of tissue ischemia, while four hours can result in irreversible axonotmesis. Prolonged ischemia exceeding six hours is associated with permanent necrosis and is more likely to cause functional impairment.[8] Due to its rarity and serious complications, discussing cases of compartment syndrome following reperfusion in acute limb ischemia is crucial. This article aimed to provide a comprehensive overview of the occurrence of compartment syndrome following reperfusion in acute limb ischemia, emphasizing the need for thorough and serious management of this condition.

CASE PRESENTATION

A 51-year-old man with multiple risk factors, including hypertension, uncontrolled diabetes mellitus, and active smoking, presented to our hospital with complaints of right leg pain persisting for the past 5 days, initially rated at 3/10 on the Numeric Rating Scale (NRS). Initially, the pain worsened with activity and improved with rest, but it intensified over the last 3 days before admission to a previous hospital, reaching an NRS of 8/10 and becoming unresponsive to rest (Figure 1A). The patient had been undergoing treatment for left ventricular thrombus for the past 7 months. Upon evaluation at the regional hospital, he was diagnosed with acute limb ischemia and received an 80 units/kgBW heparin bolus followed by an 18 units/kg/hour drip, without showing clinical improvement. Upon arrival at our emergency room, the patient was hemodynamically stable with a blood pressure of 106/71 mmHg, a regular heart rate of 76 bpm, a respiratory rate of 20 breaths per minute, a temperature of 36.7°C, and oxygen saturation of 97% on room air. Physical examination revealed bluish discoloration and pulselessness in the right tibial region, accompanied by severe pain, pallor, paresthesia, and coolness. Sensory impairment was noted in the right tibial region, and saturation oximetry detected no signal in the toes of the right foot.

The ECG showed sinus rhythm at 78 bpm with normal atrial and ventricular complexes, a PR interval of 120 ms, and a QRS duration of 100 ms. Biphasic P waves with a negative P portion exceeding 40 ms, as well as a Sokolow-Lyon index indicating left ventricular hypertrophy and poor R wave progression, were observed. Chest X-ray findings included aortic sclerosis, cardiomegaly, and signs of pulmonary congestion. Laboratory results revealed leukocytosis (12,460/uL), azotemia with urea levels of 71.5 mg/dL and creatinine at 0.99 mg/dL, and elevated D-dimer levels (10.75 mg/LFEU). Duplex ultrasonography (Figure 1B-G) detected thrombi measuring 0.49 cm x 0.32 cm at the right distal femoral artery and 0.41 cm x 0.36 cm at the right

popliteal artery. Monophasic spectral Doppler (Figure 2) flow was noted from the right iliac artery to the right distal femoral artery, with no detectable flow distally from the right popliteal artery. The patient was diagnosed with acute limb ischemia of the right lower extremity, graded as IIB to III. CT angiography (Figure 1H) confirmed multiple total occlusions at the right common iliac artery, right external iliac artery, proximal right internal iliac artery, right distal superficial femoral artery, right popliteal artery, right posterior tibial artery, right peroneal artery, and right plantar artery.

Figure 1. Diagnostic imaging and clinical presentation of acute limb ischemia. (a) Clinical picture showing bluish right lower leg. (b, c) Monophasic spectral Doppler from right iliac artery to right distal femoral artery. (d) Thrombus at right distal femoral artery. (e) Thrombus at right popliteal artery. (f, g) No flow at distal artery. (h) CT angiography showed total occlusion of the right common iliac artery and total occlusion of the right distal femoral artery.

The patient's management plan involved urgent thrombectomy and continuous intravenous heparin at 18 units/kg/hour. He also received 2 mg of IV morphine for pain relief, subcutaneous basal insulin at 16 IU, and three doses of short-acting insulin at 10 IU each. Twice daily, he received 20 mg of intravenous furosemide. Oral medications included atorvastatin 40 mg, spironolactone 25 mg, bisoprolol 5 mg, isosorbide dinitrate 15 mg, ramipril 5 mg, N-acetylcysteine 600 mg three times daily, allopurinol 300 mg, vitamin E 400 mg three times daily, and nabumetone 500 mg three times daily. Following thrombectomy, the patient was clinically reassessed and diagnosed with developing compartment syndrome, presenting with persistent pain, paresthesia, poikilothermia, pulselessness, and paralysis. Subsequent duplex sonography indicated improved distal flow compared to the initial examination, leading to scheduling of a fasciotomy (Figure 3A-B). Evaluation three days post-fasciotomy revealed no signs of local infection but indicated the wound was not ready for closure (Figure 3C). A debridement performed five days later showed clear wound conditions. However, despite plans for closure, the patient's condition deteriorated.

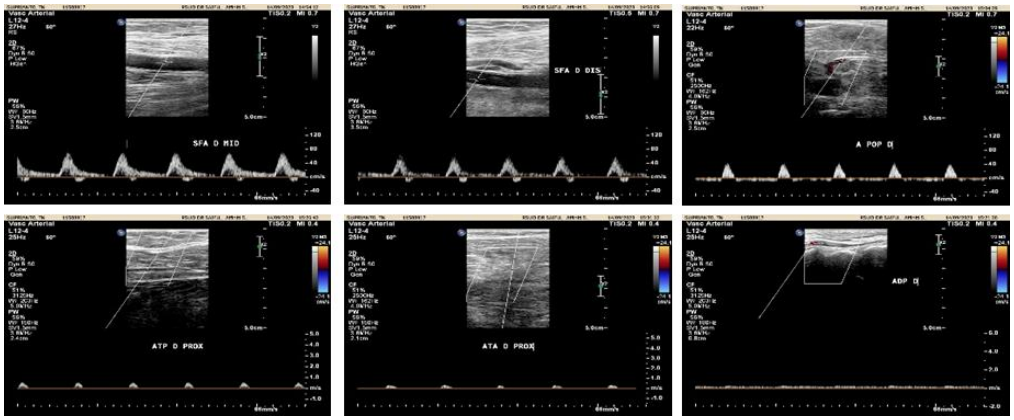

Figure 2. The images above display multiphasic spectral Doppler readings from the right femoral artery to the right popliteal artery. The final three images depict monophasic spectral Doppler readings at the distal arteries.

DISCUSSION

Our study presented a middle-aged man who presented with acute limb ischemia requiring surgical thrombectomy to address thrombotic occlusion and restore distal blood flow. Following successful revascularization, the patient developed compartment syndrome as a severe consequence of reperfusion injury, necessitating immediate fasciotomy to alleviate escalating intra-compartmental pressures and mitigate tissue damage. This case is noteworthy for its rarity and the complex management challenges it posed. At the time of our investigation, only a limited number of similar cases were documented in the literature—specifically, four case reports.[4,9-11] These reports collectively underscore the unpredictable nature of compartment syndrome following reperfusion in acute limb ischemia, emphasizing the critical need for vigilant monitoring and comprehensive clinical strategies to effectively manage such complications.[4,9-11]

In our case, vascularization post-intervention was assessed using duplex sonography, revealing multiphasic flow from the right iliac artery to the right popliteal artery and monophasic flow distally. However, within two days post-thrombectomy, the patient developed ipsilateral leg edema, coldness, and inability to move his right fingers or foot, indicative of acute compartment syndrome. Symptoms included paresthesia, poikilothermia, pallor, pulselessness, and paralysis. While distinguishing compartment syndrome from arterial ischemia remains debated due to overlapping symptoms, in this instance, it resulted from reperfusion injury post-thrombectomy.[12] Early clinical intervention was critical to prevent irreversible tissue damage like limb gangrene, rhabdomyolysis, and acute kidney injury.[13] Therefore, surgical fasciotomy was performed to relieve pressure and preserve muscle and nerve function. Literature indicates muscle ischemic necrosis can occur within three hours post-injury, with severity escalating significantly after four to eight hours of ischemia.[3] Study reported necrosis rates of 20%, 30%, and 90% after three, four, and five hours of ischemia, respectively.[14] Factors influencing fasciotomy decision in acute limb ischemia include renal insufficiency, Rutherford classification IIb, and open vascular surgery, with lower risk associated with anemia and female gender.[15] In our case, the male patient had azotemia and was Rutherford IIb without anemia, justifying fasciotomy. Despite these considerations, routine prophylactic fasciotomy is not recommended due to associated risks and potential complications.[16]

After fasciotomy, the patient was closely monitored in the cardiac intensive care unit for potential complications, including altered limb sensation, dry skin, itching, wound discoloration, limb swelling, tethered scar, recurrent ulcers, muscle herniation, and pain. Three days post-fasciotomy, wound assessment revealed no signs of infection but deemed the wound unsuitable for closure. Optimal management typically involves leaving wounds open for delayed primary closure or skin grafting within 7-10 days after complete resolution of compartment syndrome.[17] A subsequent debridement performed five days later also found the wound not ready for closure. Unfortunately, the patient's condition deteriorated further, complicated by worsening pneumonia and respiratory failure, which ultimately led to mortality. Our case aligns with studies reporting poor prognosis following fasciotomy post-thrombectomy, with mortality rates within 30 days ranging from 11% to 36%.[16]

Figure 3. Clinical and surgical interventions for acute limb complications. (A) Clinical image demonstrating leg swelling. (B) Fasciotomy performed on the right lower leg. (C) Debridement following fasciotomy.

This study had several acknowledged limitations. Firstly, our case was constrained by incomplete data regarding the patient's medical history and prior treatments, which hindered our ability to definitively explain the underlying cause of acute limb ischemia in this patient. Secondly, the study was a case report. While case reports offer valuable insights into individual cases, their ability to generalize to a broader population is often limited by their lack of statistical power and generalizability compared to larger, controlled studies. Furthermore, the study's conclusions were drawn from a single patient, thus restricting the extent to which the findings could be extrapolated and applied to other patients.

CONCLUSION

In conclusion, this case study presents a rare instance of acute limb ischemia in a male patient necessitating thrombectomy for thrombus removal and distal revascularization. However, the development of compartment syndrome following reperfusion injury necessitated surgical fasciotomy. This report highlights the crucial importance of rigorous monitoring in the management of such conditions.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

CONSENT FOR PUBLICATION

Not applicable.

AVAILABILITY OF DATA AND MATERIALS

Data used in our study were presented in the main text.

COMPETING INTERESTS
Not applicable.

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AUTHOR CONTRIBUTION
Conceptualization: MA; Data Curation: MA, NK, DAK; Formal Analysis: MA, NK, DAK; Investigation: MA, NK, DAK; Project Administration: YRKAW; Resources: YRKAW; Methodology: MA, NK, DAK; Software: MA, NK, DAK; Visualization: MA, NK, DAK; Supervision: NK, DAK; Validation: NK, DAK; Writing – Original Draft Preparation: MA, NK, DAK; Writing – Review & Editing: NK, DAK. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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