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Case report

Intravascular balloon to minimize blood loss during total hip replacement in a Jehovah's Witness☆,☆☆

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Abstract Intermittent intravascular occlusive balloons are commonly used to minimize bleeding in cases where massive blood loss is anticipated. However, the efficiency and safety of balloon occlusion remains unclear for elective procedures, and several cases of distal thrombosis have been reported. A case of intra-arterial occlusive balloon that was selectively placed preoperatively to minimize bleeding in a patient during total hip replacement is presented. Use of an external tourniquet was not feasible for this patient. The balloon was inflated to a minimum volume to achieve intravascular occlusion and was periodically deflated to minimize the risk of postoperative complications. A surgical field with minimal blood loss was created.

1. Introduction

Arterial occlusive balloons have been proposed as a blood salvaging technique for several procedures. However, distal ischemic complications have been reported as a consequence of long-term balloon inflation and are probably related to excessive pressure on the vascular wall [1]. A technique of preoperative placement of an intra-arterial occlusive balloon with calibrated balloon volume inflation is presented. The timed intermittent arterial occlusion reduced intraoperative

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blood loss and minimized postoperative complications related to limb ischemia.

2. Case report

The patient was an 88 year-old, ASA physical status III woman with a history of osteoporosis, who presented with a two-week history of severely progressive left hip pain and inability to bear weight on the left lower extremity. The pain worsened with walking and climbing stairs, and it improved with rest and nonsteroidal anti-inflammatory drugs. The patient described the pain as continuous, with an intensity of 8 on a 10-point visual analog scale (VAS). Examination of the left hip showed normal passive extension, passive flexion of 60 degrees, abduction of 40 degrees, adduction of 15 degrees, and passive external rotation in extension of 35 degrees. Muscle power in flexion, extension, abduction, and adduction was 4/5. There was mild greater trochanteric tenderness; and the Trendelenburg's gait test was positive. Magnetic resonance imaging of the pelvis showed the presence of severe osteoarthritic changes of the left hip; the patient was then scheduled for total left hip arthroplasty.

Her preoperative hemoglobin (Hb) concentration was 12.2 g/dL, with a hematocrit of 36.6%, prothrombin time of 13.6 sec, partial thromboplastin time of 28.8 sec, and international normalized ratio (INR) of 1.0 sec. The patient refused administration of any blood products for her own religious convictions, but gave her consent for an intravascular occlusion balloon catheter to be inserted preoperatively. She was admitted to the angiography suite before surgery. After adequate sedation, the right groin was prepped and draped, and the right femoral artery was accessed. The arterial access site was chosen on the contralateral side from the surgery site to keep the balloon catheter away from the surgical (left) field. A vascular 5.5-French Fogarty balloon catheter was placed in the mid-portion of the left external iliac artery and was inflated until minimal secure wall opposition was noted. An arteriogram of the left external iliac artery was performed with and without balloon inflation, as seen in Figs. 1 and 2, respectively, to demonstrate successful occlusion of the vessel.

Following catheterization, heparinized saline was infused continuously through the sheath and catheters to prevent thrombus formation in the blood distal to the occlusion. Hemodynamic measurements of systolic, diastolic, and mean arterial blood pressure (MAP) proximal to the inflated balloon showed an arterial blood pressure (BP) of 175/55 mmHg, with MAP of 95 mmHg proximal to the balloon, and BP of 45/40 mmHg with MAP of 42 mmHg distal to the balloon, as measured in the left dorsalis pedis artery. The catheter and the sheath were then secured in place with surgical adhesive tape (Steri-Strips; 3M, Maplewood, MN, USA) and a tight knot. In addition, large plastic adhesive drapes were placed on the skin to hold the catheter in place.

Fig. 1 Arteriographic view of normal contrast flow in the external iliac artery before 5.5 mm balloon inflation with a contralaterally inserted catheter.

Spinal anesthesia was performed with a 25-gauge needle inserted parallel to the spinous processes at L_4-L_5. A combination of 1.0 mL of bupivacaine (Marcaine) 0.75% and morphine (Duramorph) 0.15 mg was injected. The purpose of the spinal anesthesia was to provide postoperative analgesia, to reduce anesthesia requirements, and to increase

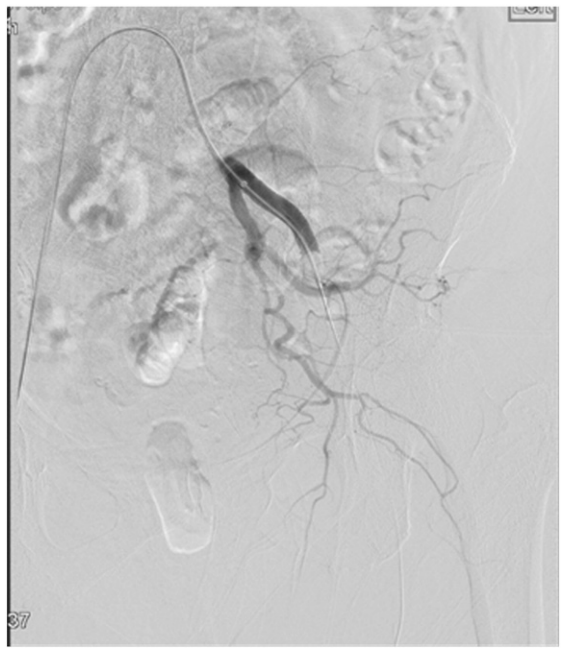

Fig. 2 Arteriographic view of occluded contrast flow in the external iliac artery after balloon inflation with 0.5 mL dilute liquid contrast.

blood flow to the extremities by sympathectomy. Following induction of general anesthesia, the patient's trachea was intubated and she was placed on mechanical ventilation with 1% to 2% sevoflurane in oxygen-enriched air. The patient's BP was 160/60 mmHg prior to the spinal and 120/58 mmHg after the spinal anesthesia was administered; it slowly increased to 160/70 mmHg by the end of the surgery. The patient's heart rate ranged from 50 to 60 beats per minute throughout the case.

The balloon was alternately inflated to achieve complete lumen occlusion for 8 to 10 minutes, then periodically deflated for two minutes to allow adequate distal limb perfusion and to prevent ischemia. This sequence was repeated 7 times throughout the whole procedure. During periods of balloon inflation, MAP in the dorsalis pedis artery was measured at 40 to 50 mmHg.

Left total hip replacement was completed with only 20 mL of blood loss, as determined by the number of blood-soaked sponges at the end of the case. A photograph of the surgical field with minimal blood loss is shown in Fig. 3. The patient received 1,700 mL of 0.9% normal saline with adequate BP measurements and urine output during the procedure. She tolerated the procedure well without any vascular complications from the balloon placement, as confirmed by a bedside arterial duplex study in the Postanesthesia Care Unit. The study showed adequate blood flow in both dorsalis pedis arteries after the intravascular balloon catheter was removed. At the end of the procedure, the patient's Hb concentration was 10.6 gm/dL, an expected value that was attributed to acute hemodilution with crystalloids. The patient did experience approximately 50 mL of blood loss postoperatively; however, her Hb stabilized at a concentration of 9.1 gm/dL on postoperative day two.

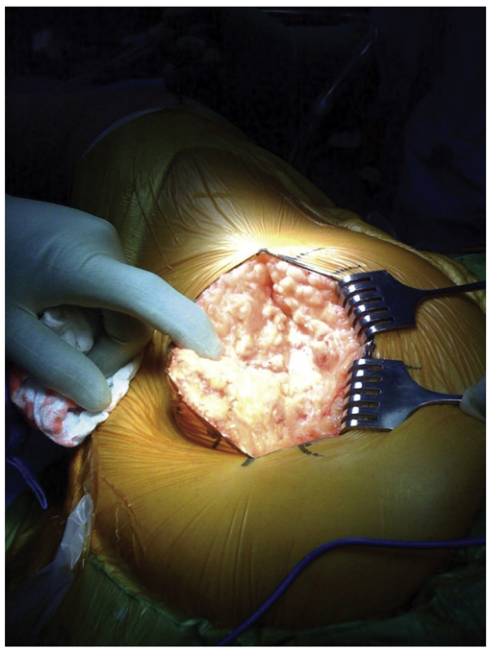

Fig. 3 Photograph of the surgical field showing minimal blood loss after occlusion of the external iliac artery with the intravascular balloon.

3. Discussion

Temporary occlusive balloons have been used to control bleeding in cases where extensive hemorrhage is expected, such as severe penetrating abdominal trauma [2], difficult surgical access sites such as basilar artery bleeding [3], ruptured abdominal aortic aneurysm [4,5], abnormal placentation [6-9], removal of sacral tumors [10], and cervical myomas [11], and to limit blood loss in Jehovah's Witness patients [12].

Despite the benefit of significantly reducing blood loss in surgery, the efficacy and safety of temporary balloon occlusion remains unclear. There have been a few reports of complications related to long-term blood flow occlusion. Ullmark et al. [1] compared the use of temporary occlusive balloons in the iliac or femoral artery in 15 cases to examine blood loss in major hip or knee arthroplasty. Of the 15 cases, two resulted in complications related to catheter dislocation and thrombosis formation. Despite dosing preoperatively and postoperatively with low-molecular-weight heparin to avoid catheter-induced thrombosis, ischemic complications still occurred. The authors documented the volume of balloon inflation but did not specify if an excessive inflation volume might have damaged the arterial lumen wall. The thrombotic events may have occurred because balloons were placed on the preoperative day, and the balloons were kept inflated throughout the entire procedure without deflation (balloons were inflated for one to 6 hrs). Intermittent occlusion of an artery obstructs the blood supply to the arterial wall via vasa vasorum compression. Long-term compression may lead to pressure necrosis of the artery [13].

Temporary balloon occlusion of the common iliac artery was used in 7 subjects who required pelvic and acetabular fracture surgery. Two serious complications were reported related to thrombotic events, which led to necrotic ulcer of the calf and heel, and sensory and motor dysfunction below the knee [14]. Long-term intra-iliac balloon inflation may affect wound healing and increase the risk of catheter-induced thrombosis.

The current case documents the use of a temporary external iliac artery occlusive balloon immediately before surgery to minimize blood loss, with intermittent deflation of the balloon, and inflation of the balloon to the minimum volume to produce precise apposition to the arterial wall to prevent ischemic complications. At the suggestion of the interventional radiologist, the balloon was deflated for two minutes after every 10-minute occlusion period. Very few reports have documented the proper amount of time to deflate the balloon to prevent thrombosis. Zhang et al. [10] performed distal abdominal aortic balloon occlusion in 5 subjects who underwent sacral tumor resection. In that study, the balloon was deflated for 10 minutes after each 60-minute occlusion period, and estimated blood loss was less than

300 mL [10]. No thrombotic events were recorded; however, the authors cautioned that inflating and deflating the balloon in the abdominal aorta might cause desquamation of atherosclerotic plaque or damage to the aortic wall. Complete occlusion of the arterial lumen for a short period of time with the inflation-deflation action performed slowly may prevent associated intimal damage and subsequent thrombosis that may occur from longer periods of balloon inflations.

Several precautions with the use of occlusive balloons reduced the occurrence of complications and resulted in a successful surgery with minimal blood loss. In addition to intermittent deflation of the balloon, the distal pulses was monitored to ensure adequate extremity circulation. Distal pressure were maintained with a baseline MAP of 40 mmHg [15,16]. In our patient, MAP never decreased below 40 mmHg during the periods of balloon inflation. Inflation and deflation of the balloon was performed slowly to avoid any damage to the vessel, such as an intimal tear or rupture. The proper size balloon was used for external iliac arteries. Balloon sizes greater than 6 to 8 mm place the vessels at risk of rupture or damage. Infusion of heparinized saline solution through the sheaths was performed to prevent thrombus formation distal to the occlusion. Dilute liquid contrast was used to inflate the balloon so as to avoid air embolism in case of balloon rupture. To insure that the balloon did not migrate during transport from the angiography suite to the operating room, the catheter was marked and sutured in place before transport.

There is no randomized trial published about balloon occlusion inflation-deflation durations to reduce thrombotic events, and the feasibility of such a trial appears limited because this technique is used on a case-by-case basis. A successful surgery with minimal blood loss with the use of an internal vascular balloon is presented. Several precautionary measures may have reduced the frequency of serious complications in a patient who refused a blood transfusion.

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