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〔Case Report〕

Treatment of protrusion of the acetabular component after total hip arthroplasty in combination with vascular surgery: a report of three cases

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Abstract

An acetabular component of total hip arthroplasty that protrudes into the pelvis carries a risk of injury to the iliac blood vessels during removal of the implant. We report three cases of intrapelvic migration of an acetabular component in contact with the iliac vessels. Preoperative computed tomography angiography in all cases revealed that the external /or internal iliac vessels were displaced superiomedially due to compression by the migrated cup. The implants were removed safely using a conventional hip approach in combination with release of vessels via a retroperitoneal approach in two cases, and via temporal intra-aortic balloon occlusion in one case. One of the two patients treated with a retroperitoneal approach underwent acetabular reconstruction in a consecutive surgery in a supine position through a direct anterior approach, and the other underwent reconstruction through a direct lateral approach after a postural change. For the patient who underwent intra-aortic balloon occlusion, we performed resection arthroplasty to allow a less invasive treatment. No marked intraoperative bleeding caused by injury to iliac vessels occurred in any patient, although one case required blood transfusion for oozing. These cases show that dissection of the iliac vessels via a retroperitoneal approach is safe with minimum morbidity during handling of the migrated acetabular components. A direct anterior approach can be used for acetabular revision of the protruded components without patient repositioning by combining this procedure with a retroperitoneal approach.

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Intra-aortic balloon occlusion is an alternative for protruded components in a case with a risk of vessel injury during dissection.

***Key words*: revision total hip arthroplasty, intrapelvic migration, iliac vessel injury, retroperitoneal approach, intra-aortic balloon occlusion**

Ⅰ. Introduction

Intrapelvic protrusion of the acetabular component is a rare but severe complication in total hip arthroplasty (THA). The revision procedure for failed THA involves a risk of injury to the visceral organs, blood vessels, and nerves adjacent to the displaced acetabular component, and there is a need to cope with anatomical impingement of vital structures inside the pelvis, such as the iliac vessels and femoral nerve[1,2]. Here, we present three cases of intrapelvic migration of an acetabular component in contact with the iliac vessels that required dissection of these vessels via a retroperitoneal approach or temporal intra-aortic balloon occlusion to avoid injury.

Ⅱ. Case Reports

Case 1: A Japanese woman with steroid-associated osteonecrosis of the femoral head.

In 1997, at age 58, primary THA had been performed on her left hip. Her postoperative recovery was uneventful, and she had a good functional outcome for over 10 years. However, the cup gradually protruded to the acetabulum with progression of osteolysis, as seen on follow-up radiographs (Fig. 1a, b). She had experienced progressively worsening moderate hip pain with gait disturbance since 2015. In 2017, at age 78, the cup migrated medially through the acetabulum into the pelvis, with a Paprosky Type 2C bone defect [3]. Inflammatory markers and a full blood count were normal in the follow-up period, and cultured fluid yielded no bacterial growth after three sessions of intra-articular aspiration. In 2017, the cause of left hip pain was diagnosed as cup migration due to aseptic loosening, and revision surgery was planned.

The locations of the migrated cup and iliac vascular structures were assessed on computed tomography (CT) angiography performed preoperatively. This revealed that the external iliac artery was displaced superiorly due to compression by the migrated cup (Fig. 2a). Given the high risk of injuring the external iliac vessels during cup removal, we asked a vascular surgeon for guidance. The patient also had severe chronic obstructive pulmonary disease and asthma, and the anesthesiologist pointed out the risk of insufficient intraoperative ventilation in the lateral decubitus position. Given these risks, a revision surgery was performed in the supine position[4].

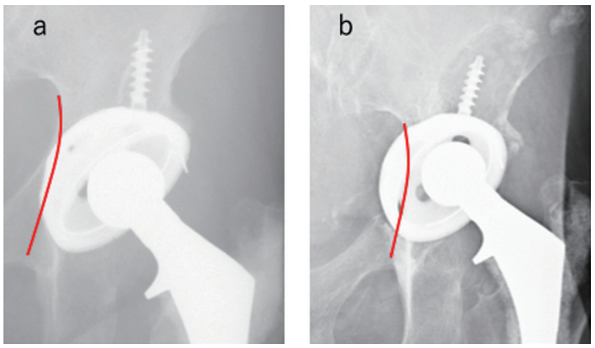

Fig. 1 Case 1. Anteroposterior radiographs of the left hip at 5 (**a**) and 20 (**b**) years after the primary surgery. Polyethylene wear progressed and the cup gradually protruded into a defect in the medial wall of the pelvis (red line).

An oblique skin incision parallel to the inguinal ligament was made at the left lower abdomen, starting from the midpoint between the umbilicus and pubic symphysis (Fig. 2b). After incision of the external oblique fascia, internal oblique muscles, and rectus abdominis muscles, the retroperitoneal space was exposed, with care taken to prevent puncturing the peritoneum. The left external iliac vessels located medially on the iliopsoas muscle belly were identified and released to allow mobilization (Fig. 2c). The migrated cup was covered with a thin obturator internus muscle fascia and was not directly visible from the retroperitoneal space. However, it was apparent that

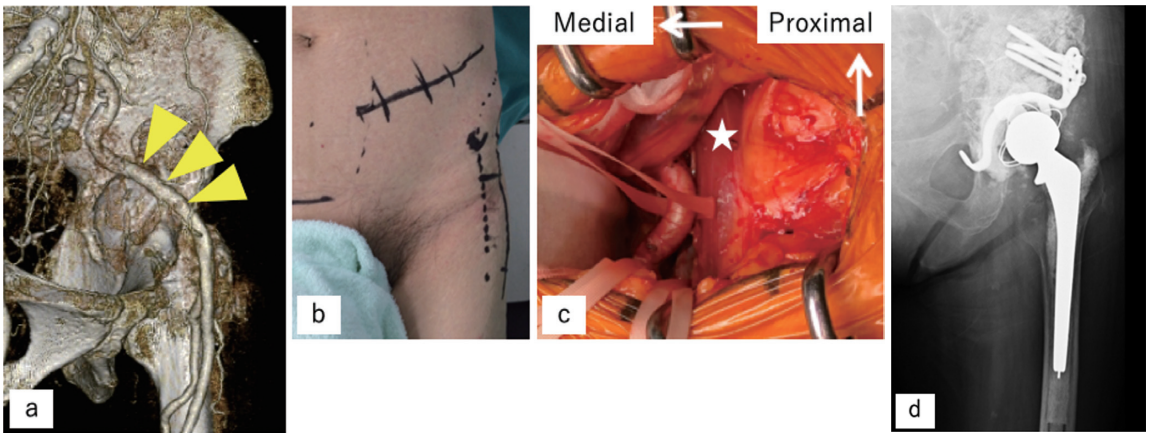

Fig. 2 **Case 1**. **a**. Anteromedial view of the left pelvis in 3D CT angiography. The external iliac artery (yellow arrowhead) was displaced superiorly due to compression of the migrated cup. **b**. Anterior view of the left abdomen and groin on a traction table. An oblique skin incision line parallel to the inguinal ligament was marked at the left lower abdomen, starting from the midpoint between the umbilicus and pubic symphysis. **c**. Operative view through the retroperitoneal approach. A tape was passed around the mobilized external iliac artery located medially on the iliopsoas muscle belly (white star). **d**. Postoperative anteroposterior radiograph showing the reconstructed left hip using a Kerboull cross-plate, structural allograft, and cemented cup.

the cup was compressing and displacing the vessels. After fully separating the external iliac vessels and the bulging muscle, another incision was made for acetabular exposure via a direct anterior approach. The cup was removed without major vascular injury, and the acetabulum was reconstructed using a Kerboull cross-plate[5], structural allograft, and cemented cup (K-MAX KT plate, Kyocera Medical, Osaka, Japan; Fig. 2d). The abdomen was closed with fascial and subcuticular sutures after finishing the revision procedure. The operative time was 6 h 13 min and intraoperative bleeding was 340 ml. No blood transfusion was required intraoperatively or postoperatively. The patient recovered well and was able to walk with a T-cane at one year after surgery.

Case 2: A Japanese man with steroid-associated osteonecrosis of the femoral head.

He had experienced systemic lupus erythematosus and undergone bipolar hemiarthroplasty on the left side in 1988 at age 31. He had bipolar head migration; therefore, a conversion surgery to THA was performed on the same side in 1991. In 2005, 14 years after THA, he had a deep periprosthetic hip infection of Staphylococcus epidermidis, and irrigation and surgical debridement were performed. Chronic suppression

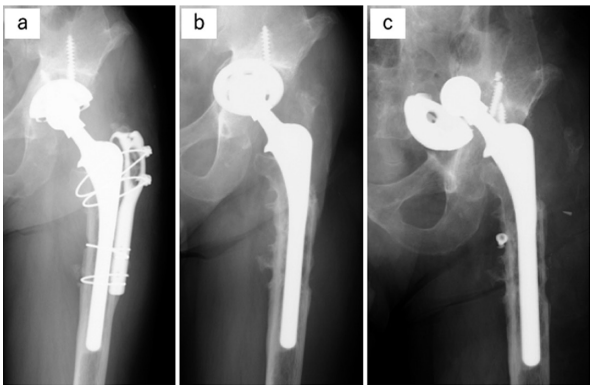

Fig. 3 **Case 2**. Anteroposterior radiographs of the left hip at 8 (**a**), 16 (**b**), and 17 (**c**) years after THA. Periprosthetic osteolysis caused a severe bone defect and implant failure.

was achieved with oral antibiotics 3 months after this surgery; however, cup displacement was seen in follow-up radiographs and progressed gradually (Fig. 3b). By 2008, at age 51, the cup had migrated proximally into the pelvis with severe destruction of the acetabulum and a Paprosky Type 3B bone defect (Fig. 3c). The femoral head was not seated properly in the cup, and the patient could not stand without bilateral crutches because of worsening hip pain.

Although a preoperative culture was negative, we diagnosed the case as septic loosening based on the clinical history. Resection arthroplasty was planned because of the general condition. Preoperative CT

angiography showed that the protruded cup and head were close to the internal and external iliac arteries (Fig. 4a). A vascular surgeon pointed out the serious risk of intraoperative vessel injuries and concluded that it was preferable to use an intra-aortic balloon occlusion catheter, rather than to detach the iliac vessels from the adherent soft tissues because of the severe migration.

During surgery, the catheter was inserted from the right femoral artery and placed in the abdominal aorta below the level of the renal arteries with the patient in the supine position before implant resection. After confirming placement of the deflated balloon using abdominal radiographs, the posture was changed to the lateral decubitus position, and the implants were removed via a direct lateral approach. The iliac arteries were seen superior and inferior of the cup, contacted in partial. The balloon was inflated partially when handling the protruded cup and removed safely within 15 minutes. No major bleeding occurred upon balloon deflation, and all implants except for a few screws and wires were removed (Fig. 4b). The operative time was 4 h 20 min and intraoperative bleeding was 1330 ml. Oozing due to thrombocytopenia occurred throughout surgery, and infusion of a total of 12 units of packed red cells, eight units of fresh frozen plasma and 20 units of platelets was needed perioperatively. Recovery was generally uneventful, with no delay in wound healing and no symptoms due to the occlusion. There was no evidence of infection recurrence in follow-up and the patient could walk a short distance with a T-cane at the latest follow-up, 10 years after resection arthroplasty.

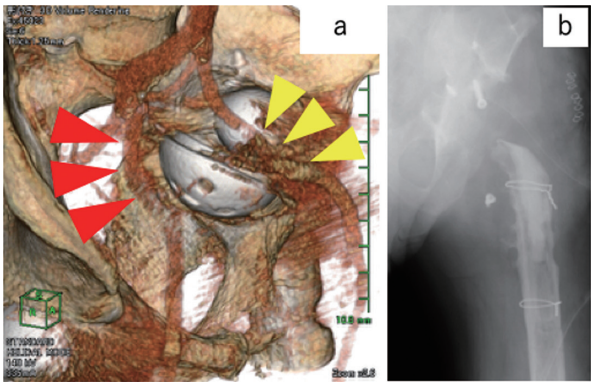

Fig. 4 **Case 2**. **a**. Anteromedial view of the left pelvis in 3D CT angiography. The external iliac artery (yellow arrowhead) was displaced by the protruded head, and the internal iliac artery (red arrowhead) was close to the migrated cup. **b**. Postoperative anteroposterior left hip radiographs.

Case 3: A Japanese woman with hip osteoarthritis.

Primary THA on her left hip had been performed in 1988, at age 52. In 2007, the first acetabular revision was performed because of cup migration with no evidence of bacterial infection in fluid culture (Fig. 5a). A cementless porous-coated jumbo cup was used for acetabular reconstruction, and the patient began to walk normally (Fig. 5b). However, 3 years later, radiographs showed displacement of the jumbo cup; and in 2013, the cup had migrated anteromedially with a Paprosky Type 3B bone defect (Fig. 5c). Gait disturbance and left hip pain were not severe; however, strongly anticipating the further migration, a second revision surgery was planned in 2013, at age 77, 6 years after the first revision.

Preoperative CT angiography showed that the left external iliac vessels were compressed and shifted superiorly by the edge of the migrated cup (Fig. 6a). After consulting with a vascular surgeon, we planned acetabular reconstruction in combination with detachment of the iliac vessels via a retroperitoneal approach. The second revision surgery was conducted in the supine position at first, and the iliac vessels were released to be mobilized with the aid of the vascular surgeon. Following adequate separation of the external iliac vessels, the posture was changed to the lateral decubitus position and the acetabular components were sufficiently exposed through a direct lateral approach. The external iliac vessels were attached with the edge of the cup, while mobilized with ease. The protruded

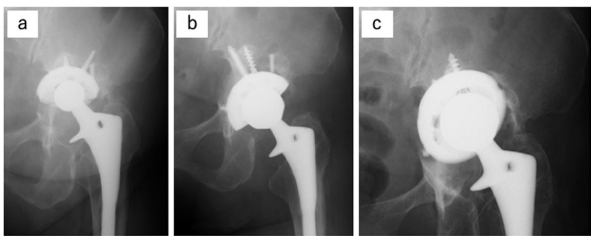

Fig. 5 **Case 3**. Anteroposterior radiographs of the left hip at 19 years after primary THA (**a**), immediately after the first acetabular revision (**b**), and 6 years after the revision (**c**).

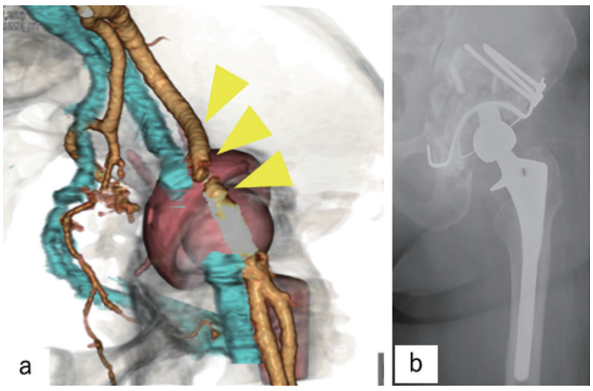

Fig. 6 Case 3. **a**. Anteromedial view of the left pelvis on 3D CT angiography. The external iliac artery (beige line) and external iliac vein (blue line) were compressed and shifted superiorly by the edge of the migrated cup (yellow arrowhead). **b**. Postoperative anteroposterior left hip radiographs.

cup was removed easily after screw removal without injury to vessels, achieving acetabular reconstruction with a Kerboull cross-plate (K-MAX KT plate, Kyocera Medical, Osaka, Japan; Fig. 6b). The operative time was 5 h 31 min and intraoperative bleeding was 275 ml. Postoperative blood transfusion was not needed.

Recovery of the surgical wound was uneventful and the general condition was stable; however, postoperative femoral nerve palsy occurred and the patient needed a brace to prevent the knee giving way for 4 months after surgery. The quadriceps femoris weakness gradually recovered and fully disappeared at 2 years after the re-revision; however, sensory disturbances that affected the anteromedial thigh and medial leg persisted. The patient was pain-free and ambulatory at 5-year follow-up.

Ⅲ. Discussion

Acetabular reconstruction for intrapelvic migration of acetabular components of THA requires use of multiple strategies to handle challenging issues such as displaced components adjacent to vital intrapelvic structures. Although rare, with a reported prevalence of 0.08-0.67%[1,6,7], vascular injury during revision hip arthroplasty can lead to serious complications, including limb amputation and hemorrhagic death. The external iliac artery and vein are located 1 and 0.5 cm from the anterior acetabular cortex, respectively, and are protected by the thickness of the iliopsoas muscle and the pectineus or obturator internus muscle, respectively [8]. Therefore, a medial wall defect of greater than Paprosky type 2C can lead to a threat to these intrapelvic organs. In such cases, a retroperitoneal approach to remove the component or mobilize the vessels may avert complications during revision THA[9,10]. This approach has several strengths, such as a low risk of digestive complication such as ileus and transmitted infection from the abdominal cavity because the peritoneum is not opened[10]. Other strengths include adequate exposure of the external iliac vessels around the acetabulum, with less invasiveness for abdominal organs and muscles[9]. In a case of serious intraoperative bleeding due to branching of these vessels, exploration of the sources and expeditious control of bleeding can be achieved by handling the separated vessels[10]. In our series, we performed vessel release before removal of the migrated component in two cases, without serious bleeding or mortality. There is controversy as to whether this procedure is essential in all similar migration cases, however, we believe that it is necessary to perform complex surgery with maximum safety regardless of primary or revision THA regarding the patient's life and their recovery. We experienced postoperative femoral nerve palsy in Case 3, whereas its motor disturbance was recovered and fully disappeared. Considering the severity between the femoral nerve palsy and major vessel injury, our cases indicate that dissection of the iliac vessels through a retroperitoneal approach is safe and has minimum morbidity when handling migrated acetabular components.

In a case of severe intrapelvic acetabular cup migration associated with chronic bacterial infection or osteolysis, several alternative approaches have been reported to cope with adhesion of surrounding tissues and safe removal of the component. A transabdominal approach is applicable for a classical median inferior laparotomy and can be used to make a direct incision into the peritoneum over the migrated component [11,12]. This provides satisfactory exposure of the common and external iliac vessels, as well as the ureter and pelvic organs. However, this approach also has

disadvantages of an increased risk of laparotomy-related digestive tract complications, such as late resumption of bowel movement, adherent ileus, and transmitted infection[11].

In case 2, we accomplished successful implant removal via the conventional direct lateral approach without major intraoperative bleeding and postoperative complications, using intra-aortic balloon occlusion. The efficacy of this method for reducing blood loss during primary and revision THA has been reported in a few studies[13,14]. Due to the difficulty in releasing vessels that are adhesive to soft tissues, we choose intra-aortic balloon occlusion when cup protrusion exceeds the midline between the ilioischial line and sacrum-pubis axis, with abdominal exposure of most of the cup surface[15], as in case 2. Intra-aortic balloon occlusion has a critical risk of ischemic complications in the lower limb and intestine[16], but inserting the catheter might be less invasive than laparotomy. It is unclear whether intra-aortic balloon occlusion is successful in Case 1 and 3, however, vessel release using a retroperitoneal approach could be safer because periods of occlusion $>$40 min can result in irreversible organ injury and death[17]. Considering them, as long as this period is not prolonged, intra-aortic balloon occlusion is an alternative to the retroperitoneal approach for protruded components with a risk of vessel injury during dissection of the vessels.

In case 1, we achieved iliac vessel release through a retroperitoneal approach with subsequent acetabular component removal and reconstruction using a direct anterior approach in the supine position, without changing the patient position. In general, postural changes made under general anesthesia can influence cardiopulmonary hemodynamics and ventilation and might cause an intraoperative drop in blood pressure and atelectasis[18]. Additionally, placing a patient in the lateral decubitus position decreases vital capacity and functional residual capacity, and increases blood flow in the dependent lung, which results in ventilation and perfusion mismatch and could cause significant impairments in elderly and critically ill patients[19]. To avoid these risks, we perform primary and revision THA via a direct anterior approach in the supine position for cases in which these factors are a concern. It is considered to be a minimally invasive surgical technique and is applicable for acetabular revision using a Kerboull cross-plate[20,21]. The current findings and previous studies show that this approach can be used for cases of complicated acetabular revision without patient repositioning, in combination with the retroperitoneal approach. The retroperitoneal approach does not require repositioning for acetabular revision; thus, it is recommended for patients at risk of cardiopulmonary failure.

We treated three cases of intrapelvic protrusion of an acetabular component in contact with iliac vessels, in which the component was removed without major bleedings via vessel release using a retroperitoneal approach or temporal intra-aortic balloon occlusion without vessel release. Dissection of iliac vessels via a retroperitoneal approach is safe and has minimum morbidity when handling the migrated acetabular components. For safety, we recommend a combination of vessel release via the retroperitoneal approach with component removal in a revision surgery. The direct anterior approach can be used for acetabular revision of protruded components without patient repositioning, in combination with the retroperitoneal approach. Intra-aortic balloon occlusion is an alternative for removal of the protruded components if there is a risk of vessel injury during dissection.

Contributors

PH and KY corrected data and drafted the manuscript. SH and JN helped to draft and proof the manuscript. YK, MS, KN, KK and SY checked and revised the manuscript from the perspective of hip reconstruction surgeons. HU and GM are cardiovascular surgeons who performed the operations related to iliac vessels, and confirmed the descriptions of these procedures in the manuscript. SO revised and approved the final version of the manuscript.

Conflict of interest

All authors declare that they have no conflicts of interest, either financial or non-financial, with regard to the contents of this article.

Ethical approval

All patients provided written informed consent prior to inclusion in the study.

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