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Case report

Bone ingrowth observed in a cup removed during revision surgery for early dislocation after primary THA: A case report

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ABSTRACT

Introduction and importance: Recently cementless total hip arthroplasty (THA) has shown good long-term results with excellent stability resulted from the porous coating of the implant. A hydroxyapatite-tricalcium phosphate (HA-TCP) coating on the porous surface is expected to promote bone ingrowth and to improve initial fixation of the implant. Here we report a case of bone ingrowth observed in a cup removed during revision surgery for early dislocation, 37 days after primary THA using a porous coating cup with HA-TCP.

Case presentation: A 61-year-old woman who has bilateral osteoarthritis underwent same-day bilateral THA. Both sides used porous coating cups with HA-TCP. Line-to-line technique and screw fixation were utilized. Anterior dislocation of the left hip occurred on days 27 and 31, and we performed cup revision on day 37 after surgery. We noted bone-like tissue on the posterior surface of the cup and in a vacant screw hole. Bone tissue was also confirmed in pathological findings.

Clinical discussion: Studies in animals have confirmed early bone ingrowth about 4 weeks after surgery with HA-TCP coated implants. In humans, the earliest report of bone ingrowth in cups is for a cup without HA-TCP coating, detected 5 weeks after surgery. In the present case, we used a porous coating cup with HA-TCP, and bone ingrowth was confirmed at approximately the same time as for the previous case.

Conclusion: Early clinical bone ingrowth was confirmed in an HA-TCP coated cup, occurring at about the same time after surgery as in previous reports.

1. Introduction

Recently cementless total hip arthroplasty (THA) has shown very good long-term results with excellent stability resulting from bone ingrowth into the porous coating of the implant [1–4]. Strong initial fixation is important to promote bone ingrowth in the implant; both press-fit and screw fixation are used for this purpose in order to prevent micromotion of the implant [5,6]. In addition, a hydroxyapatite-tricalcium phosphate (HA-TCP) coating on the porous surface promotes bone ingrowth as mesenchymal cells including osteoblasts and blood vessels invade the porous structure. Early bone ingrowth in the HA-TCP coated implant has been confirmed in animal experiments, and there are reports showing that the use of HA-TCP is associated with good fixation to the bone bed in the early postoperative period [7,8]. In humans, numerous reports have described bone ingrowth in implants in autopsy specimens and post-replacement studies, but the earliest report of bone ingrowth in a porous coating cup is 5 weeks after surgery in cups without HA-TCP coating [9–15]. Here we report a case of bone ingrowth that we observed in a cup removed during revision surgery for early dislocation, 37 days after primary THA using a porous coating cup with HA-TCP in which good initial fixation had been obtained.

This case report has been reported in line with the SCARE 2018 guidelines [16].

2. Presentation of case

A 61-year-old woman who has bilateral osteoarthritis with bilateral acetabular dysplasia underwent same-day bilateral THAs using a posterior approach. The patient wasn't taking any drug, and did not have a habit on smoking and alcohol consumption. Her past and familial medical histories were normal. The implants were spherical 50-mm Trilogy® cups (Zimmer Biomet, Warsaw, IN, USA). The acetabular cups were of fiber metal coated with HA-TCP on the surface. The line-to-line technique without press-fitting is our standard practice for acetabular cup placement and was utilized for this surgery. First, we reamed with forward rotation up to a diameter of 49 mm. After reaming the

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sclerotized bone at the edge of the acetabulum with a 50-mm diameter reamer in forward rotation, we then reamed with the same 50-mm reamer in reverse rotation in a full hemispherical arc to make a bone bed for cup insertion. We inserted the acetabular cup and tapped it gently into place. We checked the multiple holes in the cup to confirm that there were no gaps between the cup and the host bone. Because initial stability appeared insufficient, we used two screws on the right side and three screws on the left side. Since many Japanese patients are prone to hypoplasia [17], there is concern about the fixation of press-fit to fragile bone, so we always install cementless cups in this way. All screws penetrated into the medial cortical bone of the pelvis and were firmly fixed in that cortical bone. The patient did full weight bearing walking beginning the day after surgery, and rehabilitation went well, so she was discharged home. However, she experienced anterior dislocation of the left hip on days 27 and 31 after surgery (Fig. 1). A simple X-ray of the hip joint showed a 53° angle of cup abduction. CT of the hip joint, taken on the 35th day after THA, showed the angle of cup anteversion at 37° and stem anteversion at 33°, with no clear gap between the cup and the bone (Fig. 2). We diagnosed anterior dislocation due to cup malalignment, with a risk of recurrent dislocation in the future. The patient understood the risk and wanted to have revision surgery, and only about a month had elapsed since the primary THA, so we anticipated no bone ingrowth and expected that the cup would be removed easily. The cup revision on day 37 after the primary THA was performed by experienced general orthopedic surgeons (the second author).

2.1. Surgical findings

We entered through the original incision site and removed the screws. Since the cup was not highly porous, with the line-to-line technique we would normally expect easy cup extraction after screw removal. However, the left cup was firmly fixed to the acetabular bone and was difficult to remove by hand, so we inserted a chisel between the acetabulum and the cup. After removal, we noted small amounts of bone-like tissue on the posterior surface of the cup and in a vacant screw hole. Cup revision was performed using a dual mobility system with a G7 cup (Zimmer Biomet, Warsaw, IN, USA). The small amounts of bone-like tissue were submitted for pathological examination (Fig. 3). There were no visible signs of loosening of the stem or infection of the implant.

2.2. Pathological findings

Laminar bone tissue with mild acute inflammatory cell infiltration and partial degenerative necrosis was observed in the tissue attached to the surface of the removed cup. Both bone tissue and hemorrhagic inflammatory active granulation tissue were confirmed in the raised tissue in the screw hole (Fig. 4). Based on the above findings, we concluded that bone tissue of the acetabulum had already begun to invade 37 days after surgery on the surface of the porous metal fiber cup with HA-TCP coating, and bone ingrowth had already started.

2.3. Postoperative course

The postoperative course was uneventful. The patient had undertaken a rehabilitation program and was able to walk unassisted. At 1-year follow-up, there was no loosening of the implant or dislocation was confirmed.

3. Discussion

Although bone ingrowth has been reported on the porous surface of many excised implants, it is clinically important to know how early this bone ingrowth begins. The earliest report of bone ingrowth in a porous coating cup was 5 weeks after surgery by Pidhorz et al., who confirmed the invasion of fibrous bone into a porous inner cup [9]. In this case, a Harris-Galante (HG)I cup (Zimmer Biomet, Warsaw, IN, USA) was fixed

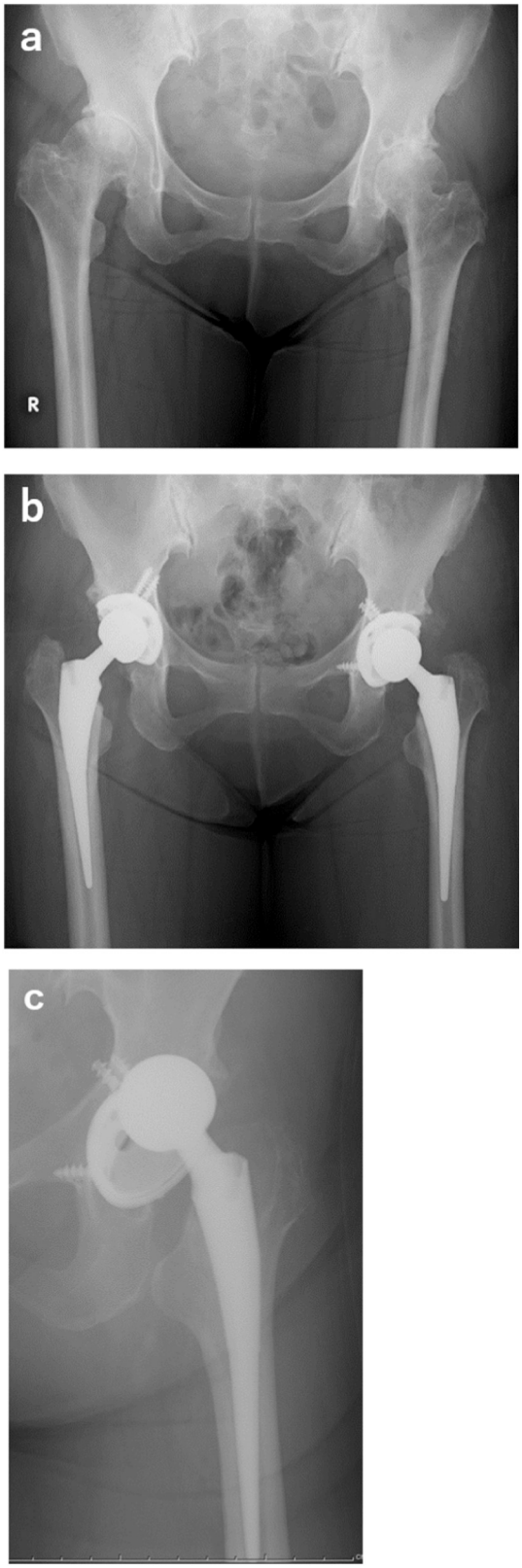

Fig. 1. (A) A radiograph of the hip joints before primary THA. The patient was a 61-year old woman who had bilateral end-stage osteoarthritis with acetabular hypoplasia of the hip. Center-edge angle for the right side was 8° and for the left side was 14°. (B) A radiograph after primary THA. Bilateral THAs were performed using the posterior approach. (C) A radiograph of dislocation of the left hip. Anterior dislocation occurred on the left side on day 31 after THA.

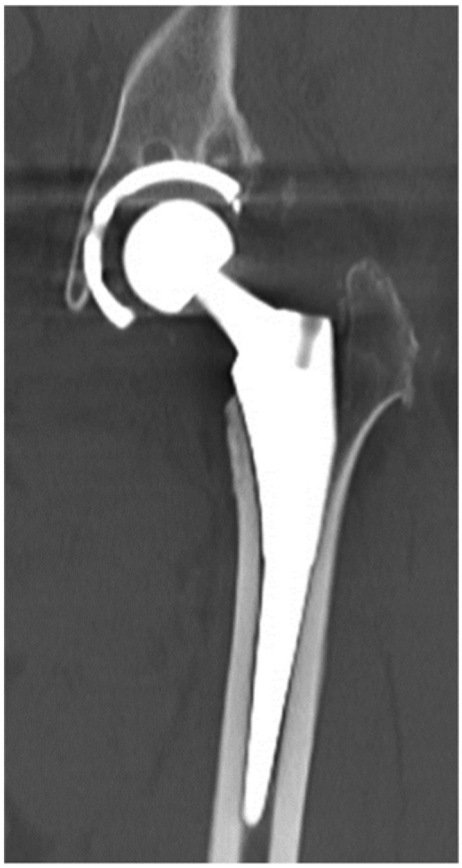

Fig. 2. A coronal CT image on the 35th day after THA. Though pre-existing bone cysts in the acetabulum were visible, there was no evident gap between the cup and the bone bed.

in place using a line to line technique with screws. For our patient, we used fiber metal similar to HGI, coated with HA-TCP.

The HA-TCP coating on the cup surface is a combination of hydroxyapatite (HA) and tricalcium phosphate (TCP), which has high osteoconductivity. The absence of fibrous tissue between the implant and the bone makes it easy to connect directly to the bone and promotes early fixation between the bone and the implant. Studies in animals have shown early bone ingrowth to the implant at about 4 weeks, and lamellar bone tissue was confirmed 12 weeks after surgery [7,8]. A comparative study of porous HA-TCP coated cups and uncoated cups showed the HA-TCP coating was associated with less tilting and fewer and smaller radiolucent lines [18]. Good long-term outcomes with HA-TCP coated cups also have been reported in large-scale trials [4,19]. These findings suggest that the HA-TCP coating may be a factor in promoting early bone ingrowth.

Although we have not confirmed micro bone ingrowth in the fiber metal on the surface of the cup, bone tissue was confirmed both on the cup and in the screw hole. The fact that the cup was firmly fixed to the acetabulum when we initiated removal also indicates that bone ingrowth had already started between the implant and the acetabular bone. We consider these to be clinically important findings.

The earliest report of bone ingrowth on a porous surface on the stem side was 4 weeks after surgery for beads coated on a porous stem. [10]. There was also a report on a Bipolar AML stem without HA-TCP coating that showed bone ingrowth 40 days after surgery. [11]. On the cup side, bone ingrowth was confirmed at 5 weeks as mentioned above [9]. Our search of the literature showed 3 reports of early bone ingrowth about 5 weeks after surgery for stems and cups. All 3 occurred around the same time as our case.

Surgical technique may have also contributed to early bone ingrowth

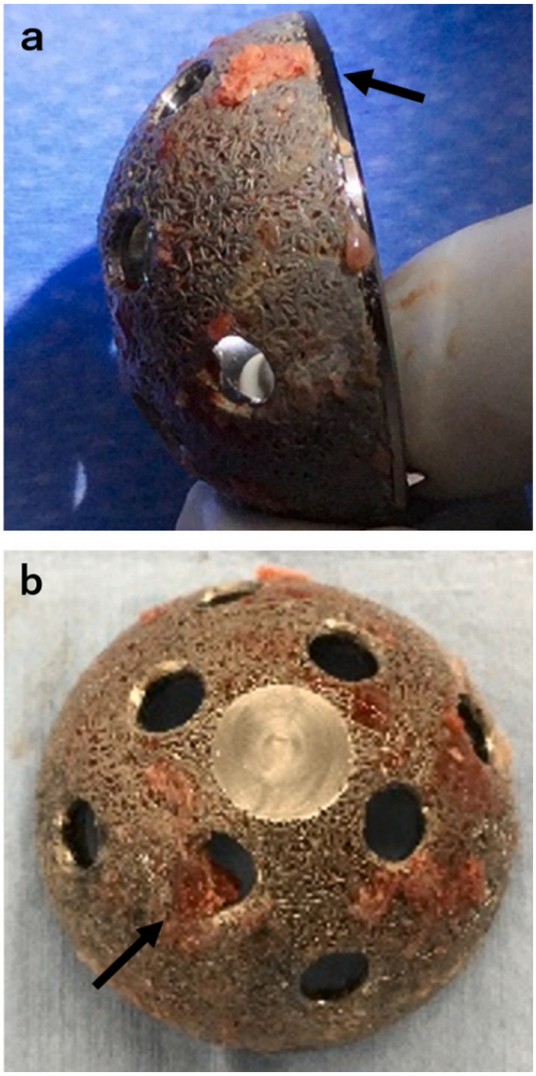

Fig. 3. (A) Surface of the cup after removal. Bone-like tissue is visible on the surface of the cup (black arrow). (B) Screw hole of the cup after removal. Bone-like tissue was also seen in the screw hole (black arrow).

and satisfactory fixation. In this case, we used a line-to-line technique with reaming to the same size as the planned cup, instead of press-fit fixation that presses the cup in with under-reaming. Many acetabular hypoplasia cases do not have sufficient cancellous bone for reaming, and the acetabular lining is often exposed. In such cases, press-fit fixation with under-reaming may cause the cup to bounce off the acetabular inner plate, resulting in inadequate fixation and fracture of the acetabular bottom. Therefore, use of the line to line technique with screw fixation is thought to provide good fixation of the cup in coxarthrosis associated with acetabular hypoplasia. In fact, good long-term outcomes have been reported with THA using this combination of line to line technique and screw fixation [20–22]. Gaps between the cup and the bone bed can be avoided with the line-to-line technique, and satisfactory screw fixation minimizes micromotion. Both of these factors may promote early bone ingrowth.

Our study includes several limitations. First, this report covers only one case, so it is unclear whether early bone ingrowth occurred in other cases. Second, the cup has not been cut to determine whether bone ingrowth occurred microscopically in the porous coating. Third, it is not clear whether similar findings will be found with different cups.

Despite these limitations, however, we consider it to be a useful finding that early clinical bone ingrowth was confirmed in a cup with

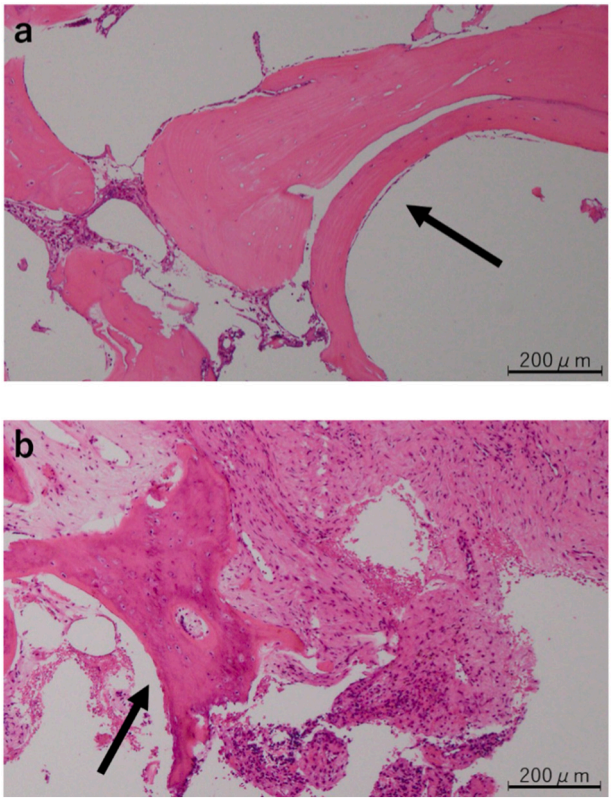

Fig. 4. (A) Pathological image of bone-like tissue on the cup after removal. Normal bone tissue with nuclei and laminar bone tissue were confirmed (black arrow), and acute inflammatory cell infiltration and partial degeneration necrosis were noted. (B) Pathological image of bone-like tissue in the screw hole. Both laminar bone tissue and hemorrhagic inflammatory active granulation tissue were confirmed (black arrow).

HA-TCP coating, consistent with previous reports.

Ethical approval

Ethical approval has been exempted by our institution because this is a case report and no new studies or new techniques were carried out.

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CRediT authorship contribution statement

Study design: Hironori Kitajima, Ayumi Kaneuji
Surgical procedure: Ayumi Kaneuji, Daisuke Soma, Makoto Fukui
Writing the paper: Hironori Kitajima, Ayumi Kaneuji
Data Collection: Hironori Kitajima, Ayumi Kaneuji
Data analysis: Hironori Kitajima, Ayumi Kaneuji
Supervision: Ayumi Kaneuji, Norio Kawahara

Guarantor

The guarantor for this case report is Hironori Kitajima.

Registration of research studies

Not applicable.

Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Provenance and peer review

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Declaration of competing interest

All the authors certify that there is no conflict of interest regarding the material discussed in the manuscript.

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