Surgical Technique Video of Revision Total Hip Arthroplasty Using T-REX, a 3D-Printed Custom-Made Acetabular Component Developed in Japan, For Patients with Large Acetabular Bone Defects

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Introduction

Revision total hip arthroplasty (THA) often involves acetabular bone defects, which can make ideal placement of the acetabular component particularly difficult in cases of severe host bone loss.

Recent advances in 3D printing technology have enabled the highly precise fabrication of custom-made implants tailored to each patient's unique bone defects. This technology has seen widespread development around the world, and Japan is no exception.

In this video, we will present key technical considerations and potential pitfalls in performing revision THA using the T-REX (Nakashima HealthForce Co., Ltd., Japan), a custom-made acetabular component developed in Japan, in a case with severe acetabular bone loss after THA.

Patient and Methods

We present a case of an 86-year-old female who underwent THA on the left side 31 years ago for osteoarthritis. The patient exhibited acetabular component breakage secondary to wear-through, with associated bone loss categorized as Paprosky type 3A. Due to the severe bone defect in the weight-bearing area, reconstruction using a standard acetabular component was deemed unfeasible, as attempting to restore the anatomical hip center would not allow adequate bone-implant contact, making initial fixation difficult. Therefore, we considered the use of a custom-made acetabular component for this case. A custom-made acetabular component was fabricated using additive manufacturing technology. Preoperative detailed planning was performed using the 3D CAD system to construct an augmentation to fill the acetabular defect, as well as a flange if necessary. A pelvic model and an implant trial made to the same shape as the custom-made implant were prepared for use as a patient-specific guide and used intraoperatively to confirm the implant alignment and position.

To verify the accuracy of the implant's position and alignment, postoperative CT scans were taken, and 3D models of each pelvis and implant were constructed using landmark registration methods.

And we conducted accuracy validation, including the presented case, for a total of 25 patients who underwent primary and revision THA with T-REX at our institution between October 2020 and November 2024.

Results

The results of the evaluation of placement alignment showed that the mean absolute error from the preoperative plan for cup inclination was 3.11 degrees, and for cup anteversion, it was 1.89 degrees. In both inclination and anteversion, 11 cases achieved placement within 3 degrees of the planned alignment, and 18 cases within 5 degrees. In 19 cases, the cup rotation stayed within a error of about 7 degrees, while significant errors of 10 degrees or more were observed in 3 cases, resulting in a relatively greater mean absolute error of 6.06 degrees compared to inclination and anteversion.

In the evaluation of position error, it was possible to place the implants within 5 mm of the planned position in 24 cases and within 3 mm in 18 cases. Absolute error of 1.70 mm in the internal/external direction, 1.51 mm in the anteroposterior direction, and 1.63 mm in the vertical direction were observed

Discussions

Reconstruction of severe acetabular bone defects remains a major challenge in revision total hip arthroplasty, and no clear consensus has been established regarding the optimal treatment approach. Custom-made implants such as the T-REX offer personalized implant designs tailored to the individual bone defect, which may be challenging to reconstruct with standard off-the-shelf implants. Consequently, such implants can be expected to offer robust initial fixation. There are some reports indicate that accurate placement of the acetabular component is difficult in cases with severe bone loss when a navigation system is not used. In this study, the use of a trial identical in shape to the final implant as a patient-specific guide enabled precise positioning and alignment during component placement.

On the other hand, rotational accuracy of placement was the only parameter with an error exceeding 5°. In the present study, no clinical problems were observed in any of the cases with large deviation in rotation. Although this study demonstrated high reproducibility in terms of bone-implant contact accuracy, considering the specific shape of the augment, rotational errors may significantly affect the contact surface area.

However, some reports have indicated that even when rotational errors exceed 10 degrees, they do not lead to clinical problems. In this case series, no clinical issues were observed in patients with large rotational deviations.

The clinical impact of rotational error remains a subject for future investigation.

Conclusion

Custom-made acetabular implants created using 3D additive manufacturing for cases with severe acetabular bone defects enable highly accurate placement and alignment through the use of patient-specific devices, and achieve strong initial fixation by replicating bone–implant contact (BIC) as planned preoperatively.Due to their high design flexibility, these implants represent an effective treatment option, particularly in revision cases with complex bone defects that are difficult to reconstruct using conventional implants.