Surgical Procedure of Total Hip Arthroplasty Using T-REX, 3D-Printed Custom-Made Acetabular Component Made In Japan, For Patients with Massive Acetabular Bone Defects

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Introduction

In total hip arthroplasty (THA), both primary and revision surgeries can be complicated by significant bone defects in the acetabulum, making the placement of the acetabular component a challenge. The emergence of 3D printing technology has enabled the production of custom-made implants tailored to the unique bone defects of individual patients. These custom-made implants have been developed globally, including in Japan.

In this video, we will explain the pitfalls of performing THA using the T-REX (Teijin Nakashima Medical Ltd., Japan), a custom-made implant developed in Japan, for patients with severe acetabular bone defects.

Patient and Methods

We present a case of an 80-year-old female with osteoarthritis of right hip joint involving Crowe group 3 high hip dislocation. We planned THA as the treatment, but due to significant acetabular bone defect in the weight-bearing area, attempting to center the cup on the original acetabulum would not achieve a sufficient bone-implant contact, making initial stability difficult to achieve. 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 20 patients who underwent primary and revision THA with T-REX at our institution between October 2020 and February 2024.

Results

The results of the evaluation of placement alignment showed that the mean absolute error from the preoperative plan for cup inclination was 3.33 degrees, and for cup anteversion, it was 1.78 degrees. In both inclination and anteversion, 9 cases achieved placement within 3 degrees of the planned alignment, and 14 cases within 5 degrees. In 17 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 large absolute errors of 6.06 degrees from the planning.

In the evaluation of position error, it was possible to place the implants within 5 mm of the planned position in all cases and within 3 mm in 15 cases. Absolute error of 1.69 mm in the internal/external direction, 1.41 mm in the anteroposterior direction, and 1.18 mm in the vertical direction were observed

Discussions

There is no consensus on the optimal treatment approach for reconstruction of severe acetabular bone defects. Custom-made implants, like the T-REX, offer personalized implant designs tailored to the individual bone defect, which may be challenging to reconstruct with conventional implants. Consequently, such implants can be expected to offer robust initial stability. There are some reports that it is difficult to accurately place an acetabular component without using a navigation system for patients with severe bone loss. In this study, using a trial with a flange as a patient-specific guide resulted in achieving precise placement and alignment with excellent accuracy, comparable to previous reports.

On the other hand, in this series, the deviation in rotation was relatively large. The clinical significance of the rotation of acetabular implants has not been evaluated. While this study demonstrated high reproducibility in bone-implant contact, errors in rotation may lead to maladjustment of augments due to their specific shape. However, there are some reports that indicate that custom-made implants with a rotation error of more than 10 degrees are not clinically problematic. In the present study, no clinical problems were observed in any of the cases with large deviation in rotation. It remains to be seen how rotation error will clinically affect outcomes, pending further evaluation.

Conclusion

T-REX, a custom-made implant developed in Japan, offers accurate placement capabilities and achieves robust initial fixation in cases of severe acetabular bone defects, making them a viable treatment option. However, long-term evaluations, including assessments of bone response and fixation around the implant, as well as clinical outcomes, are required. Additionally, further investigation is needed regarding production timelines, costs, and other factors.