Three dimensional simulation and patient specific instruments for transtrochanteric rotational osteotomy of the femur for osteonecrosis of the femoral head

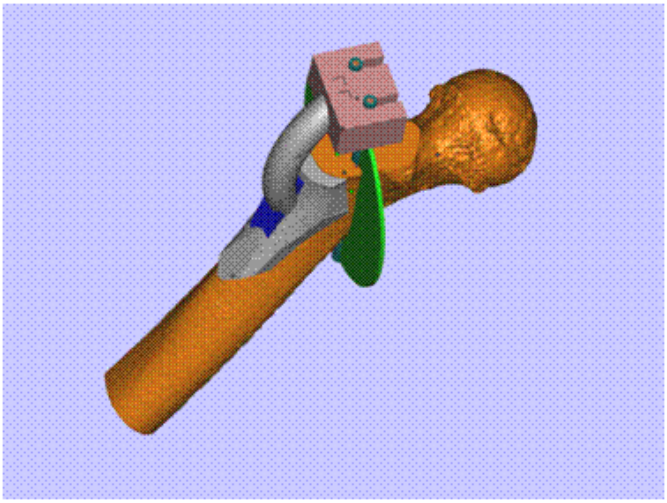
IWAKI H, IKEBUCHI M, YOSHIDA T, MINODA Y, NAKAMURA H

Department of Orthopedic Surgery, Osaka City University, Graduate School of Medicine, Osaka, Japan

iwaki0827@gmail.com

Purpose: Transtrochanteric rotational osteotomy (TRO) for avascular necrosis of the femoral head (AVN) was firstly reported by Sugioka et al (1) which was effective treatment for AVN. However, this operation is recognized as most difficult operation in hip surgery and technically demanding, and has been sometimes reported poor clinical result. We have performed 60 TRO in last 8 years at our department. We have encountered differences between preoperative planning and postoperative radiographs. We constructed a 3D template and made patient specific instruments (PSI) using a 3D printer for TRO in 3 cases.

Materials & Methods: We performed 3 TROs in 3 patients from December 2010 to August 2011 using this method. Case 1 was 39 years old male with alcoholic AVN, Case 2 was 44 years old male with post-traumatic AVN and case 3 was 17 years old male with steroid induced AVN. X-rays showed stage 3B and type C2, 3B and C1, and 3A and C2 respectively according to Japanese classification (2). We obtained volumetric data from pre-operative CT and planned using 3D CAD software. Firstly, we confirmed an indication of TRO three dimensionally.



We aimed to change a type from C preoperatively to type A or B postoperatively. PSTs were made using Laser Sintering by 3D printer which had heat tolerance for sterilization in order to insert the femoral guide wire correctly. We operated using a transtrochanteric approach for all the patients. PST has the base (contact part) to fit to the lateral aspect of the femur (Fig.1). PST consists of the arm, the base and the sleeve hole to insert the guide pin into osteotomy line. Postoperative CT is always taken one week later. We measured angles between the femoral head axis and the osteotomy surface in coronal plane using the 3D template software made by the JMM Company. We also measured the necrotic area change and accuracy of this method in three dimensions.

Results: We decided to apply 135° posterior rotational osteotomy without a change of neck shaft angle in Case 1, 90° anterior rotational osteotomy without a change of neck shaft angle in Case 2 and 135° posterior rotational osteotomy with 20° varus osteotomy in Case 3 in order to obtain type A or B postoperatively. During operation, stable PSIs placements were achieved in all cases. Postoperative X-ray showed type A or B in all cases. X-ray measurement showed differences between preoperative planning and postoperative X-ray as 1.3, 2.4 and 2.0° respectively with respect to neck shaft angle. 3D measurement showed 3.2°, 4.4° and 5.0° differences respectively with respect to neck shaft angle. We also measured the extent of rotation of the femoral head which were 133.5°, 97.0° and 110° respectively. Angles between the femoral head axis and the osteotomy surface in coronal plane were

5.4°, 3.3° and 8.7° respectively. Necrotic area among the weight bearing articular surface decreased from 39.1% to 28.4% in average.

Discussion: The mean absolute calculated difference in neck shaft angle was 1.9° by an X-ray measurement and 4.2° by a 3D measurement. We believe this is much more accurate than the conventional method. By using our PST, we could install a guide wire easily and accurately in all cases. This system enables us to decide an indication of TRO and do careful and an accurate preoperative simulation. We also reconstruct this planning to the operation. We believe this system is very useful for TRO.

References

1. Sugioka; CORR. (130):191-201, 1978
2. Sugano N; J of Orthop Sci. 7(5):601-5, 2002