EPiC Series in Health Sciences

Volume 6, 2024, Pages 59–61

Proceedings of The 22nd Annual Meeting of the International Society for Computer Assisted Orthopaedic Surgery

Accuracy and precision of cementless and cemented stem placement using CT-based navigation

Toshihito Hiraiwa[1,2] and Kunihiko Tokunaga[2]

[1] Department of Orthopaedic Surgery, University of Toyama, Toyama, Japan

[2] Niigata Hip Joint Center, Kameda Daiichi Hospital, Niigata, Japan

thiraiwa@med.u-toyama.ac.jp

Abstract

Few surgeons use computer assisted surgery for stem placement in THA because its accuracy is not sufficient rather than that for acetabular cup placement. Recently, cemented stem can be available in CT-based navigation, however, accuracy and precision of cemented stem alignment has not been reported. We compared accuracy and precision between cementless and cemented stems using the same CT-based navigation (Stryker hip navigation). We analyzed 43 cases (10 men, 33 women; average age 69.3 years) using cementless and cemented stem (Accolade II stem and Exeter stem [Stryker]) after CT-based navigation assisted THA. The differences (average ± standard deviation of absolute values) between the pre- and post-operative angles of stem anteversion were 3.8 ± 3.0° in the cementless group, and 2.4±1.8° in cemented group, respectively. There was a significant difference in precision in stem anteversion between the two groups. The accuracy and the precision of stem anteversion using the taper-wedge stem in this study was comparable to the previous reports using CT-based navigation. However, the precision of stem alignment with cemented stems was more accurate. When we used cemented stem, stem alignment consisted of 4 factors (stem flexion, varus, anteversion, and depth) could be completely controlled by checking the numbers on the navigation screens until bone cement hardened. Therefore, precision of cemented stem alignment using CT-based navigation are more accurate than that of cementless stems.

1 Introduction

Navigation and robotic surgery are used for accurate cup placement in THA, but are rarely used for stem placement. The surgeon's estimation of stem anteversion was reported to be inaccurate[1], and the accuracy of stem placement using navigation was considered insufficient compared to the accuracy of cup placement[2-3]. Previous reports about the accuracy and precision of stem alignment using CT-based navigation were analyses with cementless stems. Recently, cemented stems can be placed under control of CT-based navigation, however, the accuracy and precision of stem alignment has not yet been reported. The purpose of this study was to compare the accuracy and precision of cemented and cementless stems using CT-based navigation.

2 Methods

Forty-three patients with 48 hips (10 men, 33 women; average age 69.3 years) were included in this study. All procedures were performed by the single surgeon (TH) through modified Watson-Jones approach in lateral decubitus position. Cementless acetabular cups; Trident cups (Stryker), and cementless femoral stems; Accolade II stem (Stryker) and cemented stems; Exeter (Stryker) were placed using a CT-based navigation system, Stryker Hip Navigation 1.3. Twenty four of the 48 hips were inserted with Accolade II stems and the other 24 hips were used with Exeter stems.

Preoperative planning was made using a 3D image analysis software Zed Hip (LEXI, Japan) based on preoperative CT images, and surgical planning and actual surgery were performed using Stryker Hip Navigation 1.3. Postoperative CT images were 3D-3D matched with the preoperative CT images to measure the postoperative stem alignment in the same femoral coordinate system as in the preoperative planning. We used table to plane as a femoral coordinate system, which was created at the most posterior point of the proximal femur and the bilateral posterior epicondyles. The Z-axis was the projection of the line connecting the trochanteric fossa and the knee joint center onto the table-top plane. The stem flexion angle was defined as the angle between the Z-axis of the table top plane and the stem center axis on the YZ plane of the table top plane. The stem abduction angle was the angle between the Z-axis of the table top plane and the stem center axis on the XZ plane of the table top plane. The stem anteversion angle was the angle between the X-axis of the table top plane and the stem neck center axis on the XY plane of the table top plane. Statistical analyses were performed using Weltch t tests for accuracy and F tests for precision. P-values less than 0.05 were defined as statistically significance.

3 Results

The differences (average ± standard deviation of absolute values) between the pre- and post-operative angles of stem flexion angle, abduction angle, and anteversion were 2.8 ± 1.2°, 1.1 ± 0.7°, 3.8 ± 3.0° in the cementless group, and 1.9 ± 1.5°, 0.9 ± 0.8°, 2.4 ± 1.8° in the cemented group, respectively. There was a significant difference in precision of stem anteversion between the two groups.

4 Discussion

All previous reports about accuracy and precision of stem alignment using CT-based navigation THA were for cementless stems[3-4]. The accuracy and precision of stem anteversion using the taper-wedge stem in this study was comparable to the previous reports using CT-based navigation4. The accuracy and precision of stem anteversion with CT-based navigation were higher than those with goniometry and imageless navigation[5-6], and were considered to be sufficient for clinical use. There were few reports comparing the accuracy and precision of alignment by stem type. The stem alignment accuracy of anatomical stems was reported to be higher than that of the taper-wedge stems4, because the anatomical stem fitted and filled in proximal femoral medullary cavity, which led less flexibility than that with taper-wedge stems. The accuracy and precision of stem alignment with cemented stems were analyzed in this study and were more accurate than those at of anatomical stems. Most cementless stems require excavation of the cancellous bone and contact with the bone cortex for fixation, which may result in failure to insert stems as preoperative planning due to deviations of excavation. However, cemented stems do not require contact with bone cortex, and fine adjustments can be achieved until cement hardens. We can completely control the stem alignment consisted of 4 factors (stem flexion, varus, anteversion, and depth) by checking the numbers on the navigation screens until bone cement hardened. These degree of freedom and ease of control can lead high accuracy for stem placement.

5 Conclusion

The precision of alignment of cemented stem are more accurate than that of cementless stems in CT-based navigation.

References

1. Dorr, L. D. et al. A comparison of surgeon estimation and computed tomographic measurement of femoral component anteversion in cementless total hip arthroplasty. J. Bone Jt. Surg. - Ser. A 91, 2598–2604 (2009).
2. Hirasawa, N. et al. Effect of CT slice thickness on accuracy of implant positioning in navigated total hip arthroplasty. Comput. Aided Surg. 15, 83–89 (2010).
3. Kitada, M. et al. Evaluation of the Accuracy of Computed Tomography-Based Navigation for Femoral Stem Orientation and Leg Length Discrepancy. J. Arthroplasty 26, 674–679 (2011).
4. Nakahara, I., Kyo, T., Kuroda, Y. & Miki, H. Does difference in stem design affect accuracy of stem alignment in total hip arthroplasty with a CT-based navigation system? J. Artif. Organs 24, 74–81 (2021).
5. Fujihara, Y. et al. Use of the g-guide for measuring stem antetorsion during total hip arthroplasty. Orthopedics 39, e271–e275 (2016).
6. Fukunishi, S. et al. Accuracy of combined anteversion in image-free navigated total hip arthroplasty: stem-first or cup-first technique? Int. Orthop. 40, 9–13 (2016)..