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Twice cutting method reduces tibial cutting error in unicompartmental knee arthroplasty

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ABSTRACT

Background: Bone cutting error can be one of the causes of malalignment in unicompartmental knee arthroplasty (UKA). The amount of cutting error in total knee arthroplasty has been reported. However, none have investigated cutting error in UKA. The purpose of this study was to reveal the amount of cutting error in UKA when open cutting guide was used and clarify whether cutting the tibia horizontally twice using the same cutting guide reduced the cutting errors in UKA.

Methods: We measured the alignment of the tibial cutting guides, the first-cut cutting surfaces and the second cut cutting surfaces using the navigation system in 50 UKAs. Cutting error was defined as the angular difference between the cutting guide and cutting surface.

Results: The mean absolute first-cut cutting error was 1.9° (1.1° varus) in the coronal plane and 1.1° (0.6° anterior slope) in the sagittal plane, whereas the mean absolute second-cut cutting error was 1.1° (0.6° varus) in the coronal plane and 1.1° (0.4° anterior slope) in the sagittal plane. Cutting the tibia horizontally twice reduced the cutting errors in the coronal plane significantly ($P < 0.05$).

Conclusion: Our study demonstrated that in UKA, cutting the tibia horizontally twice using the same cutting guide reduced cutting error in the coronal plane.

1. Introduction

Accurate component positioning is important for the success of knee arthroplasty [1–3]. There are some causes of malalignment, and bone cutting error is reported to be one of them [4]. The level of bone cutting error in total knee arthroplasty (TKA) has been reported in several studies [5–9], but none have investigated cutting error in unicompartmental knee arthroplasty (UKA).

Computer-assisted navigation systems were introduced to improve alignment of components and the lower limbs [10–13]. Using such a navigation system, we can monitor bone cutting error and recut the bone to reduce this error, thereby achieving the planned alignment [14]. However, most surgeons have to perform surgeries without such navigation systems. Cutting the bone “twice” using the same cutting guide without navigation systems may appear too simple but we consider that this method has sufficient potential to reduce cutting error.

The purpose of this study was to clarify whether this twice cutting method reduced cutting error of the tibia in UKA. We therefore hypothesized that cutting the tibia twice could reduce cutting errors in UKA.

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2. Materials and methods

Out of a total of 51 consecutive primary UKA procedures performed between November 2012 and November 2013, 50 knees were replaced using an image-free navigation system (Precision N; Stryker Orthopedics, Mahwah, NJ, USA). The accuracy of this navigation system was confirmed in our previous study [12]. One patient was excluded because of malfunctioning of the navigation system.

Fifty UKAs were performed in 44 patients. Seven were male and 37 were female. The average age was 71 years (range 54 to 85 years). The diagnosis was knee osteoarthritis in 34 patients and osteonecrosis in 10 patients. The surgeries were performed by four knee surgeons and one surgeon (HI) took part in all procedures as either a chief surgeon or first assistant.

2.1. Surgical procedure

All procedures were performed using the standard minimally invasive approach and all implants used were Oxford UKA (Biomet, Swindon, United Kingdom). After setting the tibial cutting guide, we measured its alignment using the navigation system and performed vertical cutting. The chief surgeon then made the first horizontal cut in the tibia using the fixed, open cutting guide (saw blade thickness, length, and width were 0.89, 90, and 13 mm respectively). During this procedure we used two retractors, one is a medial curved retractor to

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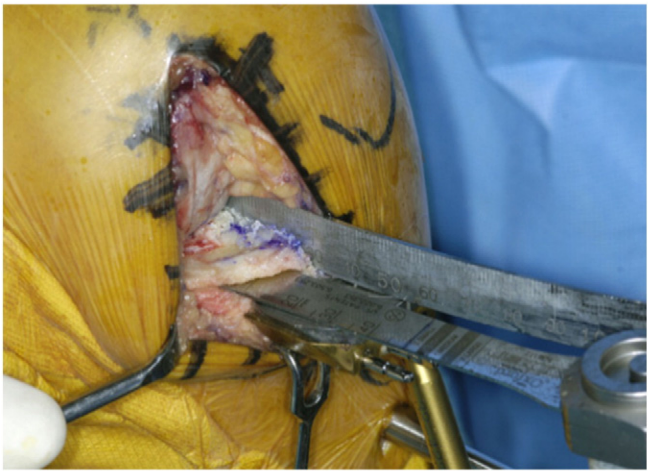

Fig. 1. Horizontal cutting of the tibia. Two retractors were inserted to protect the medial collateral ligament and bony prominences.

protect the medial collateral ligament and the other is a lateral straight retractor, a thin metal device, inserted into the notch made by the vertical cut to prevent the saw blade from undermining the tibial eminence laterally (Fig. 1). After choosing the tibial implant size, the surgeon recut the tibia using the same cutting guide with an unobstructed view after the first-cut and information of the inclination and thickness of the cut bone fragment from a visual observation, however, without knowing the amount of cutting error evaluated by the navigation system.

2.2. Measurement of cutting error

The alignment of the first-cut cutting surfaces was measured and recorded by the first assistant using the navigation system, while the chief surgeon averted his gaze from the navigation monitor to choose the tibial size using the excised plateau. The alignment of the second-cut cutting surfaces was measured by the chief surgeon using the navigation system. The third cut was performed for the outlier cases under navigation control.

Cutting error was defined as the angular difference between the cutting surface and the cutting guide, and the surgical outlier of angular difference was defined as ≥3°. We compared the angular difference and ratio of outliers between the first and second cuts.

2.3. Statistical analysis

Data were analyzed using the EXCEL statistics 2012 (SSRI Co., Ltd., Tokyo, Japan) software package for Microsoft Windows. The Mann–Whitney U-test was used to compare the two groups, and the Chi-square test was used to compare the rate of outliers between the two groups. All significance tests were two-tailed, and a significance level of $P < 0.05$ was used for all tests.

Institutional review board approval was received for this study, and all patients provided written informed consent.

3. Results

The mean absolute first-cut cutting error was 1.9 ± 1.7° [mean ± standard deviation (SD), 1.1 ± 2.3° varus, range 4.5° valgus to six degrees varus] in the coronal plane and 1.1 ± 1.0° (0.6 ± 1.4° anterior slope, range 3.5° posterior slope to four degrees anterior slope) in the sagittal plane. There were 13 outlier cases (26%) in the coronal plane and five (10%) in the sagittal plane. The mean absolute second-cut cutting error was 1.1 ± 1.0° (0.6 ± 1.3° varus, range 1.5° valgus to four degrees varus) in the coronal plane and 1.1 ± 1.0° (0.4 ± 1.3° anterior slope, range four degrees posterior slope to three degrees anterior slope) in the sagittal plane. There were four outlier cases (eight percent) in the coronal plane and four (eight percent) in the sagittal plane (Figs. 2, 3).

There were significant improvements in the second-cut group with regard to the ratio of outliers ($P = 0.017$) and absolute value in the coronal plane ($P = 0.025$).

Numbers of outlier cases after the first cut were significantly higher in the sagittal plane than in the coronal plane ($P = 0.037$).

Numbers of the patients whose cutting error was improved, did not change and was deteriorated by the second-cut were respectively 32 (64%), 13 (26%) and five (10%) in the coronal plane and 17 (34%), 27 (54%) and six (12%) in the sagittal plane.

4. Discussion

This is the first study to determine the amount of tibial cutting error in UKA using a navigation system. Our results showed that there were many instances of such error, in particular in the coronal plane. However, this study also revealed that cutting the tibia twice reduced cutting error significantly. This method is simple, easy, and effective and we recommend it to all surgeons with no access to navigation systems.

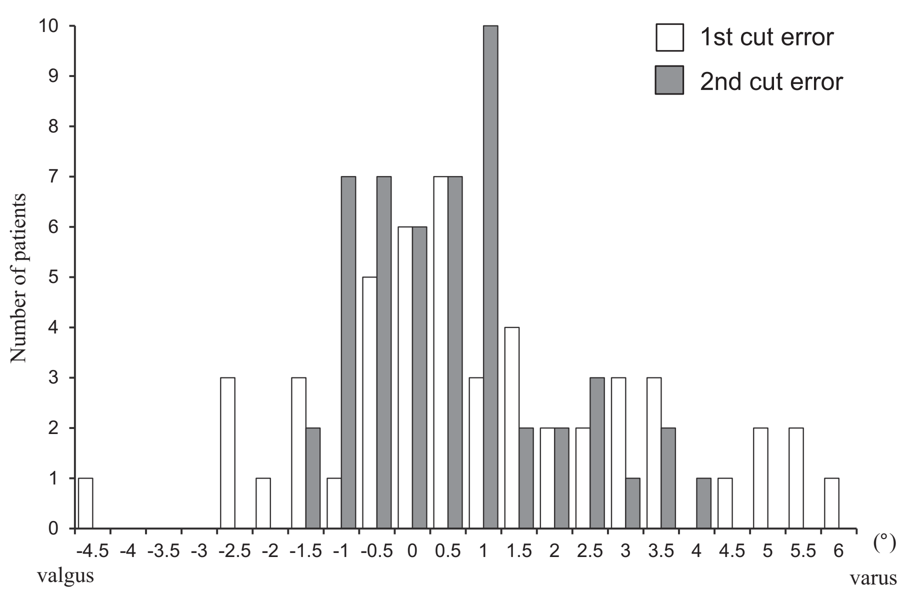

Fig. 2. Distribution of cutting error in the coronal plane.