Comparing Alignment of Proximal Tibia first cut between Narrow and Wide saw Blade in CAS TKA

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Objective: *The primary aim of the present study is to comparison between using narrow and wide saw blade of proximal tibial bone cut in close slot cutting block guide verified by computer navigation system.*
Material and Method: *The authors evaluated 80 knees in 80 patients. After cutting the proximal tibia, the cutting surface was validated using the navigated cutting block adapter, and the angular difference between the cutting surface and that preoperatively planned in the sagittal and coronal planes was recorded.*
Results: *The average cutting error of all knees was 1.8° ± 2.7° in use narrow blade and 1.2° ± 2.2° in use wide blade. The authors did not find statistically significant difference between the first 40 patients and the next 40 patients. The average cutting error of sclerotic bone was 2.3° ± 2.7° in use narrow blade and 1.1° ± 2.1° in use wide blade. The authors find statistically significant. The average error in the coronal plane was 1.5° ± 1.1° in valgus and 2 (2.5%) in varus of the 80 knees had a malalignment of more than 1° with respect to the targeted cutting plan.*
Discussion: *Alignment of cutting surface should be checked after cut proximal tibia and recut to reach target alignment and should be cut with wide saw blade especially in sclerotic bone.*

Keywords: *Total knee arthroplasty, Bone cutting, Malalignment, Distal femur, Navigation systems*

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Optimal alignment of knee implants is essential for the success of a total knee arthroplasty (TKA)[1-4]. However, it is well known that a certain degree of component malalignment can occur. There are 3 different possible steps of malalignment: (1) in setting the cutting guide, (2) in cutting the bone, and (3) in fixation of the component[5-8].

Although a computer assisted navigation system can improve the accuracy of cutting guide placement, other causes should not be ignored in achieving optimal alignment. the alignment of the knee following total knee replacement, as seen on anteroposterior radiographs, may be the most important factor determining the long-term survival of the prosthesis. Proper alignment of implants is strongly associated with greater stability, a lower rate of loosening, and higher clinical scores[1-14]; however, the current literature show a precise range of values for the postoperative tibial alignment, femoral alignment and overall anatomic alignment necessary to achieve the best possible long-term prosthesis survival.

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In the present study, we evaluated the alignment of the cutting surface after cutting the proximal tibia by using a navigation system to determine the accuracy of bone cutting.

Material and Method

From May 2011 to January 2012, the authors performed 132 TKAs including 128 cases with the use of a computed tomography-based navigation system (DePuy Sigma Rotating Platform Knee; Johnson & Johnson, USA) at Police General Hospital. The authors prospectively evaluated 40 knees of 40 patients who agreed to participate in the current study, including 2 men and 78 women. Secondary gonarthrosis due to fracture or trauma, previous osseous operations of the knee joint, revision and infection had been excluded, but we did not define other exclusion criteria such as age, sex and degree of deformity. The mean age at the time of the initial knee replacement was 70.1 ± 8.6 years (range, fifty-seven to ninety-three years); 78 (97.5%) of the patients were women and 2 (2.5%) were men. The mean preoperative BMI was 30.2 ± 5.6 kg/m^2 (range, 16.5 to 64.3 kg/m^2). The mean preoperative anatomic tibiofemoral alignment was 0.0_ ± 7.7_ (range, 25_ of varus to 35_ of valgus).

All surgeries were performed using the Sigma

Rotating Platfrom prosthesis (DePuy, Johnson & Johnson, USA). Both wide and narrow saw blade were same 1.47 mm thickness and the slot height of the cutting block was 1.47 mm (Fig. 1). Preoperative planning allowed for the tibia component to be perpendicular to the mechanical axis in the coronal plane and posterior slope 0 degree. The overall anatomic alignment was defined as the angle between the femoral anatomic axis (a line drawn through the center of the femoral shaft) and the tibial anatomic axis (a line drawn through the center of the tibial shaft) 9. The tibial alignment was defined as the angle between the proximal portion of the tibial component and the previously described tibial anatomic axis.

During surgery, the cutting guide for the proximal tibia was aligned using the navigation system. The angle and position of the guide were finely tuned to that preoperatively planned in all patients (Fig. 2). After the first proximal tibial osteotomy, the authors evaluated the angle of the cutting surface with the cutting block adapter (Fig. 3). The authors recorded the angular difference between the cutting surface and the angle preoperatively planned in the sagittal and coronal planes and the authors defined the angular difference as the cutting error. All knees whose cut surface differed by more than 1° from the planned position were recut to achieve the planned alignment.

Fig. 1 Compare narrow blade (13 mm wide) and broad blade (25 mm wide)

Fig. 2 Preoperative planning of tibia cut

Fig. 3 Verification step that measured accuracy after proxi mal tibia cut

Results

The average cutting error of all knees was 1.8° ± 2.7° in use narrow blade and 1.2° ± 2.2° in use wide blade. Forty knee (50%) of the 80 knees were cut in use narrow blade, forty knee were cut in use wide blade. The authors did not find statistically significant difference between the first 40 patients and the next 40 patients. The average cutting error of sclerotic bone was 2.3° ± 2.7° in use narrow blade and 1.1° ± 2.1° in use wide blade. The authors find statistically significantly when we use wide saw blade in sclerotic bone. The average error in the coronal plane was 0.5° ±

1.1° in valgus, and 2 (2.5%) of the 80 knees had a malalignment of more than 1° with respect to the targeted alignment (Fig. 3).

Discussion

Sagittal alignment of the tibial component is one of the important issues affecting the clinical results of TKA[9-13]. Failure was most likely to occur if the orientation of the tibial component was < 90 relative to the tibial axis (failure rate, 8.7%; $p < 0.0001$) by Ritter et al. A previous study conducted at our institution by Fang et al indicated that poor overall anatomic alignment of a total knee replacement was associated with a 6.9 times greater risk of failure due to tibial collapse and that varus tibial alignment was associated with a 3.2 times greater risk 4. Likewise, Berend et al 2 found that twenty of forty-one failures were due to collapse of the medial bone and that all twenty of these knees were in varus alignment (mean, 3.7_ of varus). If the proximal tibia is cut in narrow blade or wide blade, it is possible that the anteroposterior dimension of the cutting surface would be affected and tibiofemoral alignment change. In the present study, the first proximal tibia bone cut tended to have more malalignment by use the narrow blade than wide blade with respect to the targeted alignment even if the proximal tibia cutting guide was aligned in the desired position. The possible causes for this include wide bone saw blade was more rigid than narrow bone saw blade. Therefore, the alignment of the cutting surface should be repeatedly checked after cutting the proximal tibia and recut, if necessary, to reach the targeted alignment. From the present study, the authors conclude that a navigation system is useful during TKA for verification of the cutting surface and avoidance of varus-valgus malalignment. In the present study, the first proximal tibia cut resulted in slightly valgus alignment, which may be due to the fact that all cases had varus deformity and the medial bone was harder than the lateral bone causing the saw blade to deflect. Many studies have reported on sagittal alignment positioning after TKA. Therefore, if the proximal tibia cut is done using a conventional method in the sagittal plane, the alignment of the cutting surface tends to be inaccurate. In the present study, the authors reported that femoral cutting error is possible even with the use of the navigation system during TKA. Plaskos et al[7] measured the orientations of the cutting guides and the cut bone surfaces using a custom-built planar probe instrumented with an array of infrared-emitting diodes. They described that more than 50% of cases had sagittal plane errors more than 1° and 26% had errors more than 2° because the saw blade bends and rests along the front edge causing the blade to deflect upward. The authors exactly aligned the guide to the planned angle and measured bone resection alignment after the first bone cutting. After the first bone cutting, the authors recut the proximal tibia to achieve the planned alignment by checking resection surface alignment with the navigation system. Therefore, the present study clearly showed inaccuracy of first bone cutting. Therefore, a navigation system should be used to check the alignment of the cutting surface and the prosthetic component as well as for navigating the alignment guide. The key limitation of the present study

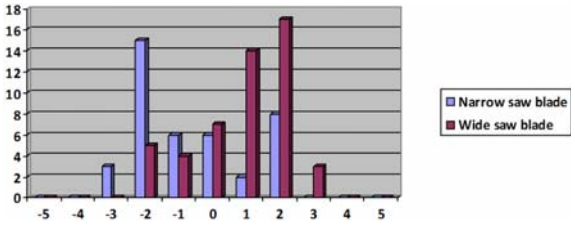

Fig. 4 Cutting error with respect to the targeted alignment in the coronal plane. A positive value indicates valgus alignment and a negative value indicates varus alignment

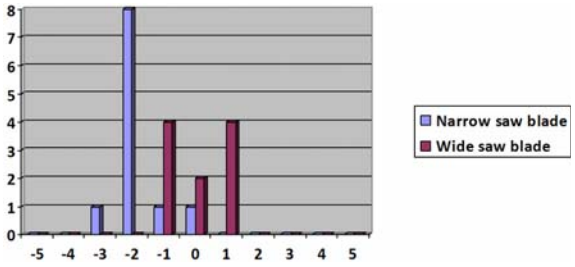

Fig. 5 Cutting error in sclerotic bone with respect to the targeted alignment in the coronal plane. A positive value indicates valgus alignment and a negative value indicates varus alignment

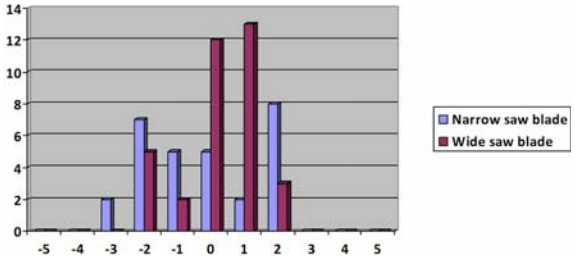

Fig. 6 Cutting error in soft bone with respect to the targeted alignment in the coronal plane. A positive value indicates valgus alignment, and a negative value indicates varus alignment

is that the authors evaluated a small number of patients. However, the present study provides accurate data obtained using the navigation system during TKA. Several studies reported on postoperative femoral component alignment using radiographs or computed tomographies[19-23], but few studies evaluated the difference between the alignment of the cutting surface and that of the cutting guide intraoperatively. Therefore, the authors believe that the present study would provide preliminary but important information. In conclusion, in the present study, the proximal tibia tended to be cut in wide saw blade with respect to the targeted alignment in the sagittal plane. Surgeons should be cognizant that during TKA, with or without navigation, the proximal tibia tends to be cut in wide with the first tibia cut in the sagittal plane.

Potential conflicts of interest

None.

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การศึกษาเปรียบเทียบความผิดพลาดของการตัดกระดูกทิเบียครั้งแรกระหว่างเลื่อยตัดกระดูกชนิดหน้าแคบกับเลื่อยตัดกระดูกชนิดหน้ากว้างในการผ่าตัดเปลี่ยนผิวข้อเข่าเทียมวัดโดยระบบคอมพิวเตอร์นำวิถี

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วัตถุประสงค์*: เปรียบเทียบความผิดพลาดของการตัดกระดูกทิเบียครั้งแรกระหว่างเลื่อยตัดกระดูกชนิดหน้าแคบกับเลื่อยตัดกระดูกชนิดหน้ากว้างในการผ่าตัดเปลี่ยนผิวข้อเข่าเทียมวัดโดยระบบคอมพิวเตอร์นำวิถี*

วัสดุและวิธีการ*: ประเมินผู้ป่วย 80 ราย 80 เข่า ที่ได้รับการผ่าตัดเปลี่ยนผิวข้อเข่าเทียมในโรงพยาบาลตำรวจ โดยใช้ใบเลื่อยชนิดหน้ากว้างในการตัดกระดูกทิเบียครั้งแรก 40 เข่า ใช้ใบเลื่อยชนิดหน้าแคบในการตัดกระดูกทิเบีย ครั้งแรก 40 เข่า เก็บข้อมูลของมุมที่ได้หลังจากการตัดกระดูกโดยใช้คอมพิวเตอร์นำวิถีหากมุมที่ได้คลาดเคลื่อนเกิน 3 องศา จะทำการตัดกระดูกทิเบียซ้ำจนกว่าจะได้มุมที่ต้องการ นำมุมที่คลาดเคลื่อนจากใบเลื่อยสองชนิดมาเปรียบเทียบกัน*

ผลการศึกษา*: พบว่าความคลาดเคลื่อนโดยใช้ใบเลื่อยชนิดหน้าแคบมีค่า $1.8^{\circ} \pm 2.7^{\circ}$ ความคลาดเคลื่อนของการตัดโดยใช้ใบเลื่อยชนิดหน้ากว้างมีค่า $1.2^{\circ} \pm 2.2^{\circ}$ ไม่พบความแตกต่างทางสถิติอย่างมีนัยสำคัญแต่ผู้นิพนธ์พบว่าความคลาดเคลื่อนของใบเลื่อยชนิดหน้าแคบในการตัดกระดูกทิเบียที่มีลักษณะแข็งมีค่า $2.3^{\circ} \pm 2.7^{\circ}$ และความคลาดเคลื่อนในการตัดกระดูกทิเบียที่มีลักษณะแข็งโดยใช้ใบเลื่อยชนิดหน้ากว้างมีค่า $1.1^{\circ} \pm 2.1^{\circ}$ มีความแตกต่างอย่างมีนัยสำคัญ*

สรุป*: การตัดกระดูกทิเบียในการผ่าตัดเปลี่ยนผิวข้อเทียมมีความสำคัญมากเพราะมีผลต่ออายุการใช้งานของข้อเข่าเทียมการใช้คอมพิวเตอร์นำวิถีในการช่วยข้อเข่าเทียมมีประโยชน์หลายอย่าง โดยเฉพาะอย่างยิ่งในการวัดความคลาดเคลื่อนของการตัดกระดูก เพื่อที่จะทำให้เกิดความคลาดเคลื่อนน้อยที่สุดทำให้ผู้ป่วยสามารถใช้ข้อเข่าเทียมได้อย่างยาวนานมากยิ่งขึ้น และควรใช้ใบเลื่อยชนิดหน้ากว้างในการตัดกระดูกทิเบียโดยเฉพาะอย่างยิ่งในกระดูกที่มีลักษณะแข็ง จะทำให้ความผิดพลาดในการตัดกระดูกน้อยกว่าใบเลื่อยตัดกระดูกชนิดหน้ากว้าง*