Radiographic Assessment in Bilateral Primary Total Knee Arthroplasty: Computer-Assisted Surgery vs. Conventional Surgery

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Objective: The purpose of this retrospective study is to compare the efficiency of computer-assisted surgery (CAS) and conventional method (CONV) in TKA using mechanical axis (MA) and component alignment measured on the post-operative radiograph in the same patient by different technique for TKA on both sides of the knee.

Material and Method: Fifty-two TKA in twenty-six patients with primary osteoarthritis of both knees that underwent stage bilateral TKA by computer-assisted surgery one side and conventional method on the other side were inclusion criteria. Digital long-leg weight-bearing radiographs were taken. The mechanical axis (MA), femoral component in coronal plane (FFC), tibial component in coronal plane (FTC), femoral component in sagittal plane (SFC) and tibial component in sagittal plane (STC) were measured and compared.

Results: The MA indicated that computer-assisted surgery (CAS) is significantly improved accuracy compared with conventional method (178.12° ± 1.56° and 176.15° ± 1.85° respectively, p = 0.00). For FFC alignment, the results showed that CAS group is significantly more accurate than CONV group (88.58° ± 1.30° and 87.38° ± 2.02° respectively, p = 0.07). CAS group showed less distribution and fewer outliers of data than CONV group. For FTC, SFC and STC alignment, the means of both groups were no difference (p > 0.05). Otherwise, the numbers of outlier CONV group trend toward greater than CAS group (FTC 3.8% and 0%, SFC 30.8% and 0%, respectively). There was no report of change in the navigator group procedure to conventional method during surgery and no perioperative or postoperative complications were noted.

Conclusion: Computer-assisted surgery (CAS) is a safe and useful intraoperative tool for total knee arthroplasty to improve accuracy of mechanical axis, good implant position and reduce number of postoperative implant outlier. Clinical studies will be required for clinical outcome assessment.

Keywords: Computer-assisted surgery, Arthroplasty, Total knee replacement

Total knee arthroplasty (TKA) has been established treatment for advanced stage of the knee osteoarthritis. Many factors are affected to long-term result such as surgical technique, implant design, malposition/orientation of the prosthesis, perioperative care and patient selection(1-3). Some authors purposed that the most important factor influence that improves implant survival is postoperative leg axis(4,5). Besides, they also concluded that the mechanical axis (MA) which is outlier more than 0 ± 3° can lead to unfavorable outcome for patients. For example, early polyethylene wear, or component loosening(6-8).

Nowadays, the navigation system has become more popular to obtain more accurate cutting guides and bone resections including improve soft tissue balancing. These could result in improved MA and component alignment(9-12). Miclke et al(13) reported that component alignment in computer-assisted surgery (CAS) is significantly improved compared with conventional instrument surgery (CONV). However, several authors reported that no difference result between two methods. Besides, CAS was considered that more time-consuming and more risk of complication than conventional method(14,15).

The purpose of this retrospective study was to compare the efficiency of CAS and conventional method in TKA by comparison of the mechanical axis (MA) and component alignment from the postoperative radiograph in patient who CAS-TKA were performed.
on one side and conventional method on the other side.

**Material and Method**

The present study was approved by the ethics committee in Rajavithi hospital (ID number 034/2555). The inclusion criteria was the patient diagnosed with primary osteoarthritis at knee that underwent stage primary total knee arthroplasty both sides by different methods (computer-assisted surgery one side and conventional method on the other side) during the period between February 2011 to January 2012. Fifty-two TKA in twenty-six patients were matched with inclusion criteria; all patients were performed TKA by single experience author (PS). The medical records and radiological data for all patients were reviewed retrospectively.

**Surgical techniques**

All TKAs were performed with minimal invasive surgery (MIS) under spinal anesthesia, used midvastus arthrotomy and stated with tibia bone cut first. No patellar were resurfaced in either group. The postoperative protocols were identical in both groups.

Most patients who underwent TKA with conventional method used cemented fixed-bearing, PS design (PFC Sigma, Deupy, Johnson and Johnson, Leeds, UK) under measure resection technique and some cases used mobile-bearing, PS design (e.motion®, BBraun, Aesculap, Tuttlingen, Germany) under gap-balance technique. Extramedullary tibial guide and intramedullary femoral guide were used for proximal tibial and distal femoral bone cut, respectively, according to a standardized protocol.

For computer-assisted TKA, all cases used cemented mobile-bearing, PS design (e.motion®, BBraun, Aesculap, Tuttlingen, Germany). Schantz pin with reflection array were applied to proximal tibia and distal femur and then, registration step by step under image-free navigation system (OrthoPilot® 4.3, Aesculap, Tuttlingen, Germany) to create virtual image on screen display. Real-time bone cutting were performed under the navigation system and used gap-balance technique to equal flexion and extension gap.

Digital long-leg weight-bearing radiographs were taken when patients had full extension of the knee, average one to three months post-operatively. The mechanical axis of lower limb was determined by angles between the mechanical axis of femur and the mechanical axis of tibia. The line of mechanical axis (MA), femoral component in coronal plane (FFC) and Tibial component in coronal plane (FTC) were measured in anteroposterior films, whereas the femoral component in sagittal plane (SFC) and tibial component in sagittal plane (STC) were measured in lateral flexion films (Fig. 1). The outlier of the component in each radiographic was setting base on $0° \pm 3°$ varus/valgus and $0° \pm 3°$ flexion/extension. All radiographs were measured by independent observer with digital radiographic software on personal computer (Synapse-PACS system, Fujifilm Medical Systems USA, Inc.).

**Statistical analysis**

Data were analyzed on SPSS ver 17 (SPSS Inc. Chicago, Illinois). Descriptive results of continuous variables were expressed as mean, standard deviation (SD) and categorical variables were expressed as number and percent. Intergroup comparisons were made using pair t-tests for normal distribution data and using Wilcoxon test for non-normal distribution data. The p-value < 0.05 was set for statistically significant.

**Results**

The mean value, standard deviations and percent of outlier of the digital long-leg weight-wearing
Radiographic measurement are shown in Table 1. The MA of the lower limb indicated that there are significant improve accuracy on the CAS group when compare with CONV group (178.12° ± 1.56° and 176.15° ± 1.85° respectively, p = 0.00). Number of TKA in the CAS group was less outlier than CONV group (11.5% and 61.5%, respectively).

For FFC alignment, the results showed that CAS group is significantly more accurate than CONV group (88.58° ± 1.30° and 87.38° ± 2.02°, respectively, p = 0.07). There were fewer outliers in the CAS than CONV group (0% and 30.8%, respectively).

For the other digital radiographic results, the means of both groups were no statistically significant difference. From the anteroposterior film, the FTC alignment of the CAS group and the CONS group were 89.54° ± 1.07° and 88.81° ± 1.58° (p = 0.44) respectively. From the lateral film, the SFC alignment of the CAS group and the CONS group were 91.04° ± 2.07° and 91.77° ± 3.15° (p = 0.39) respectively. The STC alignment of the CAS group and in the CONS group were 90.54° ± 1.55° and 91.31° ± 2.83° (p = 0.12) respectively. Otherwise, the numbers of outlier CONV group trend toward greater than CAS group (FTC 3.8% and 0%, SFC 26.9% and 15.4%, respectively).

The distribution of mechanical axis (MA) and femoral component in coronal plane (FFC) were shown in Fig. 2 and Fig. 3. CAS group showed distribution of data less than CONV group.

Discussion

Generally, the long-term clinical outcomes of total knee arthroplasty were claimed that depend on good postoperative mechanical axis and component alignment (16,17). Moreover, malposition of TKA implants resulted in early loosening and increased polyethylene wear (1,4,8). Navigation systems have been developed to improve the accuracy of bone cutting, precise component alignment, well soft tissue balancing, equal of flexion and extension gap including the MA (9,12,18,19). Thus, many current studies evaluated preoperative alignment (20), bony deformity (21), or situation in case of revision TKA (22). The result from these studies reported that computer-assisted surgery can significantly improve the component alignment and the MA.

In the present study showed that postoperative alignment of TKA in the same patient by different technique were different on both sides of the knee. According to the other studies, the postoperative alignment in the CAS group was superior to CONV group. Besides, MA and FFC alignment were also presented in the present data. In the case that outliers are present, the authors found that there are smaller present of outlier in the CAS than CONV group.
However, the authors did not compare the STC (tibial slope) alignment due to the difference type of tibial prosthesis.

Although some complications of CAS including infection or intraoperative fracture have been reported, however, no complications were found in the present study.

The limitations of the present study are that only a small number of subjects and lack of clinical outcomes. Future study designs evaluating the effect of CAS are likely to be challenged by large sample sizes and prospective study with clinical result following will be need to demonstrate clinical outcome difference.

**Conclusion**

Computer-assisted surgery (CAS) is a safe and useful intraoperative tool for total knee arthroplasty to improve accuracy of mechanical axis, good implant position and reduce number of postoperative implant outlier. Clinical studies will be required for clinical outcome assessment

**Potential conflicts of interest**

None.

**References**

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การประเมินภาพถ่ายรังสีของผู้ป่วยที่ได้รับการผ่าตัดเปลี่ยนข้อเข่าเทียมทั้งสองข้างด้วยการใช้คอมพิวเตอร์ช่วยผ่าตัดเปรียบเทียบกับวิธีธรรมดา

นที เรืองทอง, พรภวิษณ์ ศรีภิรมย์

วัตถุประสงค์: เพื่ศึกษาประเมินประสิทธิภาพของการผ่าตัดเปลี่ยนข้อเข่าเทียมโดยวิธีใช้คอมพิวเตอร์ช่วยในการผ่าตัดและการผ่าตัดโดยวิธีธรรมดา โดยการเปรียบเทียบมุม mechanical axis (MA) และมุม component alignment ในผู้ป่วยที่ได้รับการผ่าตัดเปลี่ยนข้อเข่าทั้งสองข้าง โดยเปรียบเปรียบด้วยวิธีธรรมดาหนึ่งข้างและเปรียบเปรียบด้วยการใช้คอมพิวเตอร์ช่วยผ่าตัดในข้างที่ห่างหนึ่ง

วิสัยและวิธีการ: ศึกษานานวันของเข่าทั้งหมด 52 เข่า จากหญิงจำนวน 26 ราย ในช่วงระหว่างเดือนกุมภาพันธ์ พ.ศ. 2554 ถึง มกราคม พ.ศ. 2555 ที่ได้รับการวินิจฉัยว่าเป็นข้อเข่าเสื่อมทั้งสองข้างและได้รับการผ่าตัดเปลี่ยนข้อเข่าทั้งหมดโดยการผ่าตัดด้วยวิธีธรรมดาและการผ่าตัดด้วยวิธีใช้คอมพิวเตอร์ช่วยในการผ่าตัดที่ห่างหนึ่งที่มีการประเมินภาพถ่ายรังสีก่อนและหลังการผ่าตัด ทางการผ่าตัดและประเมินมุม mechanical axis (MA), femoral component in coronal plane (FFC), tibial component in coronal plane (FTC), femoral component in sagittal plane (SFC) และมุม tibial component in sagittal plane (STC)

ผลการศึกษา: พบว่าการผ่าตัดโดยวิธีใช้คอมพิวเตอร์ช่วยเพิ่มความแม่นยำของมุม MA มากกว่าการผ่าตัดด้วยวิธีธรรมดาที่มีค่าเฉลี่ย ± 1.56° และ 1.66° ตามลำดับ (p = 0.00) สำหรับมุม FFC นั้นพบว่ามีความแม่นยำสูงจากการผ่าตัดโดยวิธีใช้คอมพิวเตอร์ช่วยมากกว่าการผ่าตัดด้วยวิธีธรรมดาที่มีค่าเฉลี่ย ± 2.02° ตามลำดับ (p = 0.07) และในกลุ่มการผ่าตัดโดยวิธีใช้คอมพิวเตอร์ช่วยพบมีการกระจายของข้อมูลและค่า outliers น้อยกว่ากลุ่มที่ได้รับการผ่าตัดแบบธรรมดา สำหรับมุม SFC และ STC นั้นไม่พบความแตกต่างระหว่างการผ่าตัดแบบธรรมดา (p > 0.05) และพบค่า outlier ของกลุ่มที่ได้รับการผ่าตัดแบบธรรมดาพื้นเมืองในกรมทหารม้าทหารช่างโดยวิธีใช้คอมพิวเตอร์ช่วย (FTC 3.8° และ 0%, SFC 6.9° และ 15.4% ตามลำดับ) โดยผู้ป่วยทั้งหมดในการศึกษานี้ไม่มีการเปลี่ยนกลุ่มการผ่าตัดโดยวิธีใช้คอมพิวเตอร์ช่วยตามที่ได้รับการผ่าตัดและเปรียบเทียบกับการผ่าตัดแบบธรรมดา

สรุป: การใช้คอมพิวเตอร์ช่วยในการผ่าตัด เนื่องจากห้องโรคติดต่อและรายเพิ่มความแม่นยำของ MA ทำให้คำแนะนำการราวข้อเข่าเทียมดีขึ้น รวมที่จะได้ผลลัพธ์ของ outlier หลังการผ่าตัด ศึกษาเฉพาะทาง clinical รวมถึงการรวบรวมพูดยาที่มาจากผลการเปรียบเปรียบในการศึกษาครั้งต่อไป

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