A Comparison of Early Clinical Outcome in Computer Assisted Surgery and Conventional Technique in Minimally Invasive Total Knee Arthroplasty

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Objective: *To compare the clinical outcomes of minimally invasive total knee arthroplasty (MIS TKA) with and without computer assisted surgery (CAS).*
Material and Method: *From September 2007 to February 2008, 64 patients (70 knees) underwent MIS TKA were included. Clinical data such as operative time, pain score, total blood loss and Radiographic data were recorded and compared.*
Results: *There were no significant different in clinical outcome of both groups but range of motion of MIS group was better than CAS group. However, the percentage of outlier of bone cut in CAS group was 6.5% on both femur and tibia while percentage of outlier in MIS group was 16.6% on femur and 25% on tibia.*
Discussion: *Combining CAS with MIS TKA showed improvement of accuracy in coronal bone cut without increase of operative time or complications. The difference of ROM may be due to different prosthesis design in each group.*

Keywords: *Computer assisted surgery, Minimally invasive total knee arthroplasty*

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Total knee arthroplasty (TKA) is one of the most successful procedures in orthopedics operations nowadays. The operation using standard approach yielded good long-term results with average 10-year survival rate more than 90%[1-3].

Minimally invasive surgery (MIS) was introduced in arthroplasty with the main purpose to reduce postoperative pain, blood loss and soft tissue trauma. Using modified instrumentation system, skin incision was dramatically reduced from at least 20-25 cm to 12-15 cm or even less than 9 cm in some cases[4]. There were studies comparing standard TKA and MIS TKA and reported less pain, less blood loss, better recovery of quadriceps strength and shorter hospital stay in MIS TKA group[4,5]. However, smaller operative field may lead to inaccurate bone cut and malposition of prosthesis. There were reports about higher percentage of mal-alignment and malposition of prosthesis in MIS group which may increase early failure rate[5-7]. These reported brought into lots of discussion and debates in orthopedics society. Although the size of skin incision seems to be less significant, the concept of reduce soft tissue trauma and multimodality post-operative pain control is generally accepted.

Computer assisted surgery (CAS) was proved to be a reliable tool to reduce the possibility of inaccurate bone cut and achieve good gap balancing. There were reports of using CAS in TKA compared with standard TKA and found significantly less outlier in CAS-TKA group[8-10]. The operation time is increased in CAS group but the complications are not different in both group. The concept of combining CAS and MIS TKA is appealing because it could improve the accuracy of bone cuts in MIS TKA with less soft tissue trauma than standard approach. Since 2006, the authors started

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MIS approach in TKA patient in selected cases and after January 2007, almost all primary TKA in the authors' institute were done with MIS-TKA. August 2007 one of the authors started using CAS in MIS TKA. Therefore, the authors retrospectively collected data comparing clinical and radiographic results in early phase of CAS between groups of patients underwent MIS TKA with standard MIS instrument and patients underwent MIS TKA with CAS starting from September 1, 2007 to February 29, 2008.

Material and Method

The authors collected data from all patients underwent MIS TKA with CAS (CAS group) or without CAS (MIS group) by two of the authors from September 1, 2007 to February 29, 2008. General data such as age, sex, height, weight, Body Mass Index (BMI) and type of prosthesis were recorded for demographic evaluation. Clinical evaluation consisted of pre-operative and post-operative Knee Society score and Functional score, tourniquet and total operative time, total blood loss intra-operative including 48 hours post-operative, pain score evaluation using Visual Analog Scale (VAS) and complications. Pre-operative and post-operative long standing hip-knee-ankle AP film, 18 inches knee AP and lateral film were taken for radiographic evaluation. The authors evaluated coronal alignment of femoral and tibial component using Radiographic evaluation of the Knee Society. The manual measurement method which describe by Petersen and Engh in 1988(11) to define the longitudinal axis of femur and tibia. The measurement was done by well-trained personnel and one of co-authors whom blinded from procedure. We use consensus agreement for recorded data. The authors excluded patients with history of prior knee surgery, history of any coagulative disorders and patient with concurrent use of any anticoagulants because it may causes abnormal variation in operating time and blood loss.

All patients underwent TKA using Mini-Midvastus approach under single shot spinal anesthesia with morphine. The skin incision length was approximately 10-12 cm depends on size of knee. All patients in MIS group underwent MIS TKA with measured resection technique as recommend by manufacturer's instruction. In CAS group, two more stab wounds were created on both Femur and Tibia for pin insertion and passive reflector attachment. The CAS system using in this study was Ci™ system installed with MITKR software (DePuy, Johnson and Johnson). The authors used Tibial First workflow in all cases. The operating technique in CAS group was following manufacturer's instruction. Tourniquet was inflated right before skin incision and deflated once the authors finished final implanting of the prosthesis for checking and coagulated bleeding points. Suction drain was inserted in all cases for 48 hours before removal. Total blood loss was summation of intra-operative blood loss and total blood loss from suction drain. Post-operative pain management and rehabilitation program were the same in all patients. The authors recorded post-operative pain score using 10 score VAS every 12 hours in all cases. VAS at 24 and 48 hours time point were used to evaluate pain different in this report. After discharge from hospital, all patients were scheduled for outpatient visit at 1 month, 3 months, 6 months and every 6 months afterward. Range of motion will be recorded at each time point of outpatient visit. All data collection was collected by one of co-authors who did not involve in operations.

The data were divided into two groups according to their procedures. Student t-test was used to analyze the results and p-value less than 0.05 was considered statistically significant.

Results

The mean age of MIS group was 68.7 $\pm$ 9.8 years was significantly older than mean age of MIS group (63.9 $\pm$ 7.3 years). There were no statistically significant in BMI and sex distribution. However, almost all patients in MIS group using Posterior Cruciate Substitute prosthesis (Nexgen LPS, Zimmer: 20 knees, PFC sigma PS, DePuy, Johnson and Johnson: 1 knee and LCS Rotating Platform, DePuy, Johnson and Johnson: 3 knees) while most of the patients in CAS group using Posterior Cruciate Sacrifice prosthesis (LCS, DePuy, Johnson and Johnson: 34 knees, PFC sigma PS, DePuy, Johnson and Johnson: 12 knees). The details were shown in Table 1.

Clinical results

There are no significant differences in operative time, tourniquet time, total blood loss, pre-operative flexion and pain score in both groups. However, post-operative range of motion in MIS group was significantly better than CAS group at all time point as shown in Table 2.

There were no significant complications such as deep wound infection or fatal pulmonary emboli in both groups. There were no significant differences in minor complications. Culture-negative in persistent wound drainage less than 10 days was found 1 case in

Table 1. Demographic data

Variable	CAS-MIS group (mean ± SD)	MIS group (mean ± SD)
Number of patients	44	23
Sex		
Male	3	7
Female	41	16
Number of knee	46	24
Age average (yr)	63.9 ± 7.3	68.7 ± 9.8
Body mass index	25.8 ± 4.7	26.5 ± 6.8
Type of prosthesis		
NexGen-LPS (Zimmer)	0	20
PFC sigma posterior stabilized (DePuy, Johnson and Johnson)	12	1
LCS (DePuy, Johnson and Johnson)	34	3

Table 2. Clinical results

Variable	CAS group (mean ± SD)	MIS group (mean ± SD)	p-value
Operative time (min)	161.73 ± 25.08	160 ± 31	0.115
Tourniquet time (min)	101.42 ± 18.23	105.25 ± 24.15	0.404
Total blood loss (ml.)	637.6 ± 222.3	689.5 ± 288.2	0.429
VAS day1	5.55 ± 2.37	5.84 ± 2.8	0.698
VAS day 2	4.04 ± 1.88	4.61 ± 1.97	0.205
Pre-operative knee flexion (degree)	121.4 ± 15.65	112.42 ± 20.85	0.406
Flexion at 1 month (degree)	100.76 ± 13.28	108.67 ± 12.51	<0.05
Flexion at 3 month (degree)	102.26 ± 13.08	111.23 ± 11.34	<0.05
Flexion at 6 month (degree)	102.95 ± 12.59	111.85 ± 12.42	<0.05
Flexion at 12 month (degree)	103.81 ± 12.85	107.71 ± 8.05	<0.05
Pre-operative Knee score	29 ± 10.8	28.7 ± 13.6	0.942
Post operative Knee score at 1 year	85.7 ± 13.2	89 ± 9.77	0.369
Pre-operative Functional score	38.7 ± 27.1	34.9 ± 26.2	0.695
Post operative functional score at 1 year	71.5 ± 19.3	71.5 ± 20.3	0.779

MIS and 2 cases in CAS group. Minor leg swelling was found 2 cases in MIS group and 5 cases in CAS group. There were no pin-site related problems in CAS groups. Two patients in CAS group achieved less than 90 degrees flexion but accepted the results.

Radiographic Results

There was no significant difference in pre-operative limb alignment of both groups. The mean pre-operative alignment in CAS group was anatomical varus 3.19 ± 5.94 degree and in MIS group was anatomical varus 4.83 ± 7.89 degree However, there were significant different in postoperative radiograph comparison. Outliers were defined by more than 3 degree deviation of prosthesis alignment; therefore on femoral side we accepted 93-99 degree of coronal alignment while on tibial side we accepted 87-93 degree of coronal alignment.

The percentage of outliers of MIS group was significantly higher than CAS group. Outliers of CAS group at femur and tibia were 6.5% equally, while in MIS group were 16.6% and 25% respectively. The radiographic results were shown in Fig. 1 and 2.

Discussion

This study reported results of early experience in CAS MIS TKA and compared with results of MIS TKA in our institution. Demographic data were generally the same except the mean age of MIS group was 4.9 year more than the mean age of CAS group

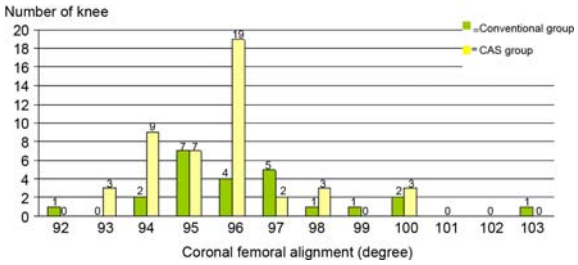

Fig. 1 Coronal femoral alignment (degree)

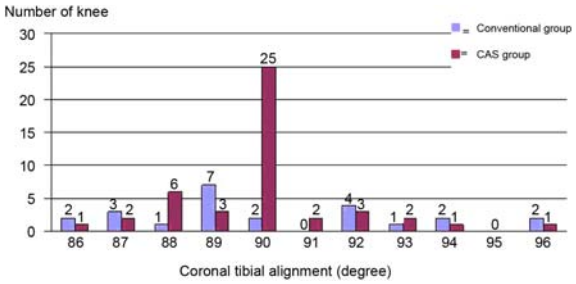

Fig. 2 Coronal tibial alignment (degree)

which might interfere with clinical results. And also variation of prosthesis in both groups of patients is significantly different. Clinical results were also generally the same in term of tourniquet time, operative time, blood loss and post-operative pain score evaluations. However, MIS group achieve statistically significant more post-operative ROM than CAS group.

The variation of prosthesis in both groups, which affected postoperative range of motion[12-14], was found in this study. Patients with posterior Cruciate substituting prosthesis especially hi-flexion design achieved more range of motion[15] when compare to LCS prosthesis so this may explain why MIS group has better ROM than CAS group at all time points. The complications found in this study were all minor complications such as prolong wound drainage or mild degree of leg swelling. There were no pin-site related problems in our study. We did not include length of stay (LOS) as a clinical parameter because there was variation in admission and discharge protocol of our institution. The significant different data in our study were percentage of outliers in coronal plane of both groups. CAS group has less outlier than MIS group on both femur and tibia. On femoral side, 6.5% of CAS group was considered outlier compared to 16.6% of MIS group. On tibial side, 6.5% of CAS group was considered outlier compare to 25% of MIS group as shown in Table 3.

Table 3. Percentages of patients with implants aligned outlier (more than ± 3 degrees)

	CAS-MIS group	MIS group
Coronal femoral component angle	6.5%	16.6%
Coronal tibial component angle	6.5%	25%

There was estimately 3-4 fold reduction of malalignment rate when we combine CAS with MIS. The percentage of tibial malalignment was higher than femoral malalignment was the same as reported earlier. Also the percentage of malalignment when using CAS in TKA was the same as other reports[8,16].

Mal-alignment was one of major risk factor of early loosening, increasing of polyethylene wear rate and instability[17-19]. Jeffery et al reported 24% loosening at 8 years follow-up in group of patient with mal-alignment more than 3 degrees compare to 3% in well-alignment group[20]. Therefore, reduction of percentage of outlier is mandatory for better long term outcome of TKA and CAS was proved to be a reliable tool even in MIS setting. The operative time was increased in the first 10-15 cases then it was gradually reduced which made equal average operative time in our report. The mean average tourniquet time in last 10 cases was less than 95 minutes. The authors did not randomized patients in this study. The different in average age may affect general clinical results and variation of prosthesis showed its affect on post-operative range of motion of patients. Further investigation with well-controlled randomized is needed to evaluate the results.

Conclusion

The early experience in CAS combining with MIS TKA achieved better control of coronal alignment while all other clinical results and complications were the same. However, the potential improvement of long-term outcome requires further investigation.

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เปรียบเทียบประสิทธิผลของการผ่าตัดเปลี่ยนข้อเข่าเทียม ด้วยวิธีเนื้อเยื่อบาดเจ็บน้อยที่ใช้ร่วมกับคอมพิวเตอร์ นำร่องกับวิธีเนื้อเยื่อบาดเจ็บน้อยที่ไม่ใช้คอมพิวเตอร์นำร่อง

พฤกษ์ ไชยกิจ, ณัฐพงศ์ หงษ์คู, สุรพจน์ เมฆนาวิน

วัตถุประสงค์: *การศึกษานี้เป็นการศึกษาเปรียบเทียบประสิทธิผลของการผ่าตัดเปลี่ยนข้อเข่าเทียมด้วยวิธีเนื้อเยื่อบาดเจ็บน้อย (MIS) ที่ใช้คอมพิวเตอร์นำร่อง (CAS) ในการผ่าตัดกับวิธีเนื้อเยื่อบาดเจ็บน้อยที่ไม่ใช้คอมพิวเตอร์นำร่อง*

วัสดุและวิธีการ: *เก็บข้อมูลย้อนหลังเพื่อเปรียบเทียบผลการผ่าตัดเปลี่ยนข้อเข่าเทียมแบบแผลเล็ก โดยใช้เครื่องคอมพิวเตอร์นำร่อง (CAS-MIS-TKA) กับ MIS-TKA ตั้งแต่เดือนกันยายน พ.ศ. 2550 ถึงเดือนกุมภาพันธ์ พ.ศ. 2551 มีผู้ป่วยในกลุ่ม CAS-MIS-TKA 46 เข่า 44 ซน และในกลุ่ม MIS-TKA 24 เข่า 23 ซน*

ผลการศึกษา: *พบว่าไม่มีความแตกต่างอย่างมีนัยสำคัญทางสถิติในเรื่องดัชนีมวลกาย การผิดรูปก่อนผ่าตัด ระยะเวลาการผ่าตัด คะแนนความปวด การสูญเสียเลือดรวม ส่วนเรื่องมุมการงอข้อเข่า พบว่า MIS-TKA ดีกว่า CAS-MIS-TKA อย่างมีนัยสำคัญทางสถิติ ไม่มีภาวะแทรกซ้อนในผู้ป่วยทั้ง 2 กลุ่ม อย่างไรก็ตามเปอร์เซ็นต์ Outlier ของ bone cut ในกลุ่ม CAS-MIS-TKA พบ 6.5% ทั้งทางกระดูกฟีเมอร์และกระดูกทิเบีย ในขณะที่กลุ่ม MIS-TKA พบถึง 16.6% ทางกระดูกฟีเมอร์และ 25% ทางกระดูกทิเบีย*

สรุป: *การใช้เครื่องคอมพิวเตอร์นำร่องควบคุมตำแหน่งการวางข้อเข่าเทียมได้ดี โดยมีระยะเวลาการผ่าตัด และภาวะแทรกซ้อนใกล้เคียงกัน มุมการงอของข้อเข่าที่แตกต่างกัน อาจจะเป็นได้จากชนิดของข้อเข่าเทียมในแต่ละกลุ่มที่ใช้คนละชนิดกัน*