

Computer-Assisted Total Knee Arthroplasty vs. Conventional Total Knee Arthroplasty: Post-Operative Ankle Radiographic Findings and Ankle Clinical Assessment

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Background: A number of previous studies have shown that conventional total knee arthroplasty (TKA) can affect talar tilt (TT) in the ankle of the operated leg. We aimed to prevent this problem by utilizing computer-assisted Total Knee Arthroplasty (CAS-TKA).

Objective: To compare pre- and post-operative talar tilt and ankle clinical assessment after computer-assisted total knee arthroplasty (CAS-TKA) and conventional total knee arthroplasty (TKA) in the 56 knees of 28 patients who underwent bilateral TKA.

Material and Method: We studied the 56 knees of 28 patients who underwent computer-assisted total knee arthroplasty (CAS-TKA) in one knee and conventional total knee arthroplasty (TKA) in the other. A combination of the Gap Balancing and Measured Resection techniques was used, and the operations were performed by a single surgeon. At follow-up 12 months post-operatively, we examined ankle radiographic findings for tibio-talar angle (TTA), tibial articular surface angle (TAS), and talar tilt (TT) which was taken as the difference between TAS and TTA. Ankle clinical assessment was performed using the foot functional index (FFI) in both groups pre- and post-operatively. The study also compared the results of computer-assisted total knee arthroplasty with those of conventional total knee arthroplasty pre- and post-operatively.

Results: We studied the 56 knees of 28 patients whose mean age was 67.79 years and who underwent bilateral total knee arthroplasty. Comparison of pre-operative and postoperative TT in the Conventional group showed a significant difference ($p = 0.016$), while there was no significant difference in the CAS group ($p = 0.657$). Ankle clinical assessment using foot functional index (FFI) revealed that there was no significant difference in the pre-operative FFI in the Conventional group = 1.85 (0.81, 6.88) and that of the CAS group = 1.91 (0.24, 66.5) ($p = 0.577$). The post-operative FFI in the Conventional group was 1.68 (0.24, 7.0) and in the CAS group it was 1.65 (0.24, 6.76), and these results were statistically significant ($p = 0.047$). In the Conventional group, the postoperative FFI was not significantly different from pre-operative FFI ($p = 0.269$), but in the CAS group there was a significant difference ($p = 0.047$).

Conclusion: This study showed that conventional total knee arthroplasty affected postoperative talar tilt while computer-assisted total knee arthroplasty had a lesser effect and did not significantly change the axis of rotation of the ankle joint. More research needs to be carried out on larger numbers of patients with longer follow-up periods.

Keyword: Total knee arthroplasty, Conventional TKA, Computer-assisted TKA, Talar tilt, Ankle score

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When osteoarthritis causes severe varus and valgus knee deformities, it is often also present in the ankle joint⁽¹⁾, and it is not rare to find those who have undergone total knee arthroplasty presenting with

ankle osteoarthritis. Many of them complain of pain in the ankle joint following total knee arthroplasty, and in some cases radiographs show progressive degenerative changes in the ankle.

Deformity of OA knee changes normal mechanical axis and may also change the axis of rotation of the ankle joint⁽²⁾. Recently, Jung Hee Lee et al found that after total knee arthroplasty, arthritis developed or progressed radiographically in many patients' ankles⁽³⁾.

As yet, there is no single recommended

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technique for minimizing postoperative ankle arthritis change in total knee arthroplasty (TKA). This study compared and evaluated computer-assisted total knee arthroplasty (CAS-TKA) and conventional total knee arthroplasty (TKA), and we anticipated that computer-assisted total knee arthroplasty might minimize the postoperative ankle effect both clinically and radiographically.

Material and Method

We retrospectively enrolled 28 patients who underwent traditional total knee arthroplasty on one knee and computer-assisted total knee arthroplasty on the other with a 6-month interval between operations. All patients attended for follow-up for at least 12 months between February 2010 and November 2012 in our institute. There were 26 females and 2 males, their mean age was 67.9, and all cases were 1° OA knee. We excluded post-traumatic knee or ankle joint, 2° OA (inflammatory, infection, congenital), and valgus knee. We performed pre-operative and postoperative scannograms in all cases for tibial articular surface angle (TAS), tibio-talar angle (TTA) and talar tilt (TT)⁽⁴⁾ (Fig. 1) after which we calculated Talar tilt (TT), for which the normal range is (-4,+4), as the difference between TAS and TTA for radiologic ankle assessment. We compared the results of total knee arthroplasty of the two groups pre- and post-operatively, and the pre- and postoperative results within each group.

We used the foot functional index (FFI)⁽⁵⁾ scores in clinical assessment pre- and post-operatively,



Fig. 1 Pre/post-operative Mechanical axis and Talar tilt angle.

and FFI was compared with talar tilt (TT) for radiologic assessment.

Surgical technique

Total knee arthroplasty was performed by a single surgeon with a combination of the gap balancing and measured resection techniques using both conventional total knee arthroplasty and computer-assisted total knee arthroplasty⁽⁴⁾. Tibial cut was performed first, after which the extension and flexion gaps were measured. The distal femoral cut thickness and angle were calculated, and after soft tissue balancing was carried out, femoral block cut was performed. Prosthesis implantation was the final step. Conventional total knee arthroplasty used NexGen LPS prosthesis, Zimmer, and computer-assisted total knee arthroplasty used Emotion knee prosthesis, Asculab, Orthopilot Navigation version 4.3.

Statistics

We used Descriptive Statistics. Mean, SD for radiographic pre-operations and post-operations. For foot functional index we used student t-test and Wilcoxon signed ranks test, and $p \leq 0.05$ was considered statistically significant.

Results

We enrolled 28 patients (56 total knee arthroplasties) of whom 26 were female and 2 were male and whose mean age was 67.9 year old (the youngest was 58, and the oldest was 82 years old). There were no significant differences in pre-operative TAS and TTA in the two groups (Table 1).

The mean pre-CAS-TKA talar tilt was 0.7°, while in the pre-conventional TKA it was 1.1°, but these differences were not statistically significant ($p = 0.45$) as shown in Table 2; however, pre-operative talar tilt (1.0°) and post-operative talar tilt (0.0°) in all cases were significantly different as shown in Table 3 ($p = 0.02$).

A comparison of pre-operative and post-operative talar tilt (TT) showed that in the CAS-TKA group, talar tilt was not significantly different; however, in the Conventional TKA group there was a significant difference ($p = 0.016$) as shown in Table 4.

A comparison of a foot functional index (FFI) for clinical foot and ankle assessment revealed that there was no significant difference between pre-operative foot functional index (FFI) in the two groups. However, postoperative pain, difficulty, and overall subscores were significantly different (p -value = 0.033, 0.039 and 0.047, respectively) while only scores for daily life

Table 1. Number, mean and quality of patient in this series (n = 56)

	Age	Pre-op_TAS	Pre-op_TTA	Pre-op_TAS	Pre-op_TTA
Mean \pm SD	67.96 \pm 6.79	91.29 \pm 3.63	90.38 \pm 3.99	91.04 \pm 4.45	90.79 \pm 4.39
Median	66.50	91.00	90.00	90.00	90.00
Minimum	58	84	80	84	84
Maximum	82	101	101	112	112

Tibial articular surface angle (TAS), Tibio talar angle (TTA)

Table 2. Mean radiographic measurement: CAS TKR vs. CONV TKR

	Computer-assisted surgery		Conventional method		<i>p</i> -value
	Mean	SD	Mean	SD	
Angle radiographs					
Pre_TAS	90.89	3.55	91.68	3.72	0.094
Pre_TTA	90.18	3.88	90.57	4.17	0.562
Post_TAS	90.71	3.68	91.36	5.15	0.369
Post_TTA	90.18	3.15	91.39	5.35	0.095
Pre-TT	0.71	2.19	1.11	3.15	0.450*
Median (min, max)	0.50 (-5, 8)		1.50 (-5, 8)		
Post-TT	0.54	1.93	-0.04	1.58	0.400*
Median (min, max)	1.00 (-3, 8)		0.00 (-5, 3)		

The *p*-value from pair t-test, * = *p*-value from Wilcoxon signed ranks test

TAS = Tibial articular surface angle; TTA = Tibio talar angle; Talar tilt (TT) = (TAS-TTA)

Table 3. Talar tilt pre vs. post-operation

	Pre-op	Post-op	<i>p</i> -value
TT angle			
Median (min, max)	1.00 (-5, 8)	0.00 (-5, 8)	0.026

Table 4. Talar tilt: pre-op vs. post-op in CAS TKR vs. CONV TKR

	Pre-op-TT	Post-op-TT	<i>p</i> -value
CAS TKR			
Median (min, max)	0.50 (-5, 8)	1.00 (-3, 8)	0.657
Mean \pm SD	0.71 \pm 2.19	0.54 \pm 1.93	
CONV TKR			
Median (min, max)	1.50 (-5, 8)	0.00 (-5, 3)	0.016
Mean \pm SD	1.11 \pm 3.16	-0.04 \pm 1.58	

activity limitation were not significantly different (see Table 5).

Clinical assessment of patients in the

Conventional TKA group, revealed no significant difference pre- and post-operatively, as shown in Table 6. In contrast, in the CAS-TKA group, pre- and postoperative clinical assessment revealed significant differences in difficulty, daily life activity limitation and overall scores (*p*-value = 0.046, 0.025 and 0.047, respectively), while the only scores that were not significantly different were those for pain (Table 7).

Discussion

Ankle osteoarthritis is mostly secondary osteoarthritis that develops as a sequel to fractures and few reports are found of primary osteoarthritis in the ankle. The factors that influence the onset and progression of osteoarthritis are not well understood, although it is known that lower extremity mal-alignment is related to joint problems^(2,7,9-12). We found that many patients complained of pain in the ankle after total knee arthroplasty, and we surmised that a change in the alignment of the lower extremity caused by a relatively large knee varus correction angle might be one of the reasons for the discomfort. Jung Hee Lee et al reported

Table 5. Foot functional index (FFI) CAS TKR vs. CONV TKR

Clinical assessment	Computer-assisted surgery			Conventional method			<i>p</i> -value
	Median	Min	Max	Median	Min	Max	
Pre-op							
Pain	1.10	0.20	6.00	1.10	0.00	6.40	0.533
Difficulty	1.94	0.22	6.78	1.89	0.22	6.89	0.269
Daily life activity limitation	2.67	0.00	8.33	2.83	0.00	9.33	0.604
Overall	1.91	0.24	6.65	1.85	0.18	6.88	0.577
Post-op							
Pain	0.80	0.20	4.80	0.80	0.20	5.00	0.033*
Difficulty	0.78	0.22	7.00	1.94	0.22	7.33	0.039*
Daily life activity limitation	2.00	0.00	9.33	2.17	0.00	9.33	0.320
Overall	1.65	0.24	6.76	1.68	0.24	7.00	0.047*

The *p*-value from Wilcoxon signed ranks test, * Significant at the 0.05 level

Table 6. Foot Functional Index (FFI): pre vs. post-CONV TKR

Clinical assessment	Conventional method						<i>p</i> -value
	Pre-op			Post-op			
	Median	Min	Max	Median	Min	Max	
Pain	1.10	0.00	6.40	0.80	0.20	5.00	1.000
Difficulty	1.89	0.22	6.89	1.94	0.22	7.33	0.314
Daily life activity limitation	2.83	0.00	9.33	2.17	0.00	9.33	0.075
Overall	1.85	0.18	6.88	1.68	0.24	7.00	0.208

The *p*-value from Wilcoxon signed ranks test

Table 7. Foot Functional Index (FFI): pre vs. post-CAS TKR

Clinical assessment	Computer-assisted surgery						<i>p</i> -value
	Pre-op			Post-op			
	Median	Min	Max	Median	Min	Max	
Pain	1.10	0.20	6.00	0.80	0.20	4.80	0.352
Life difficulty for living	1.94	0.22	6.78	1.78	0.22	7.00	0.046*
Daily life activity limitation	2.67	0.00	8.33	2.00	0.00	9.33	0.025*
Overall	1.91	0.24	6.65	1.65	0.24	6.76	0.047*

The *p*-value from Wilcoxon signed ranks test, * Significant at the 0.05 level

that 35.2% of patients had radiographic change in ankle joint after conventional total knee arthroplasty (TKA), and this may be an early sign of ankle osteoarthritic change⁽³⁾.

Takakura et al⁽⁶⁾ reported that varus deformity of the ankle was compensated by the valgus inclination of the subtalar joint, and osteoarthritis began to progress when the compensatory function was

inoperative. To date, however, the relationship between subtalar compensation and medial compartment osteoarthritis of the ankle has not yet been explored.

According to several cadaveric studies on degenerative changes of the lower extremity, about a third of patients who had osteoarthritis in the knee also had it in the ankle⁽¹³⁻¹⁵⁾. In particular, Tallroth et al⁽¹⁶⁾ analyzed pre- and postoperative radiographs and clearly observed ankle joint osteoarthritis before surgery in 30 out of 104 patients who underwent conventional total knee arthroplasty (TKA).

In our study, we aimed to minimize the alteration of mechanical axis after total knee arthroplasty by utilizing the computer-assisted technique, which we believed, could achieve superior alignment of components, resulting in more accuracy and closer-to-normal knee alignment; in turn, this might minimize the chance of future osteoarthritic change in the ankle.

We measured talar tilt for radiologic evaluation and foot functional index (FFI) for clinical assessment.

We found smaller alteration for talar tilt in the computer-assisted group, which we assume, is because this technique helps to minimize ankle problems and is less likely than conventional total knee arthroplasty to lead to ankle osteoarthritic change.

We also found that foot functional index (FFI) tended to be better in the computer-assisted TKA group than in the conventional TKA one. There were also greater post-operative clinical improvements in the computer-assisted group compared to their pre-operative assessment.

One limitation of this study is that we studied only 28 patients, which is a small number; furthermore, the follow-up period was only of 12 months' duration, and, therefore, our results may not be very reliable. Another limitation was a lack of equipment: when degenerative changes and angular deformities of the knee are severe, a varus deformity is usually three-dimensionally associated with a flexion contracture of the knee, so the varus angle measured on radiographs may not be a true varus angle^(7,8), and we did not have CT scan available to evaluate these deformities. With regard to ankle radiographic change, we did not have lateral plain film or CT scan to evaluate other dimensional deformities.

In conclusion, we studied 28 patients in 56 total knee arthroplasty operations, and our study showed that computer-assisted total knee arthroplasty was superior to conventional total knee arthroplasty in minimizing the chance of early postoperative ankle arthritis, but further research is required with larger

numbers of patients, longer follow-up and more accurate radiographic imaging applications.

What is already known on this topic ?

Some research told after convention TKA had the problem of ankle pain. The hypothesis of acute change of talar tilt angle after TKA.

What this study adds ?

The research shows results of CON TKA compared with CAS TKA in Mechanical alignment of knee in Bilateral TKA.

The research shows resulting effect of talar tilt angle post CAS TKA compared with CON TKA.

The research shows clinical results of Angle pain after pert-operation CON TKA vs. CAS TKA.

Potential conflicts of interest

None.

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การศึกษาการผ่าตัดเปลี่ยนข้อเข่าเทียมด้วยวิธีผ่าตัดโดยใช้คอมพิวเตอร์ช่วยผ่าตัดเทียบกับการผ่าตัดแบบปรกติ โดยศึกษามุมของข้อเท้าและการใช้งานข้อเท้าที่เปลี่ยนแปลงไปหลังการผ่าตัด

ธฤต ชมภูแสง, เมธี คงเผ่าพงษ์, ภัทร จุลศิริ, พรภวิษญ์ ศรีภิรมย์

ภูมิหลัง: พบการศึกษาหลังการผ่าตัด conventional TKA มีผลต่อมุมของข้อเท้าจากเอ็กซเรย์ การศึกษานี้จึงคิดว่าการผ่าตัดแบบ CAS TKA สามารถป้องกันได้

วัตถุประสงค์: การศึกษาแบบ retrospective เป็นการศึกษาหว่านการผ่าตัดเปลี่ยนข้อเข่าแบบ conventional TKA และ CAS TKA ในคนไข้คนเดียวกัน (28 คน 56 เข่า) โดยเปรียบเทียบเอ็กซเรย์และการทำงานของข้อเท้า ก่อนและหลังการผ่าตัดว่ามีเปลี่ยนแปลงอย่างไร

วัสดุและวิธีการ: ผู้ป่วย 28 คน 56 เข่า ผ่าตัด TKA ทั้งสองข้าง โดยข้างหนึ่งผ่าแบบ conventional อีกข้างผ่าแบบ CAS โดยแพทย์ท่านเดียวใช้วิธีทั้ง gap และ measurement ที่โรงพยาบาลราชวิถี, ติดตามระยะเวลา 12 เดือน วัดมุมจากเอ็กซเรย์ข้อเท้าก่อนและหลังการผ่าตัดใช้มุม TAT, TAS และ TT มีการวัดผลการใช้งานของข้อเท้าโดย foot functional index ข้อมูลที่มึนัยยะสำคัญทางสถิติใช้ $p < 0.05$

ผลการศึกษา: ผู้ป่วย 28 คน 56 เข่า ค่าเฉลี่ยอายุเท่ากับ 67.96 ปี ค่าเฉลี่ยมุมก่อนผ่าตัด TT (TT = TAS-TTA) ใน conventional = 1.5 (-5,8) ใน CAS = 0.5 (-5,8), p -value = 0.657 ค่าเฉลี่ยมุมหลังผ่าตัด-มุม TT ใน conventional = 0.0 (-5,3), ใน CAS = 1.0 (-3,8), p -value = 0.400 นำผลค่าเฉลี่ยทั้งสองกลุ่ม TT ก่อนและหลังผ่าตัดมาเทียบกัน p -value = 0.026, ผล TT ในกลุ่ม conventional ก่อนและหลังผ่าตัด p -value = 0.016 แต่ผล TT ในกลุ่ม CAS p -value = 0.657 จะเห็นว่ามุม TT มีการเปลี่ยนแปลงไปอย่างมีนัยสำคัญทางสถิติในกลุ่ม conventional แต่ไม่พบการเปลี่ยนแปลงที่มีนัยสำคัญในกลุ่ม CAS การทำงานของข้อเท้าประเมินโดย foot functional index (FFI) ก่อนผ่าตัดใน conventional = 1.85 (0.81,6.88), ใน CAS = 1.91 (0.24, 66.5) p -value = 0.577, หลังผ่าตัดใน conventional = 1.68 (0.24, 7.00), ใน CAS = 1.65 (0.24, 6.76) p -value = 0.047 จะเห็นว่ามีความแตกต่างในการใช้งานอย่างมีนัยสำคัญทางสถิติโดยกลุ่ม CAS มีแนวโน้มที่จะมีการใช้งานข้อเท้าดีกว่ากลุ่ม conventional สำหรับการเปรียบเทียบการใช้งานข้อเท้าก่อนและหลังการผ่าตัดในวิธีการผ่าตัดแบบเดียวกันพบว่ากลุ่ม conventional ไม่มีความแตกต่าง p -value = 0.208 แต่กลุ่ม CAS พบว่ามีความแตกต่างอย่างมีนัยสำคัญ p -value = 0.047, ซึ่งบ่งบอกว่าการผ่าตัดแบบ CAS TKA อาจทำให้ผู้ป่วยมีการใช้งานข้อเท้าดีกว่าเดิม

สรุป: จากการศึกษาพบว่า การผ่าตัด CAS TKA ไม่ทำให้เกิดการเปลี่ยนแปลงมุมของข้อเท้าและมีคะแนน foot functional index ดีขึ้นทำให้อาเจลดความเสี่ยงและการป้องกันการเสื่อมของข้อเท้าหลังการผ่าตัดเปลี่ยนข้อเข่าเทียมได้ในอนาคต แต่อย่างไรก็ตามเราคงต้องการจำนวนคนที่เข้าร่วมการศึกษานี้เพิ่มเติมและติดตามต่อเนื่องเป็นระยะเวลานานขึ้น เพื่อให้การศึกษามีความน่าเชื่อถือเพิ่มขึ้น
