Comparision Outcomes Between Conventional and Navigation Assisted Primary Total Knee Arthroplasty in Varus Knee Osteoarthritis

เปรียบเทียบผลการรักษาระหว่างการผ่าตัดเปลี่ยนข้อเข่าเทียม แบบมาตรฐานกับการใช้คอมพิวเตอร์ ช่วยผ่าตัดในผู้ป่วยข้อเข่าเสื่อม แบบโก่งงอเข้าด้านใน

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Abstract

Objective : The purpose was to compare clinical and radiological outcomes between conventional and navigation assisted primary total knee arthroplasty in the severity of varus osteoarthritis knee.

Methods : A retrospective study was done on 232 TKAs operated at the Hospital from January 2019–December 2021. TKAs have been divided into 150 knees with conventional TKA (CON-TKA) and 82 knees with navigation assisted TKA (NAV-TKA). CON-TKA were done by 5 surgeons. NAV-TKA were done by 2 surgeons. Patient information collected included age, gender, limb alignment, length of the follow-up period, operative time, blood loss, and Knee Society Scores.

Results : There was no statistically significant difference between the groups in mean age, follow-up period, BMI, and gender. NAV-TKA had increase in operative time and reducing blood loss more than CON-TKA with statistically significant difference (p-value < .01). There was no statistically significant difference in postoperative limb alignment, Knee Score and Functional Knee Score between two groups in mild (femorotibial angle [FTA] 176° ≤ FTA < 180°), severe (185°≤ FTA < 190°), profound (FTA ≥ 190°) varus OA knees. In the moderate (180° ≤ FTA < 185°) varus OA knee group, NAV-TKA tended to have postoperative varus angulation more than CON-TKA. But Knee Score and Functional Knee Score were not statistically different.

Conclusions : In the short term, there was no significant difference in clinical and radiological outcomes between CON-TKA and NAV-TKA in all severity of varus OA knees. Except in the moderate varus knee group, NAV-TKA had a tendency to more postoperative varus alignment than CON-TKA. The mean operative time in NAV-TKA was significantly longer than CON-TKA. The mean blood loss in CON-TKA was significantly more than NAV-TKA.

Keywords : conventional total knee arthroplasty, navigation assisted total knee arthroplasty, varus osteoarthritis knee

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บทคัดย่อ

วัตถุประสงค์: เพื่อเปรียบเทียบผลการรักษาทางคลินิกและเอกซเรย์ระหว่างการผ่าตัดเปลี่ยนข้อเข่าเทียมแบบมาตรฐานกับการใช้คอมพิวเตอร์ช่วยผ่าตัดในผู้ป่วยข้อเข่าเสื่อมแบบโก่งงอเข้าด้านใน

วิธีการศึกษา: ศึกษาย้อนหลังของผู้ป่วยข้อเข่าเสื่อมที่ได้รับการผ่าตัดเปลี่ยนข้อเข่าเทียมแบบปฐมภูมิในโรงพยาบาลนครปฐมตั้งแต่ มกราคม ค.ศ. 2019 ถึง ธันวาคม ค.ศ. 2021 จำนวน 232 เข่าแบ่งเป็นกลุ่มที่ผ่าเข่าแบบมาตรฐาน 150 เข่า และกลุ่มที่ใช้คอมพิวเตอร์ช่วยผ่าตัด 82 เข่า โดยมีศัลยแพทย์จำนวน 5 คนที่ผ่าเข่าแบบมาตรฐานและมี 2 คน ใน 5 คนนี้ที่ผ่าเข่าแบบใช้คอมพิวเตอร์ช่วยผ่าตัด ข้อมูลที่ใช้ศึกษา ได้แก่ เพศ อายุ ดัชนีมวลกาย ระยะเวลาติดตาม ตำแหน่งแกนขา ระยะเวลาผ่าตัด อัตราการเสียเลือดหลังผ่าตัด และคะแนนฟังก์ชั่นเข่าหลังผ่าตัด

ผลการศึกษา: จากการวิเคราะห์ทางสถิติพบว่า อายุ ระยะเวลาติดตาม ดัชนีมวลกาย และเพศ ของทั้ง 2 กลุ่มไม่มีความแตกต่างกัน ในกลุ่มที่ใช้คอมพิวเตอร์ช่วยผ่าตัดมีระยะเวลาการผ่าตัดที่มากกว่า แต่ก็มีอัตราการเสียเลือดน้อยกว่ากลุ่มที่ไม่ใช้คอมพิวเตอร์ช่วยผ่าตัด ในกลุ่มข้อเข่าเสื่อมที่โก่งงอเข้าด้านในแบบน้อย (176° ≤ มุมฟีเมอร์ทิเบีย < 180°) แบบรุนแรง (185° ≤ มุมฟีเมอร์ทิเบีย < 190°) และแบบชัดเจน (มุมฟีเมอร์ทิเบีย ≥ 190°) ผู้ป่วยทั้ง 2 กลุ่มไม่มีความแตกต่างกันอย่างมีนัยสำคัญในเรื่องของตำแหน่งแกนขาหลังผ่าตัดและคะแนนฟังก์ชั่นเข่าหลังผ่าตัด ผู้ป่วยเข่าเสื่อมที่โก่งงอแบบปานกลาง (180° ≤ มุมฟีเมอร์ทิเบีย < 185°) กลุ่มที่ใช้คอมพิวเตอร์ช่วยผ่าตัดมีแนวโน้มที่จะเกิดเข่าโก่งงอเข้าด้านในหลังผ่าตัดมากกว่ากลุ่มที่ไม่ใช้คอมพิวเตอร์ช่วยผ่าแต่เรื่องคะแนนฟังก์ชั่นเข่าหลังผ่าตัดไม่แตกต่างกันใน 2 กลุ่ม

สรุป: ระยะเวลาติดตามระยะสั้น (1 ปี) การใช้คอมพิวเตอร์ช่วยผ่าตัดในข้อเข่าเทียมให้ผลลัพธ์ทางคลินิกและเอกซเรย์ไม่แตกต่างกันกับการผ่าตัดแบบมาตรฐานในผู้ป่วยข้อเข่าเสื่อมแบบโก่งงอเข้าด้านใน ในระยะความรุนแรงต่างๆ ยกเว้นกลุ่มที่โก่งงอแบบปานกลางกลุ่มที่ใช้คอมพิวเตอร์ช่วยผ่ามีแนวโน้มที่จะเกิดการโก่งงอเข้าด้านในหลังผ่าตัดมากกว่ากลุ่มที่ผ่าตัดแบบมาตรฐาน กลุ่มที่ใช้คอมพิวเตอร์ช่วยผ่าตัดเปลี่ยนข้อเข่าเทียมจะใช้เวลาผ่าตัดมากกว่าแต่เสียเลือดน้อยกว่ากลุ่มการผ่าตัดแบบมาตรฐาน

คำสำคัญ: การผ่าตัดข้อเข่าเทียมแบบมาตรฐาน การผ่าตัดข้อเข่าเทียมแบบใช้คอมพิวเตอร์ช่วยผ่าตัด ข้อเข่าเสื่อมแบบโก่งงอเข้าใน

วารสารแพทย์เขต 4-5 2566 ; 42(2) : 225–235.

Introduction

Total knee arthroplasty (TKA) is the treatment of choice of most orthopedic surgeons for late stage osteoarthritis knees.

Limb and implant alignment along soft tissue balance plays a vital role in the outcomes after TKA. Computer navigation for TKA[1] (NAV-TKA) was first introduced in 1997 with the aim of implanting the prosthetic components with accuracy and precision. But NAV-TKA has significantly more expensive than conventional TKA (CON-TKA).

There were many studies for comparison of clinical and radiologic outcomes between CON-TKA and NAV-TKA in varus and valgus OA knees. Such as Burnette and Barrack[2] conducted a systematic literature review which there were few short and medium and no long-term studies demonstrating improved clinical outcomes using navigated TKA. Coronal plane alignment was improved with navigated TKA with fewer radiographic outliers. But this study was to compare outcomes in all severity of varus OA knees excluding valgus OA knees.

The anatomical axes of the femoral and tibial diaphysis from a lateral angle of 173°–175° (anatomic femorotibial angle: FTA)[3]. In genu varus, the FTA is greater than 173°–175°. The severity of varus knee[4] was classified by FTA[3] in the film both knees AP, standing view. Mild (176° ≤ FTA < 180°), moderate (180° ≤ FTA < 185°), severe (185° ≤ FTA < 190°), and profound (FTA > 190°) were defined.

Objective

This study aimed to compare clinical and radiological outcomes between CON-TKA and NAV-TKA in all severity of varus OA knees. We hypothesized that NAV- TKA would improve clinical and radiologic outcomes compared to CON-TKA in all severity of varus OA knees.

Method

The records of 346 primary TKA operations for late stage varus osteoarthritis knees during the period January 2019 through December 2021 were reviewed. Of those, 114 knees were excluded due to incomplete data, valgus OA knees, and revision surgery; 232 primary varus OA knees were included in the study. All TKAs had been performed by 5 surgeons using a cemented prosthesis (posterior stabilized, PFC-sigma, Johnson & Johnson USA). The TKAs were divided into two groups: CON-TKA and NAV-TKA. CON-TKA were done by 5 surgeons. NAV-TKA were done by 2 surgeons. Patients were depended on voluntary to choose CON-TKA or NAV-TKA.

Ethics approval was obtained from the Institutional Review Board Hospital Ethic Committee (NPH - REC No. 045/2022).

Surgical techniques

All operated cases used tourniquet. Midline incision, the medial parapatellar approach was done. Osteophyte, ACL, PCL, and meniscus were removed. We started with the femoral cut.

In NAV-TKA group, Brainlab Medical Instruments Knee 3.0 and Brainlab Medical Software Knee 3.0 were used. Extra-articular pins at femur and tibia were needed. NAV-TKA setting was done. The distal femoral cut was set perpendicular to the mechanical axis (MA), the tibia cut was set at 8 mm at unworn side, the posterior slope was set at 3 degrees. If the aiming target angle could not be achieved, recut was done. The implant was selected. Soft tissue balance was done. Joint stability was checked by using the joint stability graph.

In CON-TKA group, a similar surgical step was performed. Postoperative management protocol used tranexamic acid at 24 hours postoperative time. The radivac drain was removed at 48 hours postoperative time. Rehabilitation was done on postoperative Day 1.

Navigating leg alignment and a patient report are shown in Figure 1.

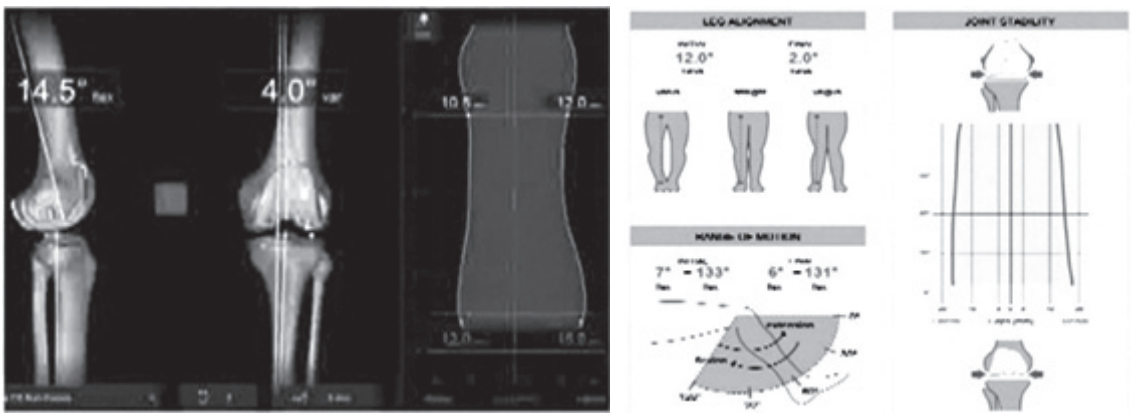


Fig 1 (a) Navigating leg alignment. **(b)** Patient report

Measurement data

Demographic data including age, sex, body mass index (BMI), follow-up period, clinical, and a radiographic information (limb alignment) were obtained from hospital records. The standard follow-up schedule was every 6 months to 1 year. Preoperative and postoperative clinical data were expressed in the form of Knee score and Function score using the Knee Society Scoring system.[5] Scores were collected preoperatively and at the latest follow-up. Drainage blood loss and operating times were collected from the operative notes and chart records. Femorotibial angle was measured by two surgeons, using an X-ray of both knees standing view in computer.

Evaluation of FTA in short film X-ray in Figure 2

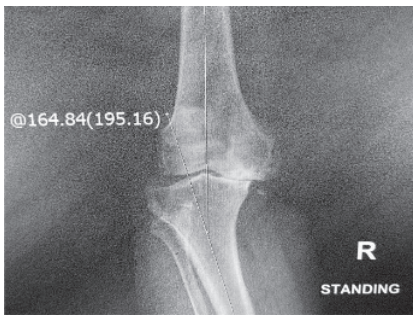
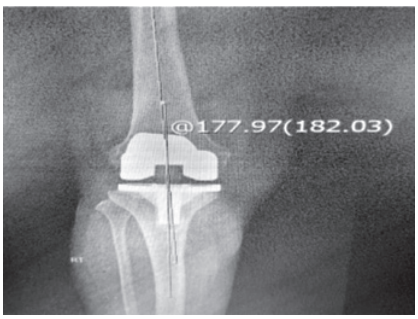


Fig 2 (a) Preoperative FTA



(b) Postoperative FTA

Statistical methods

The sample size was determined using the G*Power program (version 3.1). In the calculation, the power of test was 0.8, the statistical significance level (α) was 0.05, effect size was 0.4 and sample size allocation ratio for both groups was 2:1 (CON-TKA : NAV-TKA)

All data were presented as frequencies and percentages, means, and standard deviations as appropriate. Chi-square was used to test relationships between categorical variables and to examine proportional differences. The two-sample t test and Mann-Whitney test (when the data sets were not normally distributed) were used to determine mean differences between groups. All statistical analyses were conducted using SPSS software for windows version 23.0 (SPSS, Inc., Chicago, IL). A p-value of less than .05 was considered statistically significant.

Result

There were 150 knees in the CON-TKA group and 82 knees in the NAV-TKA group. TKA patient demographic data is shown in Table 1. There were no statistically significant differences in age, gender, BMI, and follow-up period between the two groups in all severity of varus knees. The average age of the patients was 66 years, BMI was 26.40 kg/m^2, follow-up was 12 months, and 72% of the patients were female.

The mean operative time, NAV-TKA was 97 minutes, longer than CON-TKA (89 minutes) and statistically significant (p-value < .01). The mean blood loss, CON-TKA was 689 cc, more than NAV-TKA (363 cc) and statistically significant (p-value < .01). This result is shown in Table 2.

Table 1 Demographics of TKAs.

	NAV-TKA (n = 82)	CON-TKA (n = 150)	p-value	Overall (n = 232)
Age, mean ± SD	66.39 ± 5.83	66.61 ± 6.54	.797	66.53 ± 6.29
[Range]	[55–80]	[51–83]		[51–83]
BMI, mean ± SD	26.34 ± 4.11	26.43 ± 5.13	.894	26.40 ± 4.78
[Range]	[21.07–39.21]	[16.30–59.58]		[16.30–59.58]
Gender F, n (%)	61 (74.4%)	106 (70.7%)	.647	167 (72.0%)
M, n (%)	21 (25.6%)	44 (29.3%)		65 (28.0%)
Side Right, n (%)	39 (47.6%)	80 (53.3%)	.400	119 (51.3%)
Left, n (%)	43 (52.4%)	70 (46.7%)		113 (48.7%)

SD; standard deviation, BMI; body mass index, F; female, M; male
CON-TKA; conventional TKA, NAV-TKA; navigation TKA

Table 2 Comparison mean operative time, blood loss between NAV-TKA and CON-TKA

	NAV-TKA (n = 82)		CON-TKA (n = 150)		t	p-value
	Mean	SD	Mean	SD		
Operative time (mins)	97.18	19.07	89.66	18.18	2.96	.003
Blood loss (cc)	363.05	150.30	689.33	318.54	-10.58	< .01

SD; standard deviation, CON-TKA; conventional TKA, NAV-TKA; navigation TKA

In mild varus OA knees (176° ≤ FTA < 180°), There were no statistically significant differences in mean postoperative FTA, Knee Score or Functional Knee Score between CON-TKA and NAV-TKA (p-value > .05).The detail of the result is in Table 3.

Table3 Comparison mean postoperative FTA, Knee Score and Function Knee Score between NAV-TKA and CON-TKA in mild varus knee group (176° ≤ FTA < 180°)

	NAV-TKA (n = 7)		CON-TKA (n = 12)		U	p-value
	Mean	SD	Mean	SD		
FTA (degrees)	176.14	0.69	175.25	1.36	25.5	.167
Knee score	87.86	7.78	88.50	2.61	34.0	.536
Function score	95.71	5.35	94.58	4.50	36.5	.650

SD; standard deviation, CON-TKA; conventional TKA, NAV-TKA; navigation TKA,
FTA; femur tibia angle

In moderate OA knees (180° ≤ FTA < 185°). There were no statistically significant differences in knee score, functional knee score between the two groups (p-value < .05). But the mean post-operative FTA in NAV-TKA was varus angulation more than CON-TKA statistically significant (p-value < .05). The result is shown in Table 4.

Table 4 Comparison mean postoperative FTA, Knee Score and Function Knee Score between NAV-TKA and CON-TKA in moderate varus knee group (180° ≤ FTA < 185°)

	NAV-TKA (n = 31)		CON-TKA (n = 47)		t	p-value
	Mean	SD	Mean	SD		
FTA (degrees)	177.16	1.32	176.38	1.65	2.20	.031
Knee Score	89.65	7.96	88.91	3.94	0.47	.638
Function score	94.35	9.81	96.70	4.58	-1.43	.158

SD; standard deviation, CON-TKA; conventional TKA, NAV-TKA; navigation TKA,
FTA; femur tibia angle

In severe OA knees (185° ≤ FTA < 190°). There were no statistically significant differences in mean postoperative FTA, Knee Score or Functional Knee Score between the two groups (p-value < .05). The detail of the result is in Table 5.

Table 5 Comparison mean postoperative FTA, Knee Score and Function Knee Score between NAV- TKA and CON-TKA in severe varus knee group (185° ≤ FTA < 190°)

	NAV-TKA (n = 36)		CON-TKA (n = 71)		t	p-value
	Mean	SD	Mean	SD		
FTA (degrees)	176.78	2.00	176.01	2.39	1.64	.103
Knee Score	89.19	4.86	89.90	3.77	-0.83	.408
Function score	95.00	5.21	96.76	4.23	-1.76	.084

SD; standard deviation, CON-TKA; conventional TKA, NAV-TKA; navigation TKA,
FTA; femur tibia angle

In profound OA knees (FTA > 190°). There were no statistically significant differences in mean postoperative FTA, Knee Score or Functional Knee Score between the two groups (p-value < .05). The result is shown in Table 6.

Table 6 Comparison mean postoperative FTA, Knee Score and Function Knee Score between NAV-TKA and CON-TKA in profound varus knee group (FTA > 190°)

	NAV-TKA (n = 8)		CON-TKA (n = 20)		U	p-value
	Mean	SD	Mean	SD		
FTA (degrees)	178.88	1.36	176.85	4.17	42.5	.055
Knee Score	90.13	5.96	91.45	5.32	79.5	.980
Function score	96.88	5.94	94.00	5.28	54.5	.199

SD; standard deviation, CON-TKA; conventional TKA, NAV-TKA; navigation TKA,
FTA; femur tibia angle

Discussion

In this study, the mean operative time in NAV-TKA was significantly longer than CON-TKA. The mean blood loss in CON-TKA was significantly more than NAV-TKA. There was no significant difference in Knee Score and Functional Knee Score between CON-TKA and NAV-TKA in all severity of varus OA knees. Regarding postoperative alignment, all severity of varus OA knees were not significantly different except in moderate varus OA knees. In moderate varus OA knee, NAV-TKA had a tendency to more postoperative varus alignment than CON-TKA.

About the postoperative blood loss in this study had the same result as Han et al[6] reported computer navigation was effective in reducing blood loss but has no effect on transfusion requirement following primary TKA. In the NAV-TKA techniques, femoral canal was not drilled so blood loss was less than CON-TKA. NAV-TKA techniques need extra-articular pins at femur and tibia for register and setting. Then mean operative time in NAV-TKA was significantly longer than CON-TKA.

There were many studies for comparison clinical and radiologic outcomes between CON-TKA and NAV-TKA in varus and valgus OA knees. Lee et al[7] reported there were no significant differences in clinical or radiological outcomes between NAV-TKA and CON-TKA in the medium-term and long term. Yogeesh et al[8] reported there was no significant difference between the average Oxford Knee Score (OKS) of the NAV-TKA group and the CON-TKA group at any time from one to five years. But this study was to compare outcomes in all severity of varus OA knees, excluding valgus OA knees.

Regarding postoperative alignment in varus OA knees, there were many studies comparison radiological outcomes between CON-TKA and NAV-TKA. This study had the same radiological outcomes as published studies, such as Cho et al[9] reported there was no significant difference in postoperative alignment between CON-TKA and NAV-TKA in

extra articular tibia vara even for cases with metaphyseal diaphyseal angle (MDA > 4°). Maniwa et al[10] reported in case severe varus knee (> 20°) deformity did not affect the accuracy of image-free computer NAV-TKA. Takasaki et al[11] reported in varus deformed knee, image-free navigation had a tendency to cut the tibia in varus. But this study had a different outcome in the moderate varus OA knee group. NAV-TKA has tendency to varus postoperative alignment than CON-TKA. Balancing ligament and measurement FTA in short film standing view may be influenced to interpret of postoperative alignment. The most important of post TKA alignment is mechanical axis (MA) or hip-knee-ankle (HKA) angle. But the study was retrospective. In the period of study, my hospital didn't have the long standing radiography of the lower extremities or CT scanogram for measurement MA or HKA. Kraus et al[12] reported a significant correlation was found between the mechanical-axis angle and anatomic axis angle by an anteroposterior (AP) full-limb radiograph (anatomic AP).FTA is 4°–6° valgus compared to the HKA angle[(3)]. Leonado et al[13] reported there was a significant difference in accuracy for measurement of the mechanical axis of the lower limbs, comparing long and short radiographs of the lower limbs, thus the proper measurement of the mechanical axis of the lower limbs. We suggest the performance of long radiography in the postoperative period of TKA.

Regarding clinical outcomes, the study had the same result as Lee et al[14] reported NAV-TKA showed fewer outliers in the hip-knee-ankle (HKA) angle for severe preoperative varus deformity compared with CON-TKA. The long-term clinical outcomes and survival rates were similar between both techniques. In this study, high experienced surgeons with good postoperative programs and rehabilitation may be improved Knee Scores in CON-TKA. Then Knee Scores and Functional Knee Scores were not statistically different in both groups.

This study had some limitation: the study covered a short follow-up period (1 year), a retrospective study design, not directly measured for MA or assessed for a percentage of outlier patients because of not having the long standing weight bearing film.

Conclusion

In short term study, there was no significant difference in clinical outcomes between CON-TKA and NAV-TKA in varus OA knees. Moderate varus OA knees have a tendency to more postoperative varus alignment than CON-TKA. The mean operative time was significantly longer in NAV-TKA than CON-TKA. The mean blood loss in CON-TKA was significantly much more than NAV-TKA.

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