

# Results of Computer Assisted Mini-Incision Subvastus Approach for Total Knee Arthroplasty

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**Background:** Mini-incision subvastus approach is soft tissue preservation of the knee. Advantages of the mini-incision subvastus approach included reduced blood loss, reduced pain, self rehabilitation and faster recovery. However, the improved visualization, component alignment, and more blood preservation have been debatable to achieve the better outcome and preventing early failure of the Total Knee Arthroplasty (TKA). The computer navigation has been introduced to improve alignment and blood loss. The purpose of this study was to evaluate the short term outcomes of the combination of computer assisted mini-incision subvastus approach for Total Knee Arthroplasty (CMS-TKA)

**Material and Method:** A prospective case series of the initial 80 patients who underwent computer assisted mini-incision subvastus approach for CMS-TKA from January 2007 to October 2008 was carried out. The patients' conditions were classified into 2 groups, the simple OA knee (varus deformity was less than 15 degree, BMI was less than 20%, no associated deformities) and the complex deformity (varus deformity was more than 15 degrees, BMI more than 20%, associated with flexion contractor). There were 59 patients in group 1 and 21 patients in group 2. Of the 80 knees, 38 were on the left and 42 on the right.

**Results:** The results of CMS-TKA [the mean (range)] in group 1: group 2 were respectively shown as the incision length [10.88 (8-13): 11.92 (10-14)], the operation time [118 (111.88-125.12): 131 (119.29-143.71) minutes, lateral releases (0 in both groups), postoperative range of motion in flexion [94.5 (90-100): 95.25 (90-105) degree] and extension [1.75 (0-5): 1.5 (0-5) degree] Blood loss in 24 hours [489.09 (414.7-563.48): 520 (503.46-636.54) ml] and blood transfusion [1 (0-1) unit? in both groups], Tibiofemoral angle preoperative [Varus = 4 (varus 0-10): Varus = 17.14 (varus 15.7-18.5) degree, Tibiofemoral angle postoperative [Valgus = 1.38 (Valgus 0-4): Valgus = 2.85 (valgus 2.1-3.5) degree], Tibiofemoral angle outlier (85% both groups), and Knee society score preoperative and postoperative [64.6 (59.8-69.4) and 93.7 (90.8-96.65)]: 69 (63.6-74.39) 92.36 (88.22-96.5)]. The complications found in both groups were similar. No deep vein thrombosis, no fracture at both femur and tibia, no vascular injury, and no pin tract pain or infection was found in both groups.

**Conclusion:** The computer assisted CMS-TKA is one of the appropriate procedures for all varus deformity, no limitation with the associated bone loss, flexion contractor, BMI, except the fixed valgus deformity. To ensure the clinical outcomes, multiple key steps were considered as the appropriate techniques for this approach which included the accurate registration, precision bone cut and ligament balances, and the good cement techniques.

**Keywords:** Total knee arthroplasty (TKA), Navigator, Subvastus approach

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Several minimal invasive approaches have been evolved from the standard medial parapatella approach to mini-incision medial parapatella arthrotomy, midvastus, subvastus and quadriceps-sparing approach,

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depending upon the surgeon preference. In police General Hospital, the mini-incision subvastus approach has been performed since 2005. Mini-incision subvastus approach was rendered to soft tissue preservation of the musculotenuous structures around the knee without compromising the visualization of standard

procedure. Advantages of mini-incision subvastus approach included reducing blood loss, postoperative morbidity and pain; and self rehabilitation as well as faster recovery. Some concerned about the limited visualization and component malalignment as well as more blood preservation, which have been debatable to achieve the better outcomes and preventing early failure of the TKA. The computer navigation had been introduced to improve the short term and possible long term outcomes. The combinations of computer assisted mini-incision subvastus approach Total Knee Arthroplasty (CMS-TKA) have been developed to achieve the most benefits. The purpose of this study was to evaluate the short term outcomes of the combination of computer assisted mini-incision subvastus approach Total Knee Arthroplasty (CMS-TKA).

### **Material and Method**

A prospective case series of the initial 80 patients who underwent computer assisted mini-incision subvastus approach Total Knee Arthroplasty (CMS-TKA) with posterior stabilizer for osteoarthritis of the knee from January 2007 to October 2008 with minimum 6.8 months follow-up (range between 6-12 months). The patients were classified in 2 group: the first group was defined as the patients with simple OA knee (varus deformity less than 15 degree, BMI less than 20%, no associated deformities) and the second group was defined as the patients with complex deformity (varus deformity more than 15 degrees, BMI more than 20%, associated with flexion contracture). All operations were performed by the senior author. There were 59 patients in the first group (group 1) and 21 patients in the second group (group 2). They were 18 males and 62 females, with the average age of 66 years (64-70 years). Of 80 knees, 38 were operated on the left knees and 42 on the right knees. All steps were as the follows: mini-incision subvastus approach and initial release, registration, bone cut and alignment check, ligament balancing and final releases, trial reduction, patelloplasty, and cementation component.

### **Surgical technique**

#### ***Patient setup***

The patient was placed supine on a standard operating table. A tourniquet was applied, and the standard skin preparation and draping were undertaken.

#### ***Mini-incision subvastus approach***

Oblique skin incision was performed about 6-8 inches depend upon the size of the knee. Vastus

medialis was identified including the Atraumatic dissection of vastus plane on medial gutter by finger dissection. Standard medial arthrotomy was performed with preservation of integrity of vastus muscle. The medial meniscus was removed and medial soft tissue was released and osteophyte was removed. The soft tissue was released till medial border of patella is the same level lateral border of lateral femoral condyle. All soft tissue was handling with widening atraumatic technique. The knee was flexed. ACL, PCL, medial and lateral meniscus was resected. All of the steps were preparation for registration of computer.

#### ***Registration***

Two transfixing pins were respectively introduced into each of tibia and femur. The landmarks were four-finger breath from the tibia tubercle and the superior pole of patella. For the tibial pin, a percutaneous stab wound was made. A drill guide was placed into the incision and a 3.2 drill was used to make a bicortical hole in the middle of tibia. Care must be taken during drilling through the posterior cortex of the tibia. The depth was then measured and an appropriate sized insertion pin was used to gain the bicortical fixation. For the femoral pin, a percutaneous stab wound was made, a drill guide was placed into the incision and a 3.2 drill was used to make a bicortical hole; in a mid-femur. The depth was then measured and an appropriate sized tracker pin was used to gain the bicortical fixation.

#### ***Navigation software setup***

The version 2.0 software was setup as a standard procedure. To perform such setup, go to the options menu on the screen and click as recommended in the instruction for use. The following steps must be performed; Hip flexion, centre of Femoral Head with on screen instructions guides the surgeon.

#### ***Distal femoral surface mapping***

The medial and lateral epicondyle were identified and palpated at the sulcus level through the medial incision and could be directly digitized. The following registration were mapping in the following steps: the AP axis distal femoral condyle, medial and lateral condyle, both anteriorly and posteriorly.

#### ***Tibial surface mapping***

All tibial plateau were identified with the knee in flexion and the following steps were included in mapping the center of the knee (the centre of the

ACL footprint was used as a landmark), the AP axis, a point on the medial third of the tibial tubercle was used and digitized), medial and lateral tibial plateau.

#### ***Ankle mapping***

At ankle medial malleolus, lateral malleolus. Initial Kinematics had been assessed for pre-operative deformity, and range of motion.

#### ***Bone cut and alignment check***

Distal femoral bone cut, block was placed in full extension knee and three pins were fixed. The first pin controlled the thickness of the cut; the second pin controlled the varus or the valgus, and the flexion or extension of the cut; and the last pin tight fixed the cutting block after the femoral slope was confirmed (the fourth pin for osteoporosis if necessary) then the distal femoral cut was done. Tibia bone cut, Tibia cutting block was placed and fixed by three pins (maybe 4 pins in osteoporosis) and then the cut was done, according to the preregistration plan. The equal extension gap was checked by block spacer, and the additional release was done if necessary. The proper rotation and the level of final femoral cut with correct position were determined by the navigation (without anterior notching). Next, the pin was in placed chamfer and the notch cut was performed by 4 in 1 with anterior references, then the femoral cut was placed and pin fixation (controlled rotation external rotate 3 degrees).

#### ***Trial reduction and ligament balancing***

Femoral and Tibial trial was performed to check the balanced alignment. A trial poly insert was then introduced with the knee in extension. Assessment of the correction of deformity and record stability as well as the range of motion self-alignment of tibial was determined. Trial placement femoral and tibial component was placed and self align of tibial rotation was marked (normally center of tibial tray point to 1/3 medial to tibial tubercle). Then the finished tibial was done by drilling and finning. All components were in place for digital checking alignment and range of motion

#### ***Patelloplasty***

Patellar osteophyte was removed by cauterization of circumferential patella. No patella resurfacing was found in all cases except in the inflammatory joint patients. Patella tracking is checked with the implant trials in place through the range of

motion. Trial component was check and record for proper position by navigation with satisfaction of alignment and balance.

#### ***Cementation***

The component was removed. The bone was clean and dry. Cementation of tibia femur and polyethylene with valgus pressurization were done.

#### ***Final assessment of CMS-TKA***

Once the components had been inserted and the cement was fully polymerized, the Navigation system was forwarded to the final outcome screen. As in the initial analysis, the kinematics of the knee could be assessed in a dynamic way from the extension to deep flexion. The range of motion and alignment of the limb could be recorded and compared to the initial kinematics' data to assess the success of any correction performed. This data could then be printed out and kept in the patient file as an augment to the OR record or kept electronically.

#### ***Statistical analyses***

For the tests of differences between quantitative data, the two-sided t-tests were used. Differences between the proportions and qualitative data were tested by the chi-squared test and the Mann-Whitney U test. Analyses were done by using Excel workbook. In the text, the data were presented as the mean  $\pm$  standard deviation (SD) and the p-values of  $< 0.05$  were considered as significant difference.

#### **Results**

Baseline patient characteristics are summarized in Table 1. The outcomes of study were composed of the incision length, operative time, lateral releases, and blood loss in 24 hours, ROM of patient, knee score, and the complication tibiofemoral angle outlier; which were respectively illustrated in Table 2, 3 and 4.

- the clinical outcomes of CMS-TKA were as following:

- incision length in group 1: group2 was 10.88 (8-13): 11.92 (10-14)

Operation time in group 1: group 2 was 118 (111.88-125.12) and 131 (119.29-143.71)

- lateral releases in group 1: group 2 was 0 both groups

- postoperative range of motion in flexion and extension in group 1 and group 2 was 94.5 (90-100) and 95.25 (90-105) degree of flexion and 1.75 (0-5) and 1.5 (0-5) of extension

**Table 1.** Baseline characteristics of patients

Patients characteristics	Group 1	Group 2	p-value (t-test)	Total
Number (patients)	59	21	-	80
Male	14	4	-	18
Female	45	17	-	62
Age: mean (range) (yr)	65.7 (60.1-71.3)	68 (63.34-73.66)	0.88	66 (64-70)
Number (knees)	59	15	-	80
Left knee	23	21	-	38
Right knee	36	6	-	42
BMI mean (range)	25.1 (24.2-26)	25.81 (23.9-27.03)	0.31	25.53 (24.74-32.2)

**Table 2.** Surgical outcomes

Surgical outcomes	Group 1	Group 2	p-value (t-test)	Total
Hct pre-operative	34.85 (32.81-36.87)	37.06 (34.83-39.29)	0.21	35.81 (37.08-33.54)
Hct post-operative	30.12 (29.89-31.28)	29.77 (28.53-30.01)	0.92	27.65 (26.38-28.92)
Blood loss (ml)	489.09 (414.7-563.48)	520 (503.46-636.54)	0.71	504 (436.37-572.73)
Blood transfusion	1 unit (0-1)	1 unit (0-1)	-	1 unit (0-1)
Operative time (min)	118 (111.88-125.12)	131 (119.29-143.71)	0.076	124.15 (120.12-131.18)
Incision length mean, SD, range	10.88, 1.3, (8-13)	11.92, 1.2, (10-14)	0.13	11.14, 1.37, (8-14)
Lateral releases	0	0	0	0
ROM (flexion)	94.5 (90-100)	95.25 (90-105)	0.59	95 (88.8-91.2)
ROM (extension)	1.75 (0-5)	1.5 (0-5)	0.79	1.53 (0.81-2.25)
Knee score pre-operative	64.6 (59.8-69.4)	69 (63.6-74.39)	0.28	66.3 (62.8-69.8)
Knee score post-operative	93.7 (90.8-96.65)	92.36 (88.22-96.5)	0.7	93.15 (90.59-95.71)
Hospitalization (days)	7 (4-9)	7 (5-9)	-	7 (5-9)
Complication (event)	1	1	-	2 (Superficial wound infection)

**Table 3.** Radiographic outcomes

Radiographic outcomes	Group 1		Group 2		Total		Outlier
	Pre-operative	Post-operative	Pre-operative	Post-operative	Pre-operative	Post-operative	
TF angle mean, SD, range	Varus = 4 2.71 (Varus 0-10)	Varus = 17.14 1.77 (Varus 15.7-18.5)	Valgus = 1.38 1.24 (Varus 0-4)	Valgus = 2.85 0.9 (Varus 2.1-3.5)	Varus = 7.11 6.17 (Varus 4.78-9.44)	Valgus = 2.55 0.97 (Varus 2.19-2.91)	85%

**Table 4.** Complication tibiofemoral angle outlier

Angle	Pre-operative	Post-operative	Outlier
Sagittal femoral angle (Flexion)	2.9 1.14 (2-6)	2.38 1.12 (1-6)	75%
Sagittal tibia angle (posterior slope)	5.05 0.92 (4-7)	4.81 1.5 (2-8)	80%
Coronal femoral angle (valgus)	6.06 1.78 (3-8)	1.95 1.24 (0-5)	85%

- blood loss in 24 hours in group 1: group 2 was 489.09 (414.7-563.48) and 520 (503.46-636.54) and blood transfusion in group 1: group 2 was 1 (0-1) unit both groups

- Tibiofemoral angle preoperative in group 1: group 2 Varus = 4 (varus 0-10): Varus = 17.14 (varus 15.7-18.5) degree

- Tibiofemoral angle postoperative in group 1: group 2 Valgus = 1.38 (Valgus 0-4): Valgus = 2.85 (valgus 2.1-3.5) degree

- Tibiofemoral angle outlier in group 1: group 2 was 85% both groups

- knee society score pre-postoperative in group 1: group 2 was 64.6 (59.8-69.4)-93.7 (90.8-96.65) and 69 (63.6-74.39)-92.36 (88.22-96.5)

- complications which were wound drainage 2 cases; there is no deep vein thrombosis, no fracture at both femur and tibia, no vascular injury, no pin tract pain or infection, however we found the superficial wound infection in 2 cases

## Discussion

Standard Total Knee Arthroplasty (TKA) has been developing since the introduction of the first total knee replacement in 1974. The techniques of balancing the ligaments, equalizing the flexion-extension gaps, and adjusting the overall alignment will improve the long-term results. Minimally invasive surgery for the knee arthroplasty began in the late 1990s. Several minimally invasive approaches have been evolved from the traditional extensile medial parapatella, limited medial parapatella, midvastus, subvastus and quadriceps sparing approach. The advantages of less invasive surgery included reducing the post-operative morbidity, pain, and blood lost but the faster recovery.

Not only the surgical technique but also the patients' selection was one of the key factors<sup>(1)</sup>. Although the subvastus approach was as early as in 1929, the limitation of exposure and superficial hematoma were concerned<sup>(2)</sup>. The conventional subvastus approach performed in the selected group of patients indicated the deformity with less than 15 degrees of varus, fixed valgus deformity, a flexion contracture, BMI < 20%. Several advantages of subvastus approach had been considered for preserving the blood supply to patella, the extensor mechanism, the good evaluation for the patella tracking, improving the post-operative knee range of motion, rehabilitation, decreasing blood loss and no complication increased after the Total Knee Arthroplasty<sup>(3)</sup> (TKA). With the modification of the mini-incision subvastus approach,

this technique has been performed in Police General Hospital since 2000. The development of the key steps to decrease the skin incision length, the flexion and extension of the lower limb for exposure, the windowing technique, the symbiotic use of retractors, the preserved quadriceps, the downsized instrumentation, the use of cut bone surfaces as guides allowed the possibility to perform the mini-incision subvastus approach. However, the limb alignment has been still questionable about the accuracy of the appropriate prosthesis position<sup>(4,5)</sup>.

Currently, the TKA- navigation is probably known in wide group the orthopedics communities to improve the accuracy of the alignment. The advantages of TKA navigator are good surgical vision can be assessed instantaneously and simultaneously alignment, ligament tension, avoid intramedullary canal violation, and help overcome limitation from mini-incision exposure. The disadvantages of TKA navigator are about the costly payment for the surgical team, time consuming, and pin complication. Although the numerous studies had shown the improved prosthetic alignment by using the computer assisted navigated knee surgery; there has been still the controversy about CAS that was decreased outlier < 3 degree in minimally invasive subvastus approach in coronal plane<sup>(6)</sup>. However, it was not known whether a good alignment prosthesis improved the long term survival<sup>(7)</sup> but CAS could improve the outcome after Total Knee Arthroplasty (TKA) in decreasing blood loss<sup>(8)</sup>, and decreasing deep vein thrombosis due to the intramedullary femoral guide<sup>(9,10)</sup>. Consequently, the Police General Hospital is now using the combination of soft tissue preservation and computer navigation as mini-incision subvastus approach computer assisted CMS-TKA to improve the prosthesis alignment, to decrease blood loss, to get smaller incision, to faster pain relieve and rehabilitation<sup>(11,12)</sup>.

As the combination of improving this technique, all of the advantages and disadvantages have been considered. In compiling about the improved accuracy with computer navigation, there has been significant interest in combining minimally invasive techniques and computer assisted techniques. Moreover, the improvement are the appropriated sized instrumentation, windowing technique, good soft tissue handling. Recently, a surgical technique for TKA rendered in Police General Hospital mostly approaches by computer assisted mini-incision subvastus approach have been investigation.

The computer assisted mini-incision subvastus approach for TKA will preserve the soft tissue

environment and avoid the component placement errors. The following steps which had followed the room set-up were the mini-incision subvastus exposure with soft tissue releases, the tracker placement, the registration of hip center, the anatomic registration, the assessment of pre-operative deformity, the distal femoral resection, the proximal Tibia Resection, the ligament balancing with measurement technique, the finishing cut of femur, the femoral trial prosthesis with spacer and the self alignment of tibia, the finishing tibia, Trial all component, the assessment of correction of deformity by navigator, patelloplasty, cementation with final implants, wound Closure.

In this study, no statistic significant difference was found between the 2 groups in the aspects of incision length, the operative time, the lateral releases, the blood loss, the knee score, the radiographic pre-operative and the post-operative except the limb alignment and the knee score pre-operative and post-operative. However, there was no any other difference in both groups. There were 2 cases with the superficial wound infection and were treated with the intravenous antibiotic administration. However, no deep vein thrombosis, no fracture at femur and tibia, no vascular injury, no pin tract pain or infection, and no major complication were found. The incidence of the lateral releases was found to be less comparing to the standard exposure. The results revealed that this technique could be performed in all types of deformity except the fixed valgus deformity. No limitation was mentioned in previous study. We can take the advantages of soft tissue preservation by mini-incision subvastus approach with the accuracy of navigator by computer assisted mini-incision subvastus approach in total knee arthroplasty. Limitations of the study included no control group; short period of follow-up to demonstrated the long term outcomes. Further study has been done was suggested to demonstrate whether or not the benefits of CMS-TKA comparing to standard Total Knee Arthroplasty (TKA).

### Conclusion

CMS-TKA (Computer assisted mini-incision subvastus Total Knee Arthroplasty) had been demonstrated the potential benefit of accurate prosthesis alignment, intra-operative soft-tissue balance, faster rehabilitation, less bleeding, less lateral releases, better patella tracking, better cosmesis?, and no major pin complication. Almost all deformity has been operated except fixed valgus deformity. Multiple key steps for successful surgical outcome are soft

tissue handling by windowing technique, appropriate surgical instrument and the surgical team. CMS-TKA can be performed safely with navigation with acceptable rate of complications and alignment. Further research has to be done to improve the outcomes and surgical technique for users friendly. CMS-TKA is an alternatively effective and safe approach for total knee arthroplasty.

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## การศึกษาผลการผ่าตัดข้อเข่าเทียม โดยวิธีการผ่าตัดแบบข้อวาสตัสและการใช้คอมพิวเตอร์นำวิเคเตอร์ช่วยผ่าตัด

ธนา ฐระเจน, วิโรจน์ ลาภไพบุลย์พงศ์, จตุพล คงถาวรสกุล, สามารถ ม่วงศิริ

**ภูมิหลัง:** การผ่าตัดข้อเข่าเทียมโดยวิธีรักษาเนื้อเยื่อรอบๆ เข่าได้มีการพัฒนาโดยเริ่มจากมีเดียนพาราพาเทร่าไปสู่การผ่าตัดแผลเล็กมีดวาสตัสข้อวาสตัสและการรักษาควอดิเซ็ป อย่างไรก็ตามมีข้อจำกัดคือ ความสามารถในการมองเห็นระหว่างผ่าตัด การผ่าตัดแบบแผลเล็กข้อวาสตัสสามารถรักษาเนื้อเยื่อบริเวณรอบ ๆ และสามารถมองเห็นได้อย่างเหมาะสม ข้อดีคือ ลดอาการปวดฟื้นตัวเร็ว ข้อเสียคือการเสียเลือด, การมองในที่จำกัด, การวางตำแหน่งข้อเทียมที่ไม่ถูกต้อง จึงทำให้การผ่าตัดนำวิเคเตอร์ โดยใช้คอมพิวเตอร์ช่วยผ่าตัดมีบทบาทในการทำให้ผลการผ่าตัดดีขึ้น

**วัตถุประสงค์:** เพื่อประเมินการผ่าตัดข้อเข่าเทียม และศึกษาการเลือกผู้ป่วยที่รับการผ่าตัดแบบแผลเล็กข้อวาสตัส ร่วมกับการผ่าตัดนำวิเคเตอร์โดยใช้คอมพิวเตอร์ช่วยผ่าตัด

**วัสดุและวิธีการ:** การศึกษาแบบโปรสเปกตีฟในกลุ่มตัวอย่างซึ่งเป็นผู้ป่วยจำนวน 80 ราย ที่รับการผ่าตัดข้อเข่าเทียมด้วยวิธีแบบแผลเล็กข้อวาสตัส ร่วมกับการผ่าตัดนำวิเคเตอร์ โดยใช้คอมพิวเตอร์ช่วยผ่าตัด (CMS-TKA) ตั้งแต่เดือนมกราคม พ.ศ. 2550-ตุลาคม พ.ศ. 2551 โดยแบ่งผู้ป่วยเป็น 2 กลุ่ม กลุ่มที่หนึ่ง คือ ผู้ป่วย simple deformity มีลักษณะ varus deformity น้อยกว่า 15 องศา BMI น้อยกวาร้อยละ 20 และไม่พบความผิดปกติอื่น ๆ ร่วมด้วย กลุ่มที่สอง คือ ผู้ป่วย complex deformity มีลักษณะ varus deformity มากกว่า 15 องศา BMI มากกว่าร้อยละ 20 และมีความผิดปกติอื่น ๆ ร่วมด้วยผู้ป่วยกลุ่มที่หนึ่งมีจำนวน 59 คน กลุ่มที่สองมีจำนวน 21 คนในจำนวน 80 เข่า ที่ได้รับการผ่าตัดเป็นเข่าด้านซ้ายจำนวน 38 เข่าและเข่าด้านขวาจำนวน 42 เข่า

**ผลการศึกษา:** อัตราส่วนของความยาวของแผลผ่าตัดกลุ่มที่หนึ่งต่อกลุ่มที่สองเท่ากับ 10.88 (8-13): 11.92 (10-14) ระยะเวลาการผ่าตัดกลุ่มที่หนึ่งต่อกลุ่มที่สองเท่ากับ 118 (111.88-125.12): 131 (119.29-143.71) การทำ lateral release กลุ่มที่หนึ่งต่อกลุ่มที่สองเท่ากับ 0:0 (ไม่มีการทำในทั้ง 2 กลุ่ม) การเสียเลือดภายใน 24 ชั่วโมง กลุ่มที่หนึ่งต่อกลุ่มที่สองเท่ากับ 489.09 (414.7-563.48): 520 (503.46-636.54) มล. การให้เลือดกลุ่มที่หนึ่งต่อกลุ่มที่สอง ไม่มีการให้เลือดในทั้ง 2 กลุ่ม มุมการวางข้อเทียมกลุ่มที่หนึ่งต่อกลุ่มที่สองก่อนทำการผ่าตัดเท่ากับ Varus = 4 , 2.71 (varus0-10): Varus = 17.14, 1.77 (varus 15.7-18.5) มุมการวางข้อเทียมกลุ่มที่หนึ่งต่อกลุ่มที่สอง หลังทำการผ่าตัดเท่ากับ Valgus = 1.38 (Valgus 0-4) : Valgus = 2.85 (valgus 2.1-3.5) การเคลื่อนไหวข้อก่อนผ่าตัด การเหยียดและงอเข่า กลุ่มที่หนึ่งต่อกลุ่มที่สองเท่ากับ 93.5 (80-100)/1.7 (0-4): 90.25 (90-100)/1.3 (0-4) การเคลื่อนไหวข้อหลังผ่าตัดการเหยียดและงอเข่า กลุ่มที่หนึ่งต่อกลุ่มที่สองเท่ากับ 94.5 (90-100)/1.75 (0-5): 95.25 (90-105)/1.5 (0-5) Knee score ก่อนการผ่าตัดทั้งสองกลุ่มเท่ากับ 64.6 (59.8-69.4): 69 (63.6-74.39) Knee score หลังการผ่าตัด กลุ่มที่หนึ่งต่อกลุ่มที่สองเท่ากับ 93.7 (90.8-96.65): 92.36 (88.22-96.5) ภาวะแทรกซ้อนพบไม่ต่างกันทั้งสองกลุ่ม ซึ่งได้แก่การติดเชื้อที่ผิวหนัง

**สรุป:** การผ่าตัดข้อเทียมแบบแผลเล็กข้อวาสตัสและคอมพิวเตอร์นำวิเคเตอร์ช่วยในการผ่าตัดนั้นสามารถทำได้ในทุกชนิดของการผิดรูป varus ไม่มีข้อจำกัดในกรณีมีการสูญเสียและการผิดรูปในทางอ ยกเว้นการผิดรูปที่เป็น fixed valgus เพื่อให้ได้ผลการรักษาที่ีจะต้องทำตามเทคนิคอย่างถูกต้องเหมาะสม ได้แก่ แผลเล็ก การผ่าตัดแบบข้อวาสตัส การกำหนดตำแหน่งที่ถูกต้อง การตัดกระดูกได้แม่นยำ การทำให้เอ็นมีความสมดุลและเทคนิคการใส่ซีเมนต์ที่ดี