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Research Paper

# Total Knee Replacement with iASSIST Navigation System
# iASSIST電腦導航系統在全膝關節置換術的應用

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ABSTRACT

*Background/Purpose:* The iASSIST system is a novel navigation system for total knee replacement. It is based on accelerometers built within electronic pods attached to the instruments within the operative field. The objective of this study was to compare the accuracy of iASSIST navigation with that of the conventional alignment technique.
*Methods:* A total of 91 patients (92 knees) retrospectively matched for age, gender, preoperative range of motion, and lower limb deformity underwent total knee replacement using iASSIST navigation (45 patients, 46 knees) or conventional instrumentation (46 patients, 46 knees). Operative time and radiological alignments were compared.
*Results:* The use of iASSIST navigation resulted in fewer outliners (as defined by >3° deviation from the neutral mechanical axis) in lower limb alignment. Operative time with iASSIST navigation was not longer than that using conventional instruments.
Conclusion: iASSIST navigation reduces the incidence of lower limb malalignment without adding extra time to the procedure.

中 文 摘 要

簡介：iASSIST是一個全新的全膝關節置換術電腦導航系統。本研究的目的是比較iASSIST 導航系統及傳統全膝關節置換術的準確性。
方法：回顧性分析91位病人(92膝）的全膝關節置換術，病人、年齡、性別、術前活動範圍和下肢畸形的狀態匹配。45位病人(46膝） 接受了iASSIST電腦導航全膝關節置換術。46位病人接受了傳統全膝關節置換術。我們對两組病人的手術時間及術前術後的影像對線進行了比較。
結果：使用iASSIST電腦導航全膝關節置換術之整體下肢對線較傳統全膝關節置換術較少 對線異常值 (>3°偏離中立機械軸)。而使用iASSIST電腦導航全膝關節置換術之手術時間並不比傳統全膝關節置換術長。
結論：iASSIST電腦導航降低整體下肢對線出現偏差的機會，同時無需增加額外手術時間。

## Introduction

The optimal alignment for total knee replacement is still controversial. The traditional rule of a neutral mechanical axis with implants placed perpendicular to the femoral and tibial mechanical axis has been questioned.[1] Some studies have shown similar clinical results despite malalignment.[2] There is also the development of a kinematically designed knee, hoping to improve clinical results. Regardless of belief, the aim to improve accuracy of bone cut continues to be an area of development in total knee replacement.

A novel accelerometer-based navigation system, iASSIST Knee System (Zimmer, Warsaw, IN, USA), was developed in 2012. The iASSIST consists of egg-sized electronic pods attached onto the instruments within the operative field. The pods containing an accelerometer electronic component captures information on the alignment axis and guides bone resection.

The first purpose of our study is to assess the accuracy of the iASSIST navigation system by comparing the planned resection angles, post-bone cut verification angles, and angles obtained from radiographs after operation. The second purpose of our study is to determine if iASSIST navigation improves the accuracy of femoral and tibial component positioning and the overall lower limb alignment compared with conventional alignment techniques in total knee replacement.

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## Methods

### *Patient selection*

From June 2015 to December 2015, 55 patients (56 knees) diagnosed with tricompartmental osteoarthritis of the knee who failed conservative measures underwent primary total knee replacement using the iASSIST computer navigation system in a single centre. All the operations were performed by or under the supervision of joint surgeons. Retrospective matched pairing of 46 patients (46 knees) who received total knee replacement in our centre in 2015 was performed based on age, gender, preoperative range of motion, and lower limb alignment.

### *Surgical technique for the control group*

Both groups of patients underwent total knee replacement using fixed-bearing posterior-stabilized implants (NexGen Complete Knee Solution Legacy Knee; Zimmer, Warsaw, IN, USA); the medial parapatellar approach was adopted with tourniquet control at 280 mmHg. In the control group, distal femur was prepared using an intramedullary rod. Setting of the femoral valgus cut angle was based on the preoperative long film measurement of the angle sustained between the shaft axis and the mechanical axis of femur such that the distal femur bone cut was perpendicular to the femoral mechanical axis. In case of femoral bowing, a line simulating the pathway of the intramedullary rod was drawn; the angle formed between this line and the mechanical axis of the femur represented the femoral valgus cut angle. The proximal tibia was prepared with an extramedullary guide to achieve bone cut perpendicular to the tibial mechanical axis. The overall alignment was checked after placing trial implants, and further bone cut could be made if needed. The patella was resurfaced in both groups. All patients underwent postoperative physiotherapy according to the rehabilitation protocol in our centre.

### *Surgical technique for the iASSIST group*

The iASSIST navigation system made use of the disposable electronic pod attached to the resection instrument to acquire and displace information on lower limb alignment; the system was placed entirely within the surgical field such that surgical workflow is similar to that of the convention method. Femoral registration was performed by impacting a bone spike to the distal femoral sulcus 10 mm anterior to the posterior cruciate ligament. A reference pod was inserted over the spike and fixed. Femoral coordination was acquired by multiple jerky stop-and-go movements of the leg. The information was transferred to a laptop-sized computer placed within the operation theatre via a secured local wireless (Wi-Fi) network. The distal femoral resection guide attached with a cutting guide pod was coupled to the bone spike. The computed alignment information was then transferred to and displaced on the cutting guide pod by light-emitting diode indicators (Figures 1 and 2). Adjustment of the femoral resection guide in coronal and sagittal planes was made based on the information provided on the cutting guide pod. The aim of bone resection was to achieve 0° varus and 3° flexion. Postresection validation was performed by attaching a reference pod to the bone cut surface and placing the lower limb in abduction, adduction, and neutral positions. Again the alignment information is displaced on the cutting guide pod, and further bone cut could be made if needed. Tibial registration began with placing an extramedullary tibial guide containing a cutting guide pod to the tibia. The tibial resection guide together

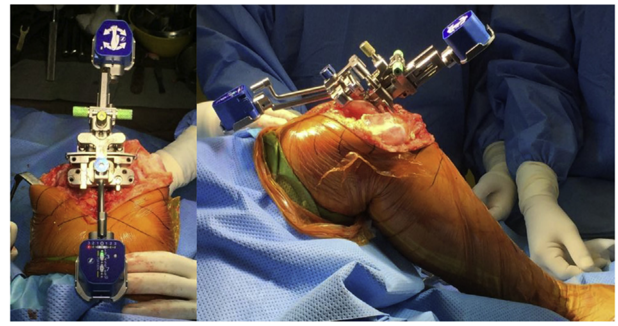

**Figure 1.** Use of iASSIST navigation to guide distal femoral cut. View from above and side showing the distal femur resection guide and its cutting guide pod displacing alignment information via LED indicators. The reference pod is attached to the distal femur. LED = light-emitting diode.

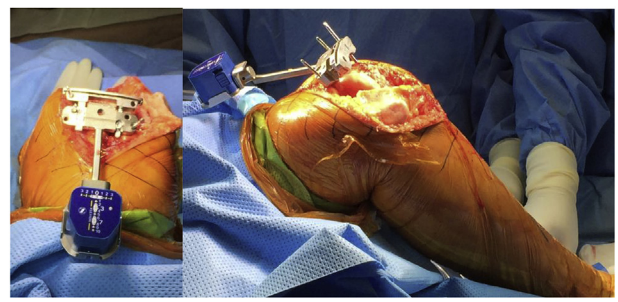

**Figure 2.** Use of iASSIST navigation to guide distal femoral cut. View from above and side showing the distal femur resection after removal of the reference pod.

with a reference pod attached was assembled to the extramedullary tibial guide and fixed by three screws (Figure 3). Tibial coordination was acquired by placing the lower limb in abduction, adduction, and neutral positions. Data acquired by the reference pod were transferred to the laptop-sized computer via Wi-Fi and then displaced on the cutting guide pod. The cutting guide pod on the extramedullary tibial guide was detached and coupled to the tibial resection guide (Figure 4). The extramedullary guide was then removed. Adjustment of the tibial resection guide in coronal and sagittal planes was made based on the information displaced on the cutting guide pod. The planned tibial bone cut was 0° varus and 7° posterior slope. Resection of proximal tibia could be performed once the position of the resection guide was satisfactory. Coronal alignment and slope of the proximal tibia could be validated after resection. Adjustment to resection could be made if needed.

### *Clinical and radiological evaluation*

Perioperative clinical variables including age, gender, preoperative range of motion, and duration of surgery were recorded. In the iASSIST group, the planned resection angle for femur and tibia in the coronal plane and the post-bone cut verification angles were documented. If any resections were made after validation, the validation process was repeated and the final verification angles were documented. A standardized radiographic evaluation was performed in all patients. Coronal hip to ankle radiographs were taken at standing position with the knee in full extension preoperatively and at 6 months after surgery. The anterior surface of the patella was placed perpendicular to the X-ray source, with the toes pointing forward. Radiographs with malrotation, as defined by the asymmetry of medial and lateral femoral condyles, will be