Handheld Navigation in Total Knee Arthroplasty

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KEYWORDS

• Knee replacement • Computer navigation • Mechanical axis • Tibial alignment • Femora alignment

KEY POINTS

- Knee replacements with tibial malalignment have been shown to lead to higher failure rates.
- A handheld navigation system is accurate and easy to use.
- With price pressure on joint replacement surgery, a disposable unit may be more attractive than an expensive large console system.

INTRODUCTION

Computer navigation for total knee arthroplasty (TKA) has been clinically available for over a decade; yet it remains an uncommonly used technology used today. Multiple clinical studies show that these computerized guides are more accurate than their mechanical counterparts, but they are not used. Several reasons have been sited, including cost, learning curve, additional incisions for pin sites, increased operating room time, line of sight issues, and lack of evidence that clinical outcomes are improved.[1]

The idea of a handheld easy-to-use navigation system was conceived in 2008, and the first system became clinically available in 2009.

Hard parameters were laid down for the development team. These included no additional incisions, no pins in the femur or tibia, no external computer or device that would require line of sight or a nonsterile operator, no capital equipment cost, little to no additional operating room time and a fast learning curve, and accuracy equivalent to or better than currently available large console navigation systems.

There is significant argument in the literature on the clinical need for tools that are more accurate than standard mechanical guides. Many studies show that navigated knee replacements are more likely to be within what is considered appropriate mechanical axis alignment.[2] Several midterm studies have shown no increased failure rates in knees that are not within this accepted alignment, called outliers.[3]

Ritter and colleagues showed increased polyethylene stresses on tibial implants in more than 3° of varus and higher failure rates. They showed a revision rate of 168 for tibias in greater than 3° of varus in patients with a body mass index (BMI) of over 33.[2]

TKA today is done using either a bony resection technique or a ligament-balancing technique. In a ligament-balancing technique, tibial alignment is critical, as femoral rotation is linked to tibial alignment. If the tibial cut is made in 4° of varus, then the femoral implant will be internally rotated by 4°. This may affect patellar tracking and kinematics of the knee.

Current literature shows that 15% to 40% of revision TKAs are done for mechanical loosening. Polyethylene wear and instability are 2 other major reasons for revision. Most remaining revisions are done for infection.[4–8] More precise alignment should decrease the number of failures for mechanical loosening, instability, and polyethylene wear.

Even if outcomes are not improved, every time a surgeon goes into a TKA procedure, the surgeon has a target for alignment in mind. If there is a

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simple, easy-to-use tool that allows that target to be hit more frequently, then why would it not be used?

SURGICAL TECHNIQUE

Two systems are currently approved by the US Food and Drug Administration and on the market. These systems are made by OrthAlign (Aliso Viego, California) and Zimmer (Warsaw, Indiana). Both systems work in similar fashion using accelerometer technology. The OrthAlign system surgical technique will be described.

Standard exposure is performed for the knee replacement. Either the distal femoral cut or proximal tibial cut can be performed first.

Distal Femoral Cut

Step 1
The device is pinned to the distal femur with the central pin in the center of the knee. This becomes the center of the knee for the navigation system (Fig. 1).

Step 2
An offset adjustment is made for the system to compensate for different sized femurs (Fig. 2).

Step 3
The sensors are attached to the mechanical device (Fig. 3).

Step 4
The femur is rotated, allowing the system to determine the center of the femoral head (Fig. 4).

Step 5
The system now knows the mechanical axis of the femur and shows the current position of the femoral cutting block (Fig. 5).

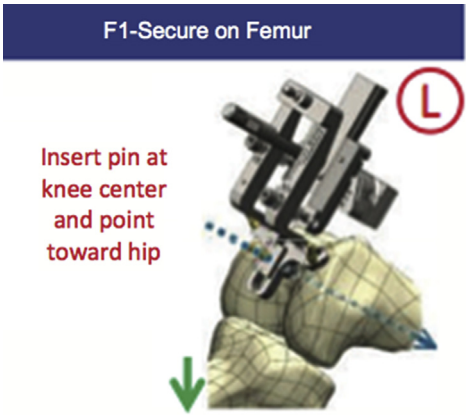

Fig. 1. The device is pinned to the distal femur.

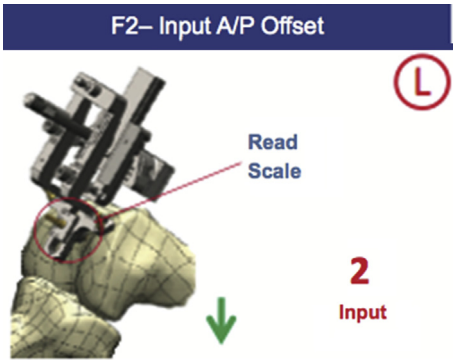

Fig. 2. Offset adjustment is made.

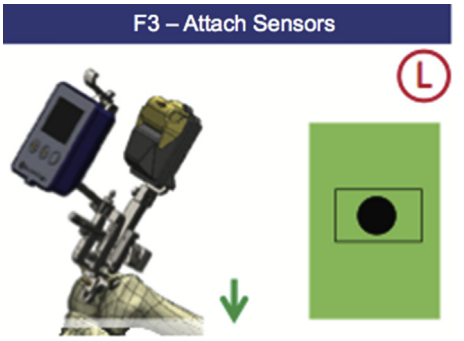

Fig. 3. Sensors are attached to mechanical device.

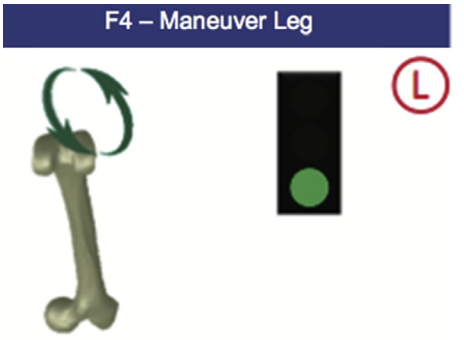

Fig. 4. The femur is rotated.

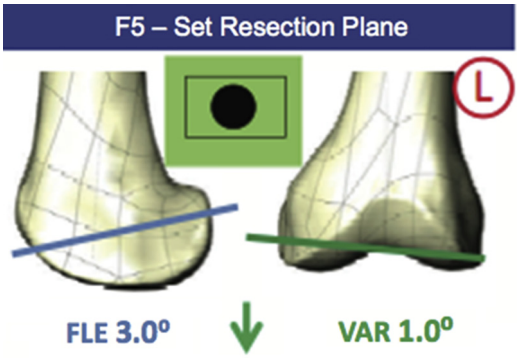

Fig. 5. The system providing a view of the current position of the femoral cutting block.