BRIEF REPORT

A Simple Approach to Assessment of a Total Knee Replacement's Rotational Profile Using Computed Tomography

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Malrotation is a cause of persistent pain and poor functioning postoperatively in those who undergo a total knee replacement (TKR). The accurate measurement of malrotation is not routinely available in most hospital settings due to an absence of three-dimensional computed tomography (CT) software. An accessible, uncomplicated technique to demonstrate TKR prosthesis malrotation would be of benefit to orthopaedic surgeons worldwide. A patient was reviewed with persistent postoperative pain, having undergone a right TKR 3 years previously for progressive osteoarthritis. Postoperative prosthetic infection, instability, loosening, and fracture were ruled out as causes for the persistent pain. A two-dimensional CT scan was obtained of the patient's affected right knee. Adhesive pieces of paper (Post-it notes) were used to highlight the posterior tibial prosthesis axis, the tibial tuberosity axis, the posterior condylar axis of the femoral prosthesis and the femoral surgical transepicondylar axis, as per the technique described by Berger *et al.* A protractor was used to assess the degree of malrotation of the tibial and femoral prostheses. Allowing for human error and that of parallax, an immediate assessment was made of the patient's prosthesis using a readily available imaging modality, and malrotation was quickly identified using accessible, affordable everyday stationary equipment.

Key words: Arthroplasty; Malrotation; Total knee replacement

Introduction

A total knee replacement (TKR) is one of the most successful orthopaedic procedures with satisfaction rates of over 90% reported¹. Malrotation is a cause of persistent pain and poor functioning postoperatively in those who undergo a TKR². This complication may be attributed to internal rotational errors, particularly that of the tibial component greater than 9°³. The rotational profile of a TKR prosthesis is traditionally difficult to measure radiologically, and is not readily achievable using plain film X-rays. Assessment is often difficult using computed tomography (CT) without specific three-dimensional (3D) software, as the investigation includes a comparison of the tibial tubercle, the epicondylar axis and the posterior prosthesis axis on two-dimensional (2D) scans. Visualization of both the medial and lateral

epicondylar landmarks on the same slice of CT is required for rotational assessment; however, this is not always achievable. This limitation can be overcome by using 3D reconstructed CT images. However, the accurate measurement of malrotation is not routinely available in most hospital settings where 3D CT is not available⁴. Given the difficulties encountered, an accessible, uncomplicated technique to demonstrate TKR prosthesis malrotation would be of benefit to orthopaedic surgeons worldwide.

Methods and Technique

A 90-year-old woman patient was reviewed in the outpatient department, having undergone a right TKR 3 years previously for progressive osteoarthritis. The prosthesis used was that of a PFC Sigma Tray (DePuy Synthes, Johnson and

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Fig. 1 An adhesive piece of paper (Post-it note) highlighting the posterior prosthesis axis.

Fig. 2 Identification of the tibial tuberosity.

Johnson Ireland Ltd, Cork, Ireland), a size 3 femoral component and a fixed bearing size 3 tibia insert with 10 mm thickness. Postoperatively, the patient's pain had persisted, with her visual analog scale score remaining consistently at 6 out of 10. She reported an increasing need to mobilize with the aid of a walking stick over the past 6 months. On examination, the patient's right knee scar was well healed, diffuse knee tenderness was elicited at the ligament attachments, and her range of motion was limited at 10°–90°. Post-operative prosthetic infection, instability, loosening and fracture were ruled out as causes for the persistent pain. A 2D CT scan was obtained of the patient's affected right knee. The rotational alignment of the tibial and femoral components were assessed according to the technique described by Berger *et al.*⁵

To identify the degree of tibial rotation, the axial slice at the level of the tibial base plate was firstly identified. An adhesive piece of paper (Post-It Brand (3M United Kingdom PLC, Berkshire, United Kingdom)), as would be available in most fracture clinics, was attached to the computer screen along the line of the posterior prosthesis axis as shown (Fig. 1). The CT scan was scrolled through inferiorly, with the adhesive paper left *in situ*, to the level of the most prominent part of the tibial tuberosity (Fig. 2). Adhesive paper was used to plot the axis perpendicular to the tibial tuberosity, as shown. A simple protractor, also available in most fracture clinics, was then used to calculate the degree of rotation, as determined by the angle between the two representative Post-it notes (Fig. 3).

Rotation of the femoral component was assessed firstly by identifying the line along the posterior condylar axis of the prosthesis, which was highlighted using a Post-it note as before (Fig. 4). The CT was scrolled through once again,

Fig. 3 A simple protractor used to calculate the degree of rotation.

Fig. 4 Assessment of the femoral component by identifying the line along the posterior condylar axis of the prosthesis.

with the adhesive paper *in situ*, until the surgical transepicondylar axis was located. This was identified as the line connecting the sulcus of the medial epicondyle and the most prominent part of the lateral epicondyle, and highlighted. The angle between the Post-it notes was measured using a protractor (Fig. 5), which determined the degree of rotation between the prosthesis and the patient's femur.

Results

Malrotation of the TKR prosthesis was quickly and easily identified in the outpatient setting using a 2D CT scan of the patient's affected right knee. The patient's tibial component was rotated internally by 18° and the femoral component internally rotated by 10° , to which was attributed to the patient's unsettling postoperative pain. The simplicity of this technique allowed for its use at the site of consultation.

Discussion

The use of 2D CT imaging is widely available. As a result, it is possible for this simple technique to be used in hospital settings where there is an absence of 3D CT software. An immediate assessment can be made of the patient's prosthesis using a readily available imaging modality, and malrotation can be quickly identified using accessible, affordable everyday stationary equipment.

The difficulties encountered in formally assessing the rotational profile of TKR prosthesis due to the facilities required and budget restrictions that exist prove how beneficial a simple, accessible technique would be to orthopaedic surgeons worldwide. Using a 2D CT scan of the patient's affected knee, a diagnosis of malrotation can be readily identified. The ability of the surgeon to demonstrate TKR prosthesis malrotation to the patient at the site of consultation permits an understanding of the potential cause of their postoperative pain.

This approach to the assessment of the rotational profile of TKR prosthesis provides a diagnosis of malrotation when gross evidence is available, as in the case described. It does not permit an accurate measurement of the degree of malrotation. Human error and interobserver variability surround the process of identifying and highlighting the posterior prosthesis axis, tibial tuberosity axis and femoral epicondylar axis using the adhesive paper. Measuring and interpreting the angles using a protractor in both of the above steps contains both human error and interobserver variability once again, as well as the error of parallax due to the thickness of the glass that separates the scan from the measurement device.

The finding of TKR prosthesis malrotation on a patient's CT scan does not necessarily identify the cause of postoperative pain. It may be possible for the surgeon to attribute the patient's symptoms to malrotation once other potential processes, such as infection, instability, loosening and periprosthetic fracture, have been excluded. Having said this, the surgeon is unable to accurately quantify the degree to which it is present.

Fig. 5 Measuring the degree of rotation of the femoral prosthesis using a protractor.

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