The Effects of Inaccurate Bone Cuts on Femoral Component Position in Total Knee Arthroplasty

Dennis W. Lennox, MD
Bruce T. Cohn, MD
H.C. Eschenroeder, Jr, MD

Introduction

Accurate bone cuts have always been important in total knee arthroplasty. With the advent of cementless total knees requiring an interference fit, the importance of precision bone cuts has increased. Making accurate bone cuts is facilitated by accurate instrumentation systems. However, even with precise instrumentation, it is still possible to make inaccurate cuts precluding an exact fit of the component to the bone. This is especially true with the femoral cuts. If an inaccurate cut has been made, the surgeon may note intraoperatively that the femoral component does not fit properly and must then decide which bone cut is inaccurate. It is not always readily apparent intraoperatively which cut is inaccurate. Will recognizable patterns of an unacceptable fit arise by reproducing common technical errors in making bone cuts? This study was designed to demonstrate the patterns of femoral component malposition which result from errors in various femoral bone cuts.

Materials and Methods

The Universal™ Total Knee Instruments System (Howmedica, Inc, Rutherford, NJ) was utilized to make cuts in plastic model femurs. In most total knee systems, five cuts are made on the distal femur to allow fitting of the femoral component. These include the distal cut, the anterior and posterior cuts, and the anterior and posterior chamfer cuts. The Universal instrumentation was utilized in a routine fashion, and on each plastic saw bone model one of the five femoral cuts was purposely made inaccurately. The femoral component was then impacted into position and the type of malposition on the femur was noted. Two choices could be made in performing the inaccurate cuts. The saw could be directed so that too much bone was taken, or, by flexing the blade, the cut could be made so that extra bone remained. When excess bone is removed, the

Reprint requests: Dennis W. Lennox, MD. The Union Memorial Hospital, Department of Orthopedic Surgery. 201 East University Parkway, Baltimore, MD 21218.

Fig. 1: This photograph demonstrates how skiving may occur when using a cutting block. In this instance, too much pressure is being applied to the flexible blade causing it to bend. The result is inadequate bone resection—skiving of the bone cut.
prosthetic component will usually seat, but a gap will appear between the component and the inaccurately made cut. This situation cannot be easily corrected by revising the cuts and bone grafting or cementing of the component should be considered. However, if the saw is directed so that extra bone remains, the situation is easily corrected by recognizing and revising the inaccurate cut. It is, therefore, better to create correctable errors with excessive saw blade flexion, leaving excess bone rather than to remove too much bone initially (Fig. 1).

Results

Excess anterior bone causes the impacted femoral component to assume a flexed position (Fig. 2). The gaps between the anterior chamfer and distal femoral cuts are asymmetric, being narrower posteriorly as viewed from the side. Correction in this situation occurs with an anterior cut. Since the flexed component position can cause the posterior aspect of the prosthesis to dig into the posterior femur, this area should be inspected for gaps once the attitude of the component has been corrected.

Skiving the anterior chamfer causes symmetric gaps between the component and the distal femoral and posterior chamfer cuts. The flexion-extension attitude of the component is normal. This error is corrected by revising the anterior chamfer cut (Fig. 3). The mirror image of this situation occurs if the posterior chamfer cut is skived (Fig. 4).

If the knee instrument system keys the anterior, posterior, and chamfer cuts from the distal cut, symmetrical failure to remove bone distally will result in relative distal placement of the component on the femur, but no misfit. This is an unlikely error, however, and often the distal femur is cut asymmetrically, leaving relative excess bone on the medial or lateral side. This is evident if one places a flat cutting block against the distal surface, as it will toggle. However, if the remainder of the cuts are made, the pattern shown in Figure 5 arises. The component will toggle and symmetric gaps at the distal cut and the anterior and posterior chamfer cuts are seen on one side (medial or lateral) only. This situation can be salvaged by recutting the distal femoral cut, which will also necessitate revision of both the anterior and posterior chamfer cuts.

If the instrument system does not key the anterior and posterior cuts from the distal cut, (not possible with the Universal instrumentation), it is possible to have the distal cut in a different flexion-extension orientation than the anterior and posterior cuts. This will create an asymmetric gap medially and laterally between the distal cut and the femoral component, and can be corrected by recutting the distal femur and chamfers. This will, however, result in some recession of the component on the femur.

Figure 6 demonstrates the effect of skiving the posterior cut. Asymmetric gaps are seen over the distal femoral and posterior chamfer cuts and the component appears extended. Seating the prosthesis in this position also may cause the component to dig into the anterior cut. Particularly with miscalc cuts anteriorly and posteriorly when the component is seen to
be assuming a flexed or extended position on the femur, impaction should be stopped and the imprecise cut corrected before damage occurs to the femoral bone.

For each of the errors shown, instead of skiving and leaving excess bone, it is possible to remove too much bone. This error results in seating of the component with a gap between the component and the poorly made cut. Anteriorly and posteriorly, these errors cannot be corrected unless the next smaller femoral component is used, which might result in notching the femur. (Down sizing works only for an anterior miscut with the Universal system.) The distal cut and chamfers can only be corrected by recessing the femoral component on the femur, recutting the distal and chamfer cuts.

**Discussion**

Accurate bone cuts have always been important in total knee arthroplasty. Cement fixation, however, provides the surgeon with some margin for error in that gaps can be filled with methylmethacrylate. With the advent of cementless fixation, it has become critically important that each bone cut be precise. Although the existing gap from an imprecise cut could be filled with bone graft, this is clearly suboptimal. Even if the components are cemented, slightly inaccurate bone cuts result in an uneven cement mantle which may result in early loosening.

It has been the authors' experience, that unless the surgeon has a great deal of expertise, it is not uncommon for one of the five femoral cuts to be slightly inaccurate.

By consistently skiving one of the five femoral cuts, it is impossible to correctly seat the trial femoral component. More importantly, recognizable patterns of imprecise fit were noted. By skiving the anterior cut, the femoral component would seat, but in a slightly flexed attitude (Fig. 2). Conversely, skiving the posterior femoral cut caused the femoral component to assume an extended position (Fig. 6). With an asymmetric distal femoral cut, there was a gap overlying the two chamfers and the distal femoral cut, and toggle was noted (Fig. 5). When a chamfer cut was skived, a gap was seen over the opposite chamfer cut and the distal femoral cut (Fig. 3, 4). Imprecise cuts where excess bone remains are
relatively easy to correct if one recognizes which cut is the source of the component not seating. Imprecise cuts where excess bone is removed are more difficult to correct and may result in ligamentous imbalance in flexion and extension. If not causing severe component stability problems, these errors are probably best dealt with by bone grafting or cementing the component.

Certainly, if more than one cut is inaccurate, the situation becomes more complicated. In these situations, the authors advise checking all cuts and recutting the entire femur if necessary. In most instances, it is usually only one bone cut that is inaccurate. In these situations, the concepts presented in this article should help the surgeon to quickly assess the malposition and correct it accordingly. It is emphasized, however, that there is no substitute for accurate initial bone cuts, for which the surgeon should strive.

**Summary**

Patterns of malposition of total knee femoral components are presented and are correlated to specific faulty bone cuts. Femoral component malposition pattern recognition will facilitate intraoperative correction of inaccurate bone cuts.