

High incidence of anterior femoral cortex notching using navigation system in total knee arthroplasty

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Introduction: Navigation system in total knee arthroplasty (TKA) has recently been developed to achieve optimal prosthetic alignment. Notching of anterior femoral cortex is a contributing factor to postoperative femoral fracture. These two issues, however, may conflict. The purpose of this study is to investigate the risk of femoral notching using 3D template system.

Methods: We obtained the 3D-CT data of lower extremities achieved from 50 female candidates for TKA. We planned femoral component setting using 3D template system (Vector Vision; Brain-LAB Inc, Munich, Germany) for the conventional technique and navigation system. Model of PFC Sigma (DePuy, Warsaw, IL) was used.

We defined the femoral axis as three lines from the center of the femoral head to one of the following three points (mechanical axis of the whole femur): (a) trochlear groove; (navigation femoral axis 1 [NFA1]); (b) 4mm anterior to trochlear groove (NFA2); and (c) 8 mm anterior to trochlear groove (NFA3). Femoral component was set vertical to these three axes.

The rotation of the femoral component was set (a) parallel to the transepicondylar axis (TEA); (b) 3-degrees externally to TEA; (c) 3-degrees internally to TEA. The notching of anterior femoral cortex was evaluated in nine positions.

Results: When the femoral component was set parallel to the TEA, notching was observed in 13/50 cases (26%) with NFA 1, 19/50 cases (38%) with NFA 2, and 24/50 cases (48%) with NFA 3. When the femoral component was set 3-degrees externally to TEA, nothing cases were increased. When the femoral component was set 3-degrees internally to TEA, nothing cases were increased (Table 1).

Table 1: Notching Cases in Each Setting of Femoral Component

Setting of	Femoral Mechanical Axis		
Rotational Position	NFA1	NFA2	NFA3
3° ER to TEA	20/50 (40%)	24/50 (48%)	28/50 (56%)
Parallel to TEA	13/50 (26%)	19/50 (38%)	24/50 (48%)
3° IR to TEA	7/50 (14%)	9/50 (18%)	17/50 (34%)

TEA: transepicondylar axis , ER: externally rotation, IR: internally rotation

Discussion: The present study showed that there is the potential risk of notching of anterior femoral cortex using navigation systems for TKA. In some cases, two of the requirements for navigation systems for TKA, perpendicular cut of the distal femoral condyle to the femoral mechanical axis and prevention of notching of the anterior femoral cortex, theoretically conflicted. The risk of notching was higher when the reference point on distal femoral condyle was set 8 mm anterior to trochlear groove and when the femoral component was set externally to TEA.

At the moment, there are two major types of navigation systems for TKA, CT-based and CT-free systems. Reliable implant alignment can be obtained using each of these types of systems. For CT-based navigation systems, preoperative CT of the entire lower extremity is required. Three-

dimensional planning of implant alignment on CT data is performed before operation. In the operating room, the surgeon reproduces the plan of implant alignment using optical instruments. Because CT-based navigation systems have the step such as three-dimensional computerized planning, surgeon can check if navigation system leads anterior notching or not before operation, and can re-adjust the mechanical axis not to make notching.

On the other hand, CT-free navigation systems do not have such preoperative planning which warns of notching. Therefore, CT-free navigation system inherently have the risk of notching of the anterior femoral cortex. Recently, combined use of navigation systems and minimal incision surgery for TKA has been introduced [3]. The disadvantage of restricted visualization in the minimal incision surgery was expected to be compensated by a navigation system. However, our results suggested that combined use of minimal incision surgery and navigation systems, especially for CT-free systems, should be used with great care to notching of anterior femoral cortex.

The present study showed that navigation systems for TKA have the potential risk of notching of the anterior femoral cortex. Surgeons and technicians using navigation systems for TKA should be aware of this risk.