

# NOTCHING THE ANTERIOR FEMUR – WHEN SHOULD FEMORAL STEMS BE USED?

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## INTRODUCTION

Femoral notching occurs when a bone defect (notch) in the anterior femoral cortex occurs due to bone cuts for the femoral component insertion in total knee arthroplasty (TKA). This can occur due to several reasons. Excessive femoral component rotation in the antero-medial and antero-lateral can promote notching. Additionally, notching can occasionally occur with the use of posterior jigs referencing systems. Although some authors refer the significance of anterior femoral notching [1], stress concentrations created by anterior femoral cortex notching are of considerable importance because of possible association with supracondylar femur fractures. A solution to reduce the risk of supracondylar fracture is the use of prophylactic femoral stems intraoperatively, but this solution is always more complex and expensive. This experimental study aims to determine the size of notching were the use of femoral stem becomes an advantage to reduce the risk of fracture or if there are defect sizes for which the use of a stem is ineffective.

## METHODS

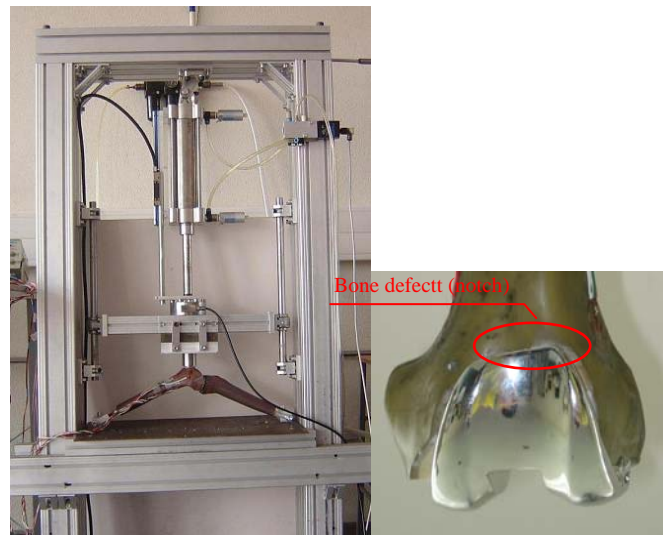
Five synthetic femurs, one of them can be seen in Figure 1, from Sawbones® were selected and used for this experimental study. The geometrical and anatomical structure of these synthetic composite bones resembles that of humans. Five femoral component of the P.F.C Sygma Modular Knee System (DePuy International, Inc) was implanted into each of these synthetic femurs. The in vitro insertion procedure was performed according to the protocol described for this type of knee prosthesis. For each femur, the femoral component was firstly implanted without a stem and in a second experiment, for the same conditions, a stem was assembled to the femoral component and the experiment repeated. The stemmed femur was placed in such a way that the stem axis formed an angle of 7° with the femur. For each femur, eight different notch depth defects were produced (0.5, 1, 2, 3, 4, 5, 6 and 7mm). The notch depths were increased from the first experiment without bone until a notch depth of 7mm in anterior aspect of the femur. This procedure was repeated five times for each femur. The values of forces applied to the synthetic femurs were based on the work Fernandez and Hunter [2]. These forces were applied directly under the patella region of the femoral component at different degrees of flexion with the diaphysis of femur and tibia rigidly fixed at the structure of the loading test machine (Figure 1). Triaxial (rosette) strain gauges were glued in femurs at five locations where a previous FE study indicated the regions of higher bone strains. Bragg sensors were also used in the zones next to the defect (notch) to evaluate the magnitude of strain concentration. The strains were evaluated with and without the stem in the same femur for each notch depth shaped. The mean and standard deviation of strains at each gauge position were determined for the five femurs.

## RESULTS AND DISCUSSION

The strains in the anterior cortex of femur show that the increase of the bone defect (notch depth) increases the localized strain next to bone cut (figure 1) for the femur without a stem. The increase of strains is more relevant above the 3mm notch depth. With the use of a femoral stem a reduction of strain occurs in the notch region (Table 1). For a notch dept greater than 4mm the strain reduction with use of stem is less important.

Notch depth	0.5	2	3	4	7
Strain reduction with use of stem	-10%	-20%	-36%	-30%	-25%

**Table 1:** Mean reduction of strains in the notch region with use of femoral stem relatively to the intact femur.



**Figure 1:** Test loading machine with a femur model in the load position and region of interest for strain analysis.

## CONCLUSIONS

In conclusion, the uses of stems for notch depths greater than 2mm are helpful and should be considered in surgery. However, if the notch dept is greater than 4mm, the reduction of strain in the implanted femur is less efficient. For these cases, it seems to be prudent to protect the patient of implant weight bearing.

## REFERENCES

1. Ritter M, Faris P, Keating E. Anterior femoral notching and ipsilateral supracondylar femur fractures in total knee arthroplasty. *J Arthroplasty* 1988; 3:185.
2. Fernandez, J. W. and Hunter, P. J.. An anatomically based patient-specific finite element model of patella articulation: towards a diagnostic tool, *Biomechan Model Mechanobiol*, 2005; 4: 20-38.