Periprosthetic tibial fractures in unicompartmental knee arthroplasty as a function of extended sagittal saw cuts: An experimental study

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INTRODUCTION:
Unicompartmental knee arthroplasty (UKA) is a common surgical treatment option for medial osteoarthritis of the knee. Good functional and clinical results have been reported in literature and excellent long-term results can be achieved.

UKAs constitute 8.2% of all knee arthroplasties performed in Sweden and 9.7% of all performed in Australia. In the US the percentage of UKAs performed has increased from 2.5% to 8.1% (1998-2005).

The increasing number of UKAs is associated with an increased prevalence of periprosthetic tibial plateau fractures (TPF). The New Zealand National Joint Registry states an incidence of 0.2% but figures up to 5% have been reported.

As TPFs usually occur perioperatively, these may be associated with intraoperative surgical errors. For example, extended sagittal saw cuts could weaken the dorsal cortex at the dorsal tibia resulting in a TPF.

The aim of the study was to evaluate TPF as a function of extended sagittal saw cuts.

METHODS:
The following study protocol was approved by the institutional university review board, accepted by the local ethics committee (ISO 9001:2000).
Six matched pairs of human fresh-frozen tibiae were used. At time of death, the donors had a mean age of 81.2 (47.0–92.0) years, a body weight of 61.7 (32.7–108.9) kg, a body height of 1.65 (1.45–1.85) m and a BMI of 21.8 (14.5–31.8) kg/m². Bone density measurement was performed at six different regions of interest.

Each pair of tibiae was randomly divided into two groups (group A and B) with equal distribution in order to rule out artifacts between left and right specimens. After removing soft tissues, cemented tibial UKA components were implanted by one experienced surgeon. Oxford III UKA was used.

An extramedullar tibial alignment jig was fixed to the anterior aspect of the tibia with two pins. The instrumentation aims for a posterior slope of 7°. The sagittal tibial cut was performed using a sagittal blade. In a second step the tibial plateau was resected horizontally with a reciprocating blade of 12mm. Dependent on the size of the tibial plateau, different tibial components (sizes B to F) were used for implantation.

For final preparation of the tibial plateau, a temporary was inserted and the keel slot was prepared with a special keel cut blade along both sides of the slot.

All specimens in group A received tibial preparation without an extended saw cut. In group B a standardised extended sagittal saw cut of 10° on the distal and dorsal cortex of the tibia was performed corresponding to the size of the tibial component. The depths of the defects at the dorsal cortex of tibia varied between 8.0 and 10.7 mm. A specially developed fixation device (Figure 1) was placed to ensure the sagittal saw cut of the dorsal cortex of the tibia and led to the medial metaphysis. The tibial plateau drifted medially in all cases (n=12).

In group A, a fracture load of $F_{\text{max}}=3.91$ (2.35–8.50) kN was measured, whereas in group B a fracture load of $F_{\text{max}}=2.62$ (1.08–5.04) kN induced the fracture. This difference was significant (p=0.03). A strong and significant correlation between the global BMD and the fracture loads could be observed for both groups (r=0.65; p=0.02).

With regard to donors’ body weight (BW) a mean of $F_{\text{max}}=645 \pm 157$ %BW was found in group A, whereas in group B the mean value accounted for $F_{\text{max}}=70 \pm 208$ %BW.

DISCUSSION:
Periprosthetic TPF represents a rare but severe complication in UKA. Our findings clearly indicate that extended sagittal saw cuts on the distal cortex of 10°, which can occur in surgery, weaken the tibial plateau and can reduce fracture loads by about 30%. The loads inducing these fractures were found to be significantly lower with an extended sagittal saw cut (group B: $F_{\text{max}}=2.62$ kN) than in a regular preparation (group A: $F_{\text{max}}=3.91$ kN).

In all our specimens, the sagittal saw cut was the origin of the fractures induced. From this starting point the fractures proceed to the cortical metaphyseal region. At first sight, an extended sagittal saw cut of 10° at the dorsal cortex of the tibia seems to be excessive. However, an analysis of 100 Sawbone® preparations made by inexperienced surgeons showed that a sagittal saw cut of more than 8mm (10°) was made in 3% of cases. The results of our study do not represent in vivo situations, as in vivo the muscles would exert an influence on the fracture load and the stabilizing effect of the soft tissues is missing.

Surgeons need to be aware of the risk of extended sagittal saw cuts and their sequelae. Due to the demanding operation technique for UKA, surgeons should receive appropriate training to minimize their learning curve, as surgical errors become less frequent with experience and time.