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

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ABSTRACT

Periprosthetic tibial plateau fractures (TPF) are rare but represent a serious complication of unicompartmental knee arthroplasty (UKA). As TPFs usually occur perioperatively, these can be associated with extended sagittal saw cuts during surgery. The aim of the study was to evaluate TPF as a function of extended sagittal saw cuts. The hypothesis was that extended sagittal saw cuts reduce the loading capacity of the tibial plateau and increase the risk of periprosthetic TPF.

In a randomised study, standardised cemented Oxford UKA tibial component implantation was performed in six matched, paired fresh-frozen tibiae. In group A, a regular preparation of the tibial plateau was performed, whereas in group B a standardised extended sagittal saw cut was made at the dorsal cortex of the tibia. All tibiae were fractured under standardised conditions and fracture patterns and fracture loads were analysed. In group A, tibiae fractured with a mean load of $F_{max}=3.9$ (2.3–8.5) kN, whereas in group B fractures occurred at a mean load of $F_{max}=2.6$ (1.1–5.0) kN. The difference was statistically significant ($p<0.05$).

Extended sagittal saw cuts in UKA weaken the tibial bone structure. Our results show that descendent extended sagittal saw cuts of 10° reduce fracture loads by about 30%. Surgeons should be aware of the potential pitfalls of an extended sagittal saw cut, as this can lead to reduced loading capacity of the tibial plateau and increase the risk of periprosthetic TPF.

1. Introduction

Unicompartmental knee arthroplasty (UKA) is a common surgical treatment option for medial osteoarthritis (OA) of the knee. The main indication is anteromedial OA with intact ligaments and a correctable varus deformity. Inflammatory arthritis and an absent or severely damaged anterior cruciate ligament are contraindications. Good functional and clinical results have been reported in the literature and excellent long-term results can be achieved [1].

UKAs constitute 8.2% of all knee arthroplasties performed in Sweden and 9.7% of all performed in Australia [2,3]. In the US the percentage of UKAs performed has increased from 2.5% to 8.1% (1998–2005) [4].

The increasing number of UKAs is associated with an increased prevalence of periprosthetic tibial plateau fractures (TPF) [5,6]. The New Zealand National Joint Registry states an incidence of 0.2% but figures up to 5% have been reported [7].

As TPFs usually occur perioperatively, these may be associated with intraoperative surgical errors [8]. For example, extended sagittal saw cuts could weaken the dorsal cortex at the dorsal tibia resulting in a TPF [9].

The aim of the study was to evaluate TPF as a function of extended sagittal saw cuts. We hypothesized that extended sagittal saw cuts reduce the loading capacity of the tibial plateau thereby increasing the risk of periprosthetic TPF.

2. Materials and methods

The following study protocol was approved by the institutional university review board, was accepted by the local ethics committee and complied with the principles laid down in the Declaration of Helsinki in 2004 (ISO 9001: 2000).

2.1. Specimens included

Six matched pairs of human fresh-frozen tibiae were used. Donor data such as age, gender, body height, body weight and BMI are shown in Table 1.

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/m. Bone density measurement was performed (QDR-2000 DXA-Densitometer, Hologic Inc. Waltham, USA) at six different regions of interest and netAVG according to Tsuji et al. [10].

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Table 1
Epidemiology of tibia specimens.

N°	Age	Sex	BW [kg]	Length [m]	BMI	Tibial size
1	86	F	40.8	1.45	19.4	B
2	47	M	108.9	1.85	31.8	F
3	90	M	65.8	1.73	22.0	D
4	92	M	49.4	1.68	17.5	C
5	83	F	32.7	1.50	14.5	B
6	89	M	72.6	1.68	25.7	C
Mean	81	4:2	61.7	1.65	21.8	
SD	17		27.5	0.15	6.2	
Min	47		32.7	1.45	14.5	
Max	92		108.9	1.85	31.8	

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 (M.C.). Oxford III UKA was used.

2.2. Surgical procedure

An extramedullar tibial alignment jig was fixed to the anterior aspect of the tibia with two pins as described in the surgical manual (Oxford unicompartmental Uni Knee, Biomet®). The instrumentation aims for a posterior slope of 7°. The sagittal tibial cut was performed using a sagittal blade (Synvasive® Technology Inc, El Dorado Hills, USA). In a second step the tibial plateau was resected horizontally with a reciprocating blade of 12 mm (11-2326: Synvasive® Technology Inc, El Dorado Hills, USA). The thickness of the bone removed from the tibia was measured prior to the resection to ensure the same resection height and the resected plateau was measured for thickness. Dependent on the size of the tibial plateau, different tibial components (sizes B–F) were used for implantation (Table 2). In all pairs the same tibial size was used for both tibiae. For final preparation of the tibial plateau, a template was inserted and the keel slot was prepared with a special keel cut blade along both sides of the slot. The remaining bone between the cuts was removed using a special pick.

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 (Fig. 1). The depths of the defects at the dorsal cortex of tibia varied between 8.0 and 10.7 mm (Table 2). A specially developed fixation device (Fig. 2) was placed to ensure the calculated depths of the sagittal saw cut and a digital caliper (Wiha DialMax ESD, Wiha, Schonach, Germany) was used to check this depth.

After jet lavage had been performed, the keel slot was dried and filled with bone cement (Refobacin bone cement R, Biomet, Bridgend, UK®). A thin layer of cement was spread over the tibial surface and the cemented tibial component was implanted. In accordance with the surgical manual the implant was pressurized until the cement cured.

2.3. Experimental set-up

The distal tibia was removed leaving 20 cm distal to the tibial plateau. The tibial slope of each specimen was measured three times

Table 2
10° of extended vertical saw cuts corresponding to the length of the tibial component.

Length of tibial component [mm]	Length of sawing defect [mm]
A = 45.38	8.0
B = 48.58	8.6
C = 51.79	9.1
D = 55.00	9.7
E = 58.20	10.3
F = 60.90	10.7

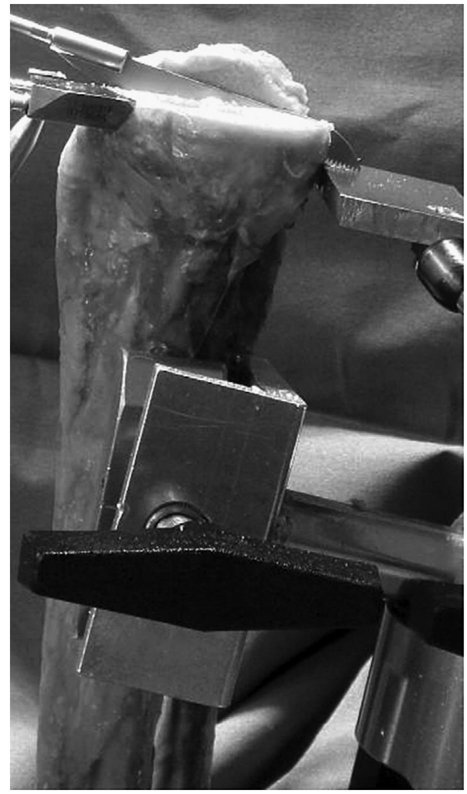

Fig. 1. Extended sagittal cut of 10° at dorsal cortex of tibia.

with a goniometer by an experienced surgeon before and after inducing the fractures.

The specimens were moulded into a metal base fixture frame using polyurethane (Rencast FC53 Polyol, Huntsman, Everberg, Belgium)

Fig. 2. Measurement of extended sagittal cut of 10° with a digital caliper.