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Fixed Flexion Deformity After Unicompartmental Knee Arthroplasty: How Much Is Too Much

Jerry Yongqiang Chen, MBBS, MRCS (Edin) *, Bryan Loh, MBBS, Yew Lok Woo, MBBS, MRCS (Edin), Shi-Lu Chia, MBBS, FRCS (Edin), PhD, Ngai Nung Lo, MBBS, FRCS (Edin), FAMS, Seng Jin Yeo, MBBS, FRCS (Edin), FAMS

Department of Orthopaedic Surgery, Singapore General Hospital, Singapore, Singapore

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A B S T R A C T

Background: The detrimental impact of postoperative fixed flexion deformity (FFD) after unicompartmental knee arthroplasty (UKA) is manifold. This study aims to define the amount of postoperative FFD that is clinically relevant after UKA.
Methods: Between 2005 and 2012, 803 patients who underwent a primary UKA at a tertiary hospital were prospectively followed up. They were categorized into 3 groups based on the amount of postoperative FFD: (1) 0° (control); (2) 1°-10° (mild FFD); and (3) >10° (severe FFD).
Results: There were 26 patients (3%) with severe FFD at 2 years after UKA. The Knee Society Function Score and Knee Score in the severe FFD group were 10 ± 4 and 10 ± 2 points lower than in the control group, respectively ($P = .017$ and $P = .001$). Similarly, the Oxford Knee Score and Physical Component Score in the severe FFD group was 5 ± 1 and 7 ± 2 points lower than in the control group, respectively ($P = .033$ and $P < .001$).
Conclusion: This study suggests that postoperative FFD of >10° after UKA is associated with significantly poorer functional outcomes.

The detrimental impact of postoperative fixed flexion deformity (FFD) after unicompartmental knee arthroplasty (UKA) is manifold. First, the clinical consequence of FFD is that the quadriceps has to be in continuous contraction to support the knee so as to avoid buckling, resulting in greater energy expenditure and fatigue. Perry et al [1] found that an FFD of 15° increased the quadriceps contraction force by 22% during weight-bearing; as the FFD increased to 30°, the quadriceps had to contract with 50% more force.

Second, the increased force generated by the quadriceps muscle is directed onto the patellofemoral joint and the posterior half of the tibial plateau [1-3]. Excessive loading of the patellofemoral joint causes anterior knee pain, whereas abnormal loading of the posterior half of the tibial plateau is detrimental to implant survival [1].

Third, gait studies have shown that walking velocity decreases in a linear manner with an FFD between 15° and 20°. An FFD of 20° also significantly increases the energy cost of walking [4].

Despite the importance of knee extension to functional outcomes, the majority of studies on the range of motion (ROM) after UKA have focused on knee flexion [5-8]. There is a lack of literature recommending the amount of postoperative FFD that is clinically relevant after UKA.

This study aims to define the amount of postoperative FFD that is clinically relevant after UKA. The authors hypothesize that a postoperative FFD of >10° after UKA is associated with poorer functional outcome and quality of life.

Materials and Methods

This study was approved by the institution's ethics committee (CIRB: 2015/2634) and carried out in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki. Informed consent was obtained from the patients.

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* Reprint requests: Jerry Yongqiang Chen, MBBS, MRCS (Edin), Department of Orthopaedic Surgery, Singapore General Hospital, Outram Road, Academia Building Level 4, Singapore 119228.

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Between 2005 and 2012, 894 patients diagnosed with medial compartment osteoarthritis of the knee who underwent a primary UKA at a single tertiary hospital were included in this study. Patients with previous knee joint surgery were excluded. At the authors' institution, medial UKA was indicated for patients with unicompartmental osteoarthritis who (1) had isolated medial joint line pain; (2) had good range of movement with >90° of flexion; (3) had no joint instability; and (4) had <10° of varus malalignment [9-11].

All surgeries were performed using the subvastus quadriceps sparing approach with patella subluxation under a tourniquet. The surgical aim was to achieve an equal flexion-extension gap. All patients received fixed-bearing UKA implants.

Postoperatively, all the patients completed the institution's standard postoperative physiotherapy protocol. On postoperative day (POD) 1, this protocol included self-assisted passive knee ROM exercises, static isometric quadriceps exercises with the knee in extension, standing, and ambulating with an assistive device as per pain tolerance, continuous passive motion (CPM), and cryotherapy to the operated knee. On POD 2, patients were asked to repeat POD 1 ROM and muscle strengthening exercises but increasing the number of repetitions to 20, increase ambulatory distance to ≥15 m, begin stairs climbing training, as well as CPM and cryotherapy to the operated knee. From POD 3 onward till discharge, the rehabilitation consisted of repeat POD 2 ROM and muscle strengthening exercises, further increase ambulatory distance and stair climbing training, as well as CPM and cryotherapy to the operated knee.

Preoperative and postoperative weight-bearing knee anteroposterior radiographs were taken for all patients. An independent orthopedic resident measured the tibiofemoral angle (TFA) using picture archiving and communication systems, which have higher interrater and intrarater reliability than using hard-copy radiographs [12].

An independent health care professional assessed the patients preoperatively and at 2 years after UKA. The amount of FFD in the knee was measured using an analog transparent plastic goniometer on the lateral aspect of the leg, with the patients in supine position. For the 2 arms of the goniometer, the line formed between the greater trochanter and the lateral epicondyle represented the reference line for the femur, whereas the line formed between the lateral condyle and the lateral malleolus represented the reference line for the tibia. This technique of measurement had excellent intrarater reliability with intraclass correlation coefficients value of between 0.953 and 0.997 [13,14]. Measurements were recorded to the nearest degree (°).

The functional outcome score collected used the Knee Society Score [15] and Oxford Knee Score (OKS) [16] as knee-specific outcome measures. A 200-point scoring system developed by the Knee Society was used: 100 points for Knee Society Function Score (KSFS) and 100 points for Knee Society Knee Score (KSKS). The original OKS devised by Dawson et al [16] used a questionnaire comprising of 12 items on daily activities, which the patient must answer without help from health care personnel. Each item was scored from 1 to 5, with 1 representing best outcome/least symptoms. Scores from each item were subsequently added to obtain the global score ranging from 12 to 60 with 12 being the best outcome.

The quality of life of patients was assessed with the use of SF-36 (Medical Outcomes Trust, Hanover, NH) [17], which consisted of 8 subscales: physical functioning, physical role, bodily pain, general health, vitality, social functioning, emotional role, and mental health. Summary scores were developed to aggregate the most highly correlated subscales and simplify analyses without substantial loss of information. In this study, the medical outcome study approach proposed by Ware et al [18] was used to derive 2 higher-order summary scores: Physical Component Score (PCS) and Mental Component Score (MCS). These 2 summary scores were found to account for between 80% and 85% of the reliable variance of the standard 8 subscales. They have good validity in discriminating among clinically meaningful groups, as well as high internal consistency and test-retest reliability estimates when used in a general population [18,19].

Power analysis was performed before the conduct of this study. To detect a minimal clinically important difference (MCID) of 5 points in OKS from a baseline score of 18 with standard deviation of 5, a sample size of at least 23 patients in each group would be required to achieve a power of 0.95 [20]. This calculation was done for a 1-sided test with a type I error of 0.05.

Statistical analysis was carried out in consultation with the in-house biostatistician, using SPSS 19.0 (IBM, Armonk, NY). Statistical significance was defined as a P value of ≤.05. Sequential analysis was carried out based on postoperative FFD at 1° intervals. The authors started from a postoperative FFD of 5° and increasing at 1° intervals, until there was a difference of at least 5 points in both OKS and PCS between the groups. There were 91 patients with postoperative recurvatum. The remaining 803 patients were categorized into 3 groups based on the amount of postoperative FFD: (1) 0° (control); (2) 1°-10° (mild FFD); and (3) >10° (severe FFD).

The 1-way ANOVA with Bonferroni post hoc test was used to compare the 3 groups for quantitative variables including age, body mass index, TFA, knee extension, KSFS, KSKS, OKS, PCS, and MCS, whereas the Pearson chi-square test was used for qualitative variable such as gender. The Pearson correlation coefficient was calculated to explore the relationship between preoperative and postoperative FFD after UKA.

Additional statistical analysis was performed to evaluate if the preoperative FFD of >10° influenced the postoperative functional outcome and quality of life of patients at 2 years after UKA. After excluding 66 patients with preoperative recurvatum, the remaining 828 patients were recategorized into 3 groups based on the amount of preoperative FFD: (1) 0° (preoperative control); (2) 1°-10° (preoperative mild FFD); and (3) >10° (preoperative severe FFD).

Results

There were 301 patients in the control group, 476 patients in the mild FFD group, and 26 patients (3%) in the severe FFD group. There was no difference in age, body mass index, and gender between the 3 groups. Similarly, the mean preoperative and postoperative TFAs measured were comparable among the 3 groups (Table 1).

The mean preoperative FFD in the severe FFD group was 8 ± 1° more than in the control group ($P < .001$) and 5 ± 1° more than in the mild FFD group ($P < .001$). The mean FFD at 2 years in the severe FFD group was 14 ± 1° more than in the control group ($P < .001$) and 9 ± 1° more than in the mild FFD group ($P < .001$; Table 1).

Table 1
Patient Demographics.

	Control (n = 301)	Mild FFD (n = 476)	Severe FFD (n = 26)	P Value
Age (y)	62 ± 8	63 ± 8	63 ± 9	.888
BMI (kg/m^2)	27.3 ± 4.8	27.2 ± 4.3	27.7 ± 4.2	.851
Gender (M:F)	72:229	131:345	4:22	.251
TFA (°)				
Preoperative	3.4 ± 2.8	3.1 ± 2.5	3.1 ± 1.5	.387
Postoperative	5.0 ± 2.9	5.0 ± 2.9	6.3 ± 4.1	.108
FFD in knee (°)				
Preoperative	3 ± 5	6 ± 6	11 ± 7	<.001
Postoperative	0	5 ± 2	14 ± 2	<.001

FFD, fixed flexion deformity; BMI, body mass index; TFA, tibiofemoral angle.