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### **► To cite this version:**

Sophie Putman, Matthieu Ehlinger, Bruno Tillie, Benjamin Puliero, Nassima Ramdane, et al.. Total knee replacement on more than 20° valgus: A case control study. *Orthopaedics & Traumatology: Surgery & Research*, 2019, 105, pp.613 - 617. <10.1016/j.otsr.2018.12.014>. <hal-03484741>

**HAL Id: hal-03484741**

**<https://hal.science/hal-03484741v1>**

Submitted on 20 Dec 2021

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*Original article*

# Total knee replacement on more than 20° valgus: a case-control study

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## **Abstract**

### **Introduction**

Lower-limb valgus deformity exceeding 20° is a particular case, with few publications assessing the impact of the severity of the valgus. The present retrospective case-control study compared a series of >20° valgus versus a series of 10-20° valgus, assessing 1) operative data (approach, type of total knee replacement (TKR)), 2) complications and implant survival, and 3) clinical and radiological results.

### **Hypothesis**

Severe valgus deformity requires TKR with greater constraint, incurring a higher rate of complications and poorer implant survival.

### **Material and Method**

A multicenter retrospective study for the period January 2006 to December 2010 included 53 patients, with a mean age of  $72 \pm 10$  years, presenting >20° valgus. The study series was matched for age and gender with a series of 53 cases of 10-20° valgus. Convexity laxity was greater in the >20° group ( $p=0.004$ ).

### **Results**

There was no significant inter-group difference in approach ( $p=0.13$ ). Greater constraint was more frequent in the >20° group (7/53 versus 1/53;  $p=0.03$ ), independently of convexity laxity or Krackow grade ( $p=0.14$ ).

There were 7 complications (13.2%) in the >20° group and 7 in the 10-20° group (NS).

Eight-year survivorship was 95.12% in the >20° group and 94.9% in the 10-20° group ( $p=0.63$ ).

There were no significant differences in Oxford score ( $p=0.30$ ) or HKA angle ( $p=0.78$ ) at last follow-up.

### **Conclusion**

The study hypothesis was partially confirmed: greater constraint was more frequent in >20° valgus. The number of complications was low, and survival was identical to that of a control group with less severe deformity.

**Level of evidence:** III, retrospective case-control study

**Key-words:** knee prosthesis, valgus knee, complication, constrained prosthesis

## 1. Introduction

Total knee replacement (TKR) is a reliable and reproducible procedure, showing >90% 10-year survivorship [1-9]. Deformities are sometimes severe, and it is consensual that TKR in severe valgus is complicated, but that results are satisfactory and similar to those in minor deformity [10,11].

Few reports have focused on severe deformity, whether in varus [10-15] or valgus [10,11], and the latter combined both valgus and varus, hindering analysis and interpretation of the results. Deformities exceeding 20° are a special case, rarely encountered, for which high-constraint implants are often recommended [15]. The surgical approach is also a matter of discussion, and can entail skin problems.

Few series concerned >20° valgus with a control group not of varus or normal alignment but of less severe valgus. The present retrospective case-control study comparing >20° valgus versus 10-20° valgus aimed to assess 1) operative data (approach, implant constraint), 2) complications and implant survival, and 3) clinical and radiological data. The study hypothesis was that severe valgus deformity requires greater implant constraint, entailing a greater rate of complications and lower survivorship.

## 2. Materials and Methods

### 2.1 Study design

A multicenter retrospective study was conducted in 17 public and private sector hospitals under the aegis of the French Society of Hip and Knee Surgery (SFHG). The inclusion period was January 2006 to December 2010, allowing a minimum 5 years' and maximum 10 years' follow-up so as to limit incomplete records.

### 2.2 Patients

557 patients with valgus knee exceeding 10° received TKR.

53 patients (8 male, 45 female; mean age, 72 ± 10 years; mean body-mass index (BMI), 28 ± 4.5 [range, 18-37]) had >20° valgus, and were matched for age, gender and BMI to a control group of 53 patients with 10-20° valgus.

The two groups were comparable for age, gender, BMI, Devane activity score and IKS pain score. They differed on IKS knee and function scores, Krackow classification [16], and convexity laxity (Table 1).

## **2.3 Assessment methods**

Operative data comprised: medial or lateral approach, any ligament release, associated extensor system procedures, type of implant, and complications. TKR was classified as: PCL-retaining (CR), ultracongruent (UC), posterior stabilized (PS), constrained condylar knee (CCK) or hinged.

Data at last follow-up comprised: preoperative scores, and Oxford-12 score [19]. Radiographic assessment on full long-leg view was identical to the preoperative assessment. Any progressive radiolucency exceeding 2 mm, osteolysis or wear were noted.

Postoperative complications were noted as early (first 3 months) or late (>3 months). Survival was defined as TKR present at follow-up without revision of any component.

## **2.4 Statistical analysis**

Data were analyzed on SAS software, version 9.4 (SAS Institute Inc., Cary, NC, USA). Qualitative variables were reported as number and percentage and quantitative variables as mean, standard deviation and range. Normal distribution was checked graphically and on Shapiro-Wilk test.

To avoid exclusion of cases from matched analysis due to missing data, simple imputation was applied using regression switching (chained equation with  $m = 1$ ), using all preoperative parameters. This enabled case-control matching on gender, age (to within 5 years) and BMI (to within 3 points). Quantitative variables were compared between groups on Student test for matched variables or Wilcoxon signed ranks test, and qualitative variables on McNemar test. Pre- to post-operative progression within groups was analyzed on Student test for matched variables or Wilcoxon signed ranks test. Survivorship was estimated following Kaplan-Meier. Associations between implant survival and qualitative variables were analyzed on log-rank test, and by Cox model for quantitative variables. The significance threshold was set at 5%.

## **3. Results**

### **3.1 Operative data**

#### **Approach**

There was no significant inter-group difference in approach ( $p=0.43$ ). With the numbers available, no difference in complications according to associated anterior tibial tubercle (ATT) osteotomy was found (3 complications for 30 osteotomies).

## Type of TKR

Higher constraint was more frequent in the  $>20^\circ$  group ( $p=0.03$ ). The rate of high-constraint implants did not differ according to whether convexity laxity was zero ( $n=3$ ),  $<5^\circ$  ( $n=3$ ),  $5-10^\circ$  ( $n=3$ ) or  $>10^\circ$  ( $n=3$ ), or according to Krackow classification ( $p=0.14$ ).

## 3.2 Complications and survival

Four patients in each group had died by last follow-up, of causes unrelated to TKR.

There were 7 complications (1 early, 6 late) in the  $>20^\circ$  group and 7 (3 early, 4 late) in the  $10-20^\circ$  group (on-line [Appendix 1](#)). Relative risk of complications was identical in both groups: HR, 0.460 [0.134-1.583].

Eight-year survivorship was 95.12% (95% CI, 81.4 – 98.8) in the  $>20^\circ$  group, and 94.9% in the  $10-20^\circ$  group ( $p=0.63$ ).

## 3.3 Clinical and radiological results

IKS scores improved significantly after TKR ([Table 3](#)). The  $>20^\circ$  group showed poorer clinical results than the  $10-20^\circ$  group on IKS knee score ( $p=0.024$ ) and function score ( $p=0.012$ ) and flexion (0.0046), but these values had been poorer preoperatively. There was no significant difference in Oxford score at last follow-up ( $p=0.30$ ).

HKA angle showed improvement over preoperative values in both groups:  $180.8^\circ \pm 2.8^\circ$  [range,  $172-189^\circ$ ] at last follow-up in the  $>20^\circ$  group, and  $180.6^\circ \pm 2.3^\circ$  [ $176-186^\circ$ ] in the  $10-20^\circ$  group, with no significant difference ( $p=0.78$ ).

## 4. Discussion

The present study found that valgus deformity exceeding  $20^\circ$  required more frequent high-constraint TKR, but did not incur more complications or affect implant survival as compared to a control group with  $10-20^\circ$  valgus. The study hypothesis was thus partially confirmed.

Various approaches have been described for valgus deformity [[20-24](#)], and notably a lateral approach in severe valgus, often associated to tibial tubercle osteotomy. In the present series,

the approach was medial or lateral, whatever the implant, and proved unrelated to the rate of complications, as already suggested by Gunst et al. [25]. Tibial tubercle osteotomy is often thought to increase the risk of complications [26], but did not alter the present results.

On the other hand,  $>20^\circ$  valgus was independently associated with more frequent high constraint;  $>20^\circ$  valgus was indeed also associated with greater convexity laxity, but this factor was not itself associated with choice of implant. According to Girard et al. [15], in valgus exceeding  $5^\circ$ , valgus laxity was the only factor associated with higher constraint on multivariate analysis. It thus seems difficult to clearly identify risk factors.

There were few complications in the present series. Patellar complications are commonly reported in valgus deformity [27]. In the present series, however, there was only 1 case of late patellar instability, in the  $>20^\circ$  group. The literature on implant survival in severe deformity is sparse (Table 4). Ritter et al. [11] compared cases of severe varus and valgus versus a control group with milder deformity. Ten-year survivorship in series of TKR for all deformities is greater than 90%: Rand et al. [4] reported 91%, Argenson et al. [9] 92% and Sundberg et al. [7] 97% in the Swedish register. The present series of severe valgus likewise showed more than 90% 8-year survivorship, suggesting that severity does not impact implant survival.

Ritter et al. [11] reported no significant difference in clinical scores between  $>20^\circ$  and  $<5^\circ$  deformity, suggesting that the severity of initial deformity does not impact results, in contrast to the findings of Teeny et al. [10] for  $>20^\circ$  varus. In the present series, certain scores were poorer in the  $>20^\circ$  group, but these patients had lower baseline scores and actually showed significant improvement.

The present study had certain limitations. 1) The design was retrospective; however, such severe deformity is too rare to allow prospective assessment. 2) The design was also multicenter, with a variety of TKR techniques; this, however, corresponds to average clinical activity. 3) The participating surgeons varied in their experience; this, however, only strengthens the external validity of the conclusions. 4) The series was not continuous and, despite all effort, some cases were doubtless not included, as it is difficult to identify these severe deformities without a dedicated data-base; however, the inclusion period was limited and follow-up was not too long, so that implant survival rates were not biased by patient mortality. A minimum 5 years' follow-up is, moreover, considered sufficient to screen for risk factors for failure.

## **5. Conclusion**

High-constraint implants were used in 20% of cases, although no associated factors could be identified. The choice of surgical approach was at the surgeon's discretion, and did not affect the rate of complications. The complications rate in  $>20^\circ$  valgus was low and identical to that in less severe deformity, with implant survival exceeding 95%.

## **Acknowledgments**

We thank all the centers that contributed data: Amiens, Arras, Berck-Calot, Clermont-Ferrand, Grenoble, Lille, Marseille, Montélimar, Rennes, Rouen, Strasbourg, St Étienne, Arras, St Omer, Toulouse, Antilles and Limoges, and the SFHG.

We thank personally the symposium members and their teams for involvement in the study: J.L. Rouvillain, C. Mabit, B. Boyer, M. Ehlinger, D. Hutten, B. Rubens-Duval, S. Descamps, A. Cazenave, A. Gabrion, T. Gaillard, T. Jouanin, R. Bouchet, P. Bizzozéro, B. Boyer, H. Common, J. Zalahoui, J Taviaux, J. Murgier, R. Pailhé, and J.L. Briard.

Conflicts of interest: None of the authors have conflicts of interest to disclose in relation to the present study. Outside the study, SP is a consultant for Corin; ME is a consultant for Depuy-Synthes, Newclip and Lepine and associate editor for the SoFCOT Instructional Courses; FR is a consultant for Zimmer/Biomet; GP is a consultant for Zimmer/Biomet.

Funding: none

Author contributions:

SP: article writing and data collection; ME: article writing and data collection; BP: data collection; BT: data collection; NR: statistical analysis; FR: data collection; GP: article writing and data collection.



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Table 1: Preoperative data for the two series

Preoperative data	Valgus >20°	Valgus 10-20°	p-value
Devane activity grade			0.20
n (%) [17]			
Grade 1	8 (15.1%)	4 (7.6%)	
Grade 2	26 (49.1%)	23 (43.4%)	
Grade 3	13 (24.5%)	20 (37.7%)	
Grade 4	5 (9.4%)	6 (11.3%)	
Grade 5	1 (1.9%)	0 (0.0%)	
Mean ± SD [range]			
IKS pain [18]	10.2 ± 8.9 [0-30]	13.3 ± 11.3[0-45]	0.10
IKS knee [18]	22.5 ± 15.9 [0-63]	33.4 ± 17.9 [0-80]	0.0012
IKS function [18]	40.4 ± 21.6 [0-90]	48.7 ± 20.1 [0-90]	0.0342
Flexion	105.9 ± 16.9 [50-30]	114.4 ± 16.3 [60-140]	0.0046
HKA angle	203.6 ± 4.0 [201-215]	191.8 ± 1.2 [190-194]	-
Femoral angle	98.0 ± 4.0 [91-111]	96.0 ± 3.3 [89-103]	0.0107
Tibial angle	96.5 ± 5.7 [90-116]	91.5 ± 3.8 [79-105]	<0.0001
Tibial slope	8.3 ± 5.7 [-10-20]	6.7 ± 3.7 [-3-18]	0.08
Krackow classification			0.001
n (%)			
Type 1	15 (28.3%)	45 (85%)	
Type 2	32 (60.4%)	4 (7.5%)	
Type 3	6 (11.4%)	4 (7.5%)	
Convexity laxity			0.004
n (%)			
zero	9 (17%)	23 (43.4%)	
< 5°	16 (30.2%)	21 (39.6%)	
5-10°	25 (47.2%)	7 (13.2%)	
>10°	3 (5.6%)	2 (3.8%)	

Table 2: Approach and TKR type

Operative results	Valgus >20°	Valgus 10- 20°	p- value
<p>Approach n (%)</p> <p>Lateral - with ATT osteotomy</p> <p>Medial -mid-vastus -transquadricipital -sub-vastus</p>	<p>32 (60.4%) 21 (39.6%)</p> <p>21 (39.6%) 8 (15.1%) 13 (24.5%) 0 (0%)</p>	<p>24 (45.3%) 9 (17%)</p> <p>29 (54.7%) 6 (11.4%) 22 (41.5%) 1 (1.8%)</p>	0.43
<p>Type of TKR n (%)</p> <p>-posterior-stabilized - ultra-congruent -cruciate ligament-sparing -CCK -hinged</p>	<p>21 (39.6%) 13 (24.5%) 8 (15.1%) 4 (7.6%) 7 (13.2%)</p>	<p>30 (56.6%) 16 (30.2%) 6 (11.4%) 0 (0%) 1 (1.8%)</p>	0.03

Table 3: Postoperative results in the two series

Postoperative results	Valgus >20°	Valgus 10-20°	p-value
Devane activity grade			0.77
n (%) [17]			
Grade 1	7 (13.5%)	6 (12.8%)	
Grade 2	21 (40.4%)	17 (36.2%)	
Grade 3	15 (28.9%)	14 (29.8%)	
Grade 4	9 (17.3%)	10 (21.3%)	
Mean ± SD [range]			
IKS pain [18]	43.4 ± 10.2 [10-50]	44.3 ± 11.3 [10-50]	0.23
IKS knee [18]	83.3 ± 19.7 [0-100]	87.5 ± 21.0 [10-100]	0.0244
IKS function [18]	60.1 ± 27.5 [0-100]	73.4 ± 24.8 [20-100]	0.0126
Flexion	112.9 ± 16.7 [40-135]	120.6 ± 11.4 [90-140]	0.0024
HKA angle	180.8 ± 2.8 [172-189]	180.6 ± 2.3 [176-186]	0.78
Femoral angle	90.6 ± 1.4 [88-94]	90.6 ± 1.6 [86-94]	0.80
Tibial angle	90.3 ± 1.6 [86-94]	89.9 ± 1.8 [85-96]	0.12
Tibial slope	2.4 ± 4.1 [-6-12]	4.7 ± 3.7 [-3-13]	0.0094
Oxford score [20]	33.6 ± 10.4 [8-45]	37.9 ± 10.5 [9-48]	0.30

**Table 4: Main literature series on severe deformity**

<i>Series</i>	<i>Number</i>	<i>Type of deformity</i>	<i>Comparative study?</i>	<i>Survival</i>	<i>Follow-up (years)</i>	<i>Results</i>
<i>Teeny et al. [12]</i>	27	Varus >20°	Yes (vs. “non-significant deformity”)	ND	4.9	Knee Evaluation Score = 89 points Significantly poorer than in controls
<i>Karachalios et al. [10]</i>	51	Varus and valgus >20°	Yes (vs. <5° deformity)	ND	5.5	Bristol Knee Score = 81 points Equivalent clinical results
<i>Ritter et al. [11]</i>	82	Varus and valgus >20°	Yes (vs. <5° varus/valgus)	98%	6 .5	IKS knee = 87.8 points No significant difference between > 20° and < 5° groups
<i>Mullaji et al. [13]</i>	173	Varus >20°	No	96%	2.6	IKS global = 163.2 points IKS knee= 91.1 points IKS function = 72.1 points
<i>Kim et al. [14]</i>	50	Varus >20°	Yes (vs. <20° varus)	100%	1	IKS global = 174.3 points IKS knee= 93.3 points IKS function = 81 points No difference in clinical scores or alignment
<i>Czekaj et al. [28]</i>	170	Varus >10 and valgus >10°	No	98%	5-12	10-year survival >98% with non-constrained implants
<i>Present series</i>	53	Valgus >20°	No	95.12%	8	

ND: no data