



## Patellar Height Decreasing After Distal Femur Endoprosthesis Reconstruction Does Not Affect Functional Outcome



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### ABSTRACT

**Introduction:** The patellar height can influence extensor mechanism and the knee function. Thus, during knee arthroplasty, the surgeon seeks to maintain the correct patellar height. However, it is more difficult to define and maintain the correct patella height in megaprosthesis reconstructions after tumor resections. The objective of this study was to evaluate patellar height after distal femur endoprosthesis reconstruction and its association to knee function.

**Methods:** This retrospective analysis included 108 patients who underwent distal femur resections and endoprosthesis reconstruction. The minimum follow-up was 1 year or until the patients underwent patellar resurfacing or endoprosthesis revision. Patellar height was calculated using Insall-Salvati ratio (ISR) and Insall-Salvati patellar tendon insertion ratio (PTR) at 2 different times: postoperatively and at the final follow-up. The postoperative ratio was calculated using the best postoperative radiograph taken at least 1 month after the procedure. The final measures were based on the radiograph available at the last follow-up consultation. The ISR and PTR were associated to anterior knee pain (AKP), range of motion (ROM), and extension lag (EXL).

**Results:** The average follow-up was 4.5 years. The mean postoperative ISR was 1.02, and the mean ISR at final follow-up was 0.95 ( $P < .0001$ ). The mean postoperative PTR was 1.45, and the mean PTR at final follow-up was 1.40 ( $P = .016$ ). There was no association between patellar height and AKP, ROM, and EXL. Patellar height decreases significantly after distal femur resections but does not affect AKP, ROM, and EXL.

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### Background

Change in patellar height has been noted after knee arthroplasty [1]. The patellar height can influence extensor mechanism and the knee function [2]. Thus, during knee arthroplasty, the surgeon seeks to maintain the correct patellar height. However, it is difficult to define and maintain the correct patella height after megaprosthesis reconstruction after oncologic resections [3]. The endoprostheses used in the oncologic settings are constrained rotating hinge devices. The rotating hinge prostheses improve stability but produce a less physiologic movement, and this can affect the knee extensor mechanism. In addition, oncologic resections around the knee are more aggressive, for the amount of bone and soft tissue removed is extensive, which increases scar formation and can affect patellar height.

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Change in patellar height has been studied for proximal tibia tumor resections and endoprosthesis reconstruction. In these cases, over the time, the patella gradually migrates proximally and affects knee performance [4]. However, few studies analyze the outcome of patellar height and knee performance after distal femur resections and endoprosthesis reconstructions [3]. Postoperative change of patellar height and its consequences on knee function should be examined. The key parameters to be studied are anterior knee pain (AKP), range of motion (ROM), and extension lag (EXL). The purpose of this study is to evaluate how much the patellar height changes after distal femur endoprosthesis and what is the impact of these changes on AKP, ROM, and EXL.

### Materials and Methods

After an institutional review board approval was obtained, we retrospectively reviewed the medical record of patients who underwent distal femur resection and endoprosthesis reconstruction from 1993 to 2013 in our institution. We included patients with resurfaced and nonresurfaced patellas, at least 1-year follow-up or until they underwent patellar resurfacing or endoprosthesis revision. The

exclusion criteria were revisions, expansible prostheses, and associated amputation.

The patellar height was determined by the Insall-Salvati ratio (ISR) and Insall-Salvati patellar tendon insertion ratio (PTR) [5]. The ISR and PTR were collected 3 times: preoperatively, postoperatively, and at the final follow-up. The preoperative ratio calculation was based in the radiograph taken before the operation and was only to demonstrate that patellar height was between the normal ranges in this cohort. The postoperative ratio was calculated using the best postoperative radiograph taken at least 1 month after the procedure. The final measures were based in the radiograph available at the last follow-up.

Data regarding AKP, ROM, and EXL were collected at last follow-up. Pain was graded from 0, I, II, to III according to the criteria of Waters and Bentley [6]. However, to facilitate statistical analysis, only presence or absence of pain was considered.

Descriptive statistics were used to describe patient characteristics. For 2-sample comparison, *t* test and Fisher exact test were used for continuous and categorical data, respectively. Multivariate linear regression models were used to access the relationship among covariates and continuous score measurements such as the change in postoperative ISR and PTR, and logistic regression was used when the outcome variable is dichotomous, such as the AKP. Statistical significance level was set at 0.05. For all analyses, model assumptions are checked; log transformation was used as the appropriate method to reduce the skewness of data and satisfy modeling assumptions.

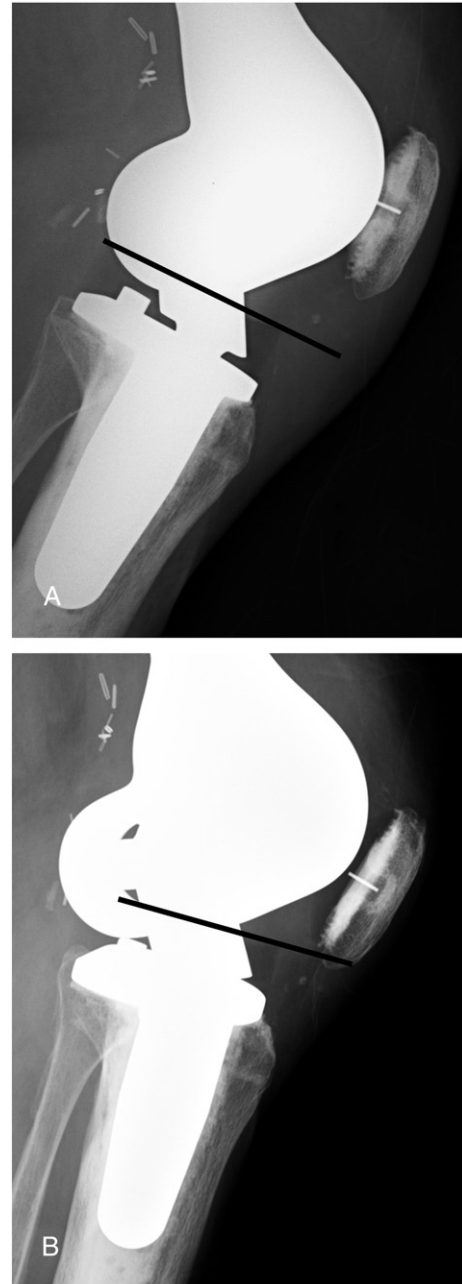
**Results**

A total of 108 patients who underwent distal femur resections and endoprosthesis reconstructions (Table 1) fit the inclusion criteria. The mean age was 34 years (range, 12-75 years). There were 54 men and 54 women. The procedures were performed to treat 81 primary malignant bone tumors, 15 metastases, 11 benign bone tumors, and 1 postradiation distal femur fracture. All the implants used were rotating hinge, and most of them were Finn (Biomet Manufacturing Corp, Warsaw, IN) or GMRS (Stryker Corp, Kalamazoo, MI). There were 60 nonresurfaced and 48 resurfaced patellas. The average follow-up was 4.5 years (range, 8 months to 20 years).

**Table 1**  
General Demographic Data, Functional Results, and Patellar Height.

Total No. of Patients		108		
Age (mean)		34 y		12-75 SD, 19 Median, 27
Sex	Female	54		
	Male	54		
Diagnosis	Malignant	81 (75%)		
	Benign	11 (10%)		
	Metastasis	15 (14%)		
	Nontumoral	1 (1%)		
Follow-up (mean)		4.5 y		Range, 8 mo to 20 y SD, 3.97 y
ROM (mean)		105°		Range, 25°-140° SD, 21.6
EXL (mean)		3°		Range, 0°-90° SD, 10.2
AKP	No	82 (76%)		
	Yes	26 (24%)		
ISR	Mean		SD	
	Preoperative	1.05	0.17	
	Postoperative	1.02	0.19	<i>P</i> < .0001
PTR	Mean		SD	
	Preoperative	2.00	0.49	
	Postoperative	1.45	0.36	<i>P</i> = .016
Final follow-up	ISR	0.95	0.21	
	PTR	1.40	0.34	

The preoperative patellar height ratios were obtained for 104 patients. Complete preoperative radiographs were unavailable in 4 patients. The mean preoperative ISR and PTR were 1.05 (SD, 0.17) and 2.00 (SD, 0.49), respectively. The mean postoperative ISR and PTR obtained for 108 patients were 1.02 (SD, 0.19) and 1.45 (SD, 0.36), respectively. The mean final follow-up ISR and PTR obtained for 108 patients were 0.95 (SD, 0.21) and 1.40 (SD, 0.34), respectively. The final follow-up ISR decreased significantly in relation to the postoperative ISR (*P* < .0001). The final follow-up PTR was also significantly lower than postoperative PTR (*P* = .016). (Table 1; Figs. 1 and 2). Considering only the postoperative and the final follow-up measures, the mean ISR and PTR decreased 7% and 3%, respectively.



**Fig. 1.** This 72-year-old woman underwent a distal femur resection and rotating hinge endoprosthesis reconstruction due to a chondrosarcoma. (A) Lateral knee radiograph made 3 months after the procedure. Note patella height in relation to the tibia plateau line. (B) Lateral knee radiograph made 6 years after the procedure. There is a marked decrease in patellar height. Despite of the evident patellar tendon shortening, the patient did not experience anterior knee pain and had 115° of flexion and no extension lag.

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