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## Intraoperative Flexion Against Gravity as an Indication of Ultimate Range of Motion in Individual Cases After Total Knee Arthroplasty

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**Abstract:** To assess a method of predicting the final postoperative flexion in individual cases after total knee arthroplasty, 364 primary posterior cruciate-retaining total knee arthroplasties were reviewed retrospectively. The knees were subdivided into three preoperative flexion groups—I: poor motion (0° to 85°), II: intermediate motion (90° to 110°), and III: good motion (115° to 140°). There were 302 cases of osteoarthritis and 62 rheumatoid knees (12 juvenile rheumatoid). Correlation was made between preoperative, intraoperative, and postoperative (minimum 2-year follow-up) passive knee flexion for individuals. Intraoperative flexion against gravity was measured after capsular closure by passively flexing the patient's hip 90° and allowing the weight of the lower leg to flex the knee joint. The overall mean value of postoperative flexion for all three groups was similar to preoperative and intraoperative flexion in both osteoarthritis and rheumatoid arthritis. In the poor motion group (I), postoperative flexion (103°) was increased over preoperative flexion (84°) but similar to intraoperative flexion (104°). In the intermediate group (II), postoperative flexion (110°) was similar to both the preoperative flexion (108°) and intraoperative flexion (110°). In the good group (III), postoperative flexion (119°) tended to be less than preoperative flexion (123°) and more than intraoperative flexion (116°), but the differences were not statistically significant. When comparing preoperative and intraoperative flexion to postoperative flexion for individual cases, 55% of knees had postoperative flexion  $\pm 10^\circ$  of their preoperative value, while 97% of knees had postoperative flexion  $\pm 10^\circ$  of their intraoperative value. This study indicates that the final postoperative mean flexion for a group of patients with poor preoperative flexion (<85°) and for individual cases (regardless of their preoperative mobility) can best be predicted by intraoperative flexion against gravity rather than by a preoperative value. **Key words:** range of motion, postoperative flexion, total knee arthroplasty.

Having a satisfactory range of motion is an important goal of total knee arthroplasty. Good motion after total knee replacement improves function such as the ascending and descending of stairs

(90°–100°) and arising easily from a low chair (at least 105°) [1,2]. Also the amount of flexion significantly influences the knee score and the walking ability score. Many factors that affect range of motion are known [3–20]:

1. Preoperative range of motion and preoperative quadriceps muscle tendon unit
2. Good surgical technique
3. Prosthesis type
4. Postoperative rehabilitation
5. Manipulation

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0883-5403/1305-0003\$3.00/0

Previous studies have shown a correlation between mean preoperative flexion and mean postoperative flexion after total knee replacement. All these reports, however, concern the comparison of group averages rather than individual cases.

The purpose of this study is to determine whether intraoperative flexion against gravity can also be used as a predictor of final range of motion (ROM) and to ascertain if there is less variability in ROM between intraoperative and postoperative motion than between preoperative and postoperative ROM in individual cases.

## Materials and Methods

Between October 1987 and December 1994, the 364 primary total knee arthroplasties (female: 247, male: 117) using a posterior cruciate-retaining condylar prosthesis in 304 patients were retrospectively reviewed to assess the significance of preoperative and intraoperative flexion in determining ultimate range of motion. The surgeries were done by one surgeon under epidural anesthesia in most cases. The epidural anesthesia was discontinued after 48 hours and oral analgesics were utilized. A continuous passive motion machine (CPM) was applied in the recovery room and set for 90° of flexion (or the patient's intraoperative flexion value if less than 90°). The CPM was utilized approximately 12 hours a day until discharge from the hospital at an average of 6 days after surgery. Patients were divided into two disease categories: osteoarthritis (302 cases) and rheumatoid arthritis (62 cases); and further subdivided into knees with three preoperative flexion categories—I: Poor (0° to 85°); II: Intermediate (90° to 110°); and III: Good (115° to 140°). All values of ROM, before, during, and after surgery (2 years) were also assessed in both disease groups. None of the knees required postoperative manipulation.

Correlation was made between preoperative, intraoperative, and postoperative passive knee flexion for individuals. All flexion measurements were passive supine values determined by one examiner using a standard goniometer and recording the value in 5° increments. Preoperative flexion was measured just before surgery. Intraoperative flexion against gravity was obtained after capsular closure by passively flexing the patients hip 90° and allowing the weight of the lower leg to flex the knee joint. Postoperative (ultimate) flexion was measured at a minimum 2-year follow-up examination [5,21,22]. Averages were calculated for each group and subgroup. Graphs were calculated to show the distribution of individual cases as they varied from the

**Table 1. Mean ROM of the Overall Index Group (n = 364)**

ROM	Preoperative	Intraoperative	Postoperative
Range	60-135	80-135	70-140
Mean	111 ± 13	112 ± 9	113 ± 11

predictive value of the preoperative and intraoperative flexion.

## Results

### Overall

The overall results include all three preoperative flexion categories and both disease categories.

The mean flexion for the entire group was 111° for preoperative flexion, 112° for intraoperative flexion, and 113° for postoperative flexion (Table 1). When separated into patients with osteoarthritis and rheumatoid arthritis, the overall values were 112°, 112°, and 112° for osteoarthritis 111°, 113°, and 113° for rheumatoid arthritis (Table 2).

### Subdivision into Preoperative Flexion Categories

The preoperative flexion categories are subdivided as follows—Poor: 0°-85°; Intermediate: 90°-110°; Good: 115°-140°.

In the Poor motion group (I), postoperative flexion (103°) was increased over preoperative flexion (84°) but similar to intraoperative flexion (104°). In the Intermediate motion group (II), postoperative flexion (110°) was similar to both the preoperative flexion (108°) and intraoperative flexion (110°). In the Good motion group (III), postoperative flexion (119°) tended to be less than preoperative flexion (123°) and more than intraoperative flexion (116°), but the differences were not statistically significant (Table 3) (chi-square test).

**Table 2. Mean ROM of the Osteoarthritic and Rheumatoid Group**

Flexion	Preop	Intraop	Postop
Osteoarthritis (n = 302)			
Mean	112 ± 12	112 ± 8	112 ± 11
Range	60-135	90-135	70-140
Rheumatoid arthritis (n = 62)			
Mean	111 ± 12	113 ± 8	113 ± 12
Range	60-130	90-135	75-140

**Table 3. Mean ROM of the Three Subgroups (Osteoarthritic and Rheumatoid Arthritis Groups Combined)**

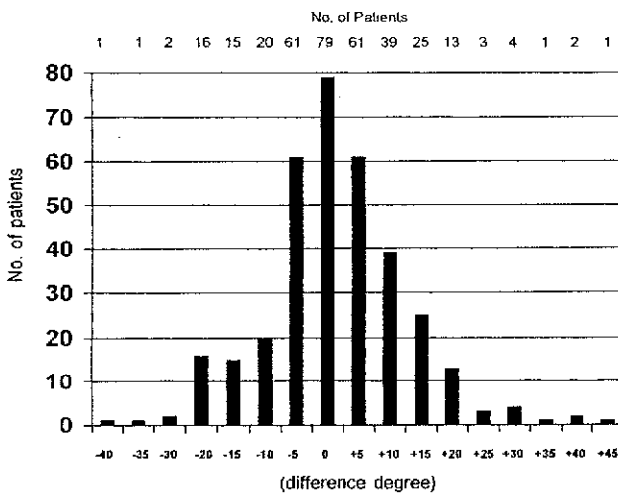
	Group I (n = 34)	Group II (n = 193)	Group III (n = 137)
Preoperative	84 ± 11	108 ± 6	123 ± 12
Intraoperative	104 ± 12	110 ± 8	116 ± 13
Postoperative	103 ± 14	110 ± 10	119 ± 10

**Comparison of Individual Cases**

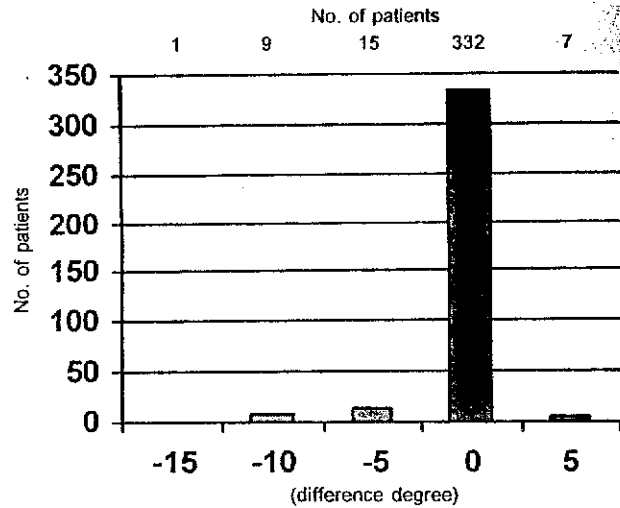
When comparing preoperative and intraoperative flexion to postoperative flexion for individual cases, 55% of knees had postoperative flexion ±10° of their preoperative value (Fig. 1), while 97% of knees had postoperative flexion ±10° of their intraoperative value (Fig. 2).

**Discussion**

The restoration of functional knee flexion is a primary goal of total knee arthroplasty. Predicting a patient's postoperative flexion potential can be helpful in managing the physical therapy program and determining when a knee manipulation might be indicated. Several prior reports have linked preoperative flexion to postoperative flexion potential [10,14,15]. Some have also studied the significance of the preoperative diagnosis (osteoarthritis vs rheumatoid arthritis) with two reports [14,15] showing no difference and one indicating that flexion is greater in osteoarthritis than in rheumatoid arthritis [21].



**Fig. 1. Difference in range of motion (preoperative vs postoperative).**



**Fig. 2. Difference in range of motion (intraoperative vs postoperative).**

All of these studies concentrated on group averages rather than individual cases, although some did show that patients with poor preoperative flexion tended to improve, while those with superior preoperative flexion tended to lose some motion [21,22].

Our study confirmed the concept that overall, the mean preoperative flexion of total knee arthroplasty patients was similar to the postoperative mean regardless of the preoperative diagnosis. We discovered, however, that if patients had 85° of flexion or less preoperatively, the postoperative flexion could not be predicted by the preoperative value but could be predicted by measuring the intraoperative flexion against gravity. In addition, the intraoperative flexion value was able to predict the ultimate flexion to within ±10° in 97% of individual cases. By contrast, only 55% of individual cases had ultimate flexion ±10° of their preoperative value.

In summary, this study indicates that the final postoperative mean flexion for a group of patients with poor preoperative flexion (<85°) and for individual cases (regardless of their preoperative mobility) can best be predicted by intraoperative flexion against gravity rather than by a preoperative value.

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