Perceived Leg-Length Discrepancy After Primary Total Knee Arthroplasty: Does Knee Alignment Play a Role?

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Abstract

Leg length discrepancy (LLD) is common after total knee arthroplasty (TKA) although its incidence has not been well documented. The purpose of this study was to determine the incidence of perceived LLD before and after primary total knee arthroplasty as well as to determine the correlation between mechanical axis of the knee and perceived LLD. The incidence and time frame of resolution of postoperative LLD was also assessed.

Seventy-three patients were prospectively enrolled. Evaluation included patient surveys regarding perceived LLD preoperatively, and at 3- to 6-week, 3-month, 6-month, and 1-year visits. Mechanical axis radiographs were obtained and the relationship of mechanical axis in patients with and without perceived LLD, both before and after surgery, was determined. Analysis was also performed for separate varus and valgus deformities. The effect of surgery on patients' perception of LLD was also determined.

Fifty-three patients did not perceive a LLD preoperatively and 18 perceived a LLD preoperatively. Sixty-four patients did not perceive a LLD postoperatively and 7 patients perceived a LLD postoperatively. There was a significant difference in patients who perceived LLD preoperatively and those who perceived LLD postoperatively ($P = .035$). Of the 7 patients with a perceived LLD postoperatively, all noted resolution of LLD at a mean of 8.5 weeks. There were no statistically significant correlations of knee alignment to perceived LLD in any patient groups. Body mass index and age did not demonstrate any statistical differences between patient groups.

Perceived LLD is common in patients undergoing TKA; however, perceived LLD decreases after surgery. Although approximately 10% of patients perceive a LLD after surgery, the vast majority resolve within 3 months. Our study did not show any relationship between mechanical knee alignment and perception of LLD.

Leg-length discrepancy (LLD) is common in the general population[1] and particularly in patients with degenerative joint diseases of the hip and knee.[2] Common complications of LLD include femoral, sciatic, and peroneal nerve palsy; lower back pain; gait abnormalities[3]; and general dissatisfaction. LLD is a concern for orthopedic surgeons who perform total knee arthroplasty (TKA) because limb lengthening is common after this procedure.[4,5] Surgeons are aware of the limb lengthening that occurs during TKA,[4,5] and studies have confirmed that LLD usually decreases after TKA.[4,5]

Despite surgeons' best efforts, some patients still perceive LLD after surgery, though the incidence of perceived LLD in patients who have had TKA has not been well documented. Aside from actual, objectively measured LLD, there may

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be other factors that lead patients to perceive LLD. Study results have suggested that preoperative varus–valgus alignment of the knee joint may correlate with how much an operative leg is lengthened after TKA[4,5]; however, the outcome investigated was objective LLD measurements, not perceived LLD. Understanding the factors that may influence patients' ability to perceive LLD would allow surgeons to preoperatively identify patients who are at higher risk for postoperative perceived LLD. This information, along with expected time to resolution of postoperative perceived LLD, would allow surgeons to educate their patients accordingly.

We conducted a study to determine the incidence of perceived LLD before and after primary TKA in patients with unilateral osteoarthritis and to determine the correlation between mechanical axis of the knee and perceived LLD before and after surgery. Given that surgery may correct mechanical axis misalignment, we investigated the correlation between this correction and its ability to change patients' preoperative and postoperative perceived LLD. We hypothesized that a large correction of mechanical axis would lead patients to perceive LLD after surgery. The relationship of body mass index (BMI) and age to patients' perceived LLD was also assessed. The incidence and time frame of resolution of postoperative perceived LLD were determined.

Methods

Approval for this study was received from the Institutional Review Board at our institution, Rush University Medical Center in Chicago, Illinois. Seventy-three patients undergoing primary TKA performed by 3 surgeons at 2 institutions between February 2010 and January 2013 were prospectively enrolled. Inclusion criteria were age 18 years to 90 years and primary TKA for unilateral osteoarthritis; exclusion criteria were allergy or intolerance to the study materials, operative treatment of affected joint or its underlying etiology within prior month, previous surgeries (other than arthroscopy) on affected joint, previous surgeries (on unaffected lower extremity) that may influence preoperative and postoperative leg lengths, and any substance abuse or dependence within the past 6 months. Patients provided written informed consent for total knee arthroplasty.

All surgeries were performed by Dr. Levine, Dr. Della Valle, and Dr. Sporer using the medial parapatellar or midvastus approach with tourniquet. Similar standard postoperative rehabilitation protocols with early mobilization were used in all cases.

During clinical evaluation, patient demographic data were collected and LLD surveys administered. Patients were asked, before surgery and 3 to 6 weeks, 3 months, 6 months, and 1 year after surgery, if they perceived LLD. A patient who no longer perceived LLD after surgery was no longer followed for this study.

At the preoperative clinic visit and at the 3-month or 6-week postoperative visit, standing mechanical axis radiographs were viewed by 2 of the authors (not the primary surgeons) using PACS (picture archiving and communication system software). The mechanical axis of the operative leg was measured with ImageJ software by taking the angle from the center of the femur to the middle of the ankle joint, with the vertex assigned to the middle of the knee joint.

We used a 2-tailed unpaired *t* test to determine the relationship of preoperative mechanical axis to perceived LLD (or lack thereof) before surgery. The data were analyzed for separate varus and valgus deformities. Then we determined the relationship of postoperative mechanical axis to perceived LLD (or lack thereof) after surgery. The McNemar test was used to determine the effect of surgery on patients' LLD perceptions.

To determine the relationship between preoperative-to-postoperative change in mechanical axis and change in LLD perceptions, we divided patients into 4 groups. Group 1 had both preoperative and postoperative perceived LLD, group 2 had no preoperative or postoperative perceived LLD, group 3 had preoperative perceived LLD but no postoperative perceived LLD, and group 4 had postoperative perceived LLD but no preoperative perceived LLD. The absolute value of the difference between preoperative and postoperative mechanical axis was then determined, relative to 180°, to account for changes in varus to valgus deformity before and after surgery and vice versa. Analysis of variance (ANOVA) was used to detect differences between groups. This analysis was then stratified based on BMI and age.

Results

Of the 73 enrolled patients, 2 were excluded from results analysis because of inadequate data—one did not complete the postoperative LLD survey, and the other did not have postoperative standing mechanical axis radiographs—leaving 71 patients (27 men, 44 women) with adequate data. Mean

Table 1. **Preoperative Mechanical Axis and Perceived Leg-Length Discrepancy**

	Perceived Leg-Length Discrepancy		
Mechanical Axis	**Yes (n = 18)**	**No (n = 53)**	***P***
Mean mechanical axis, degrees	6.0 (n = 18)	7.6 (n = 53)	.27
Mean varus mechanical axis, degrees	6.7 (n = 14)	7.7 (n = 41)	.53
Mean valgus mechanical axis, degrees	3.6 (n = 4)	7.1 (n = 12)	.20

Table 2. **Postoperative Mechanical Axis and Perceived Leg-Length Discrepancy**

	Perceived Leg-Length Discrepancy		
Mechanical Axis	**Yes (n = 7)**	**No (n = 64)**	***P***
Mean mechanical axis, degrees	4.8 (n = 7)	3.1 (n = 64)	.42
Mean varus mechanical axis, degrees	4.6 (n = 5)	3.4 (n = 44)	.29
Mean valgus mechanical axis, degrees	1.7 (n = 2)	2.3 (n = 20)	.52

Table 3. **Mechanical Axis Correction in 4 Patient Groups**

	Perceived Leg-Length Discrepancy			
Group	**Preoperative**	**Postoperative**	**Patients, n**	**Mean Absolute Value of Mechanical Axis Correction, degrees**
1	Yes	Yes	1	5.5
2	No	No	47	5.8
3	Yes	No	17	6.3
4	No	Yes	6	4.7

(SD) age of all patients was 65 (8.4) years (range, 47-89 years). Mean (SD) BMI was 35.1 (9.9; range, 20.2-74.8).

Of the 71 patients with adequate data, 18 had preoperative perceived LLD and 53 did not; in addition, 7 had postoperative perceived LLD and 64 did not. All 7 patients with postoperative perceived LLD noted resolution of LLD, at a mean of 8.5 weeks (range, 3 weeks-3 months). There was a significant difference between the 18 patients with preoperative perceived LLD and the 7 with postoperative perceived LLD ($P = .035$, analyzed with the McNemar test).

Table 1 lists the mean preoperative mechanical axis measurements for patients with and without preoperative perceived LLD. There was no significant difference between the 2 groups ($P = .27$). There was also no significant difference in preoperative mechanical axis when cases were separated and analyzed as varus and valgus deformities (varus $P = .53$, valgus $P = .20$).

Table 2 lists the mean postoperative mechanical axis measurements for patients with and without postoperative perceived LLD. There was no significant difference between the 2 groups ($P = .42$). There was also no significant difference in postoperative mechanical axis for separate varus ($P = .29$) and valgus ($P = .52$) deformities.

Table 3 lists the mean absolute values of mechanical axis correction (preoperative to postoperative) for the 4 patient groups described in the Methods section. ANOVA revealed no significant statistical difference in these values among the groups ($P = .9229$). There were also no significant statistical differences when the groups were stratified by age (40-59.9 years, $P = .5973$; 60-69.9 years, $P = .6263$; 70 years or older, $P = .3779$) or when ANOVA was used to compare the groups'

mean ages ($P = .3183$). In addition, the 4 groups were not significantly statistically different in BMI: obese (BMI >30; $P = .3891$) and nonobese (BMI <29.9; $P = .9862$).

Discussion

In this study, 18 patients (25%) had preoperative perceived LLD, proving that perceived LLD is common in patients who undergo TKA for unilateral osteoarthritis. Surgeons should give their patients a preoperative survey on perceived LLD, as survey responses may inform and influence surgical decisions and strategies.

Of the 18 patients with preoperative perceived LLD, only 1 had postoperative perceived LLD. That perceived LLD decreased after surgery makes sense given the widely accepted notion that actual LLD is common before primary TKA but in most cases is corrected during surgery.[4,5] As LLD correction during surgery is so successful, surgeons should tell their patients with preoperative perceived LLD that in most cases it will be fixed after TKA.

Although the incidence of perceived LLD decreased after TKA (as mentioned earlier), the decrease seemed to be restricted mostly to patients with preoperative perceived LLD, and the underlying LLD was most probably corrected by the surgery. However, surgery introduced perceived LLD in 6 cases, supporting the notion that it is crucial to understand which patients are at higher risk for postoperative perceived LLD and what if any time frame can be expected for resolution in these cases. In our study, all cases of perceived LLD had resolved by a mean follow-up of 8.5 weeks (range, 3 weeks-3 months). This phenomenon of resolution may be attributed to some of the physical, objective LLD corrections that naturally occur throughout the postoperative course,[4] though psychological factors may also be involved. Our study results suggest patients should be counseled that, though about 10% of patients perceive LLD after primary TKA, the vast majority of perceived LLD cases resolve within 3 months.

One study goal was to determine the relationship between the mechanical axis of the knee and perceived LLD both before and after surgery. There were no significant relationships. This was also true when cases of varus and valgus deformity were analyzed separately.

Another study goal was to determine if a surgical change in the mechanical alignment of the knee would influence preoperative-to-postoperative LLD perceptions. In our analysis, patients were divided into 4 groups based on their preoperative and postoperative LLD perceptions (see Methods section). ANOVA revealed no significant differences in absolute values of mechanical axis correction among the 4 groups. Likewise, there were no correlations between BMI and age and mechanical axis correction among the groups, suggesting LLD perception is unrelated to any of these variables. Ideally, if a relationship between a threshold knee alignment value and perceived LLD existed, surgeons would be able to counsel patients at higher risk for perceived LLD about how their knee alignment may contribute to their perception. Unfortunately, our study results did not show any significant statistical relationships in this regard.

The problem of LLD in patients undergoing TKA is not new, and much research is needed to determine the correlation between perceived versus actual discrepancies, and why they occur. Our study results confirmed that TKA corrects most cases of preoperative perceived LLD but introduces perceived LLD in other cases. Whether preoperative or postoperative LLD is merely perceived or is in fact an actual discrepancy remains to be seen.

One limitation of this study was its lack of leg-length measurements. Although we studied knee alignment specifically, it would have been useful to compare perceived LLD with measured leg lengths, either clinically or radiographically, especially since leg lengths obviously play a role in any perceived LLD. We used mechanical alignment as a surrogate for actual LLD because we hypothesized that alignment may contribute to patients' perceived discrepancies.

Another limitation was the relatively small sample. Only 24 cases of perceived LLD were analyzed. Given our low rates of perceived LLD (25% before surgery, 10% after surgery), it is difficult to study a large enough TKA group to establish a statistically significant number of cases. Nevertheless, investigators may use larger groups to establish more meaningful relationships.

A third limitation was that alignment was measured on the operative side but not the contralateral side. As we were focusing on perceived *discrepancy*, contralateral knee alignment may play an important role. Our study involved patients with unilateral osteoarthritis, so it would be reasonable to assume the nonoperative knee was almost neutral in alignment in most cases. However, given that varus/valgus misalignment is a known risk factor for osteoarthritis,[6] many of our patients with

unilateral disease may very well have had preexisting misalignment of both knees. The undetermined alignment of the nonoperative side may be a confounding variable in the relationship between operative knee alignment and perceived LLD.

Fourth, not all patients were surveyed 3 weeks after surgery. Some were first surveyed at 6 weeks, and it is possible there were cases of transient postoperative LLD that resolved before that point. Therefore, our reported incidence of postoperative LLD could have missed some cases. In addition, our mean 8.5-week period for LLD resolution may not have accounted for these resolved cases of transient perceived LLD.

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