Published in final edited form as:

J Geriatr Phys Ther. 2011 ; 34(3): 148–152. doi:10.1519/JPT.0b013e31820e16dc.

Influence of self reported leg length discrepancy on function and satisfaction 6 years after total hip replacement

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BACKGROUND

Osteoarthritis (OA) of the hip is a major cause of restricted locomotor activity and functional disability.^{1,2} Total hip replacement (THR) is a valuable procedure for the management of end stage arthritis and is effective in improving quality of life and physical function and alleviating pain.^{3,4}

Leg length discrepancy (LLD) is an adverse outcome of THR.^{5,6} There are two types of LLD—apparent and true. Apparent LLD is pelvic obliquity, which occurs after THR due to tight hip abductors and usually resolves within 6 months with abductor stretching. In contrast, true LLD reflects unequal bone length (e.g. due to bone loss, growth alteration, subsidence).^{4,6} Love and Wright reported an 18% incidence of limb lengthening greater than 1.5 cm after unilateral THR, with 6% of patients treated with a shoe lift on the non-operated leg.⁷ A similar study by Woo and Morrey found an average lengthening of 1 cm in a series of 333 cases.⁸ Although LLD as much as 2 cm is common among the normal population,^{3,5} discrepancies after THR may lead to patient dissatisfaction and functional impairment.

While a large number of subjects are satisfied with their pain relief and improved function following THR, LLD arising from either lengthened or shortened femur following THR is a significant source of patient dissatisfaction.^{5,9,10} Lengthening of the leg can contribute to the development of nerve palsy, specifically of the sciatic nerve palsy, leading to functional limitations. Discrepancies in limb leg have also been associated with alterations in gait, chronic low back pain, and chronic hip pain. Hence, LLD following THR has been a leading cause of litigation and may lead to revision surgery.⁶ Even relatively minor differences in leg length can be detected by patients and may impact satisfaction with surgery, especially

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This paper was presented as an abstract at the Association of Rheumatology Health Professionals, American College of Rheumatology Annual Scientific Meeting.

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when patients are required to wear a lift in the contralateral shoe to correct the discrepancy.
5–7

Most studies of LLD after THR have focused on methods to minimize the problem or on techniques to assess true leg length differences. Few studies have examined the long-term influence of LLD on satisfaction and function. The purpose of this study was to determine if perceived LLD influences function and satisfaction six years after primary THR, adjusting for other predictors of functional status and patient satisfaction.

MATERIALS AND METHODS

This paper summarizes the results of a secondary data analysis of a large cohort that has been described previously.^{13,14} The parent study used Medicare claims data to identify subjects in the US Medicare population, aged 65 years and older, who underwent elective primary THR between July 1, 1995, and June 30, 1996.¹⁴ Subjects with diagnostic codes indicating infection, cancer, hemiarthroplasty, fracture and/or dislocation of the hip or femur and those who underwent bilateral and revision surgeries were excluded from the analysis because these individuals were likely to have outcomes that differ from those undergoing elective THR. Trained abstractors reviewed the medical records.¹⁴

Medicare claims data provided information about patient characteristics such as age, gender and race. Medical record data included a patient's primary diagnosis (osteoarthritis, rheumatoid arthritis, or avascular necrosis), other relevant medical co-morbidities (Charlson co-morbidity index) and type of fixation (cemented, uncemented, or hybrid). Subjects provided information on their educational background, which was categorized as either less than a college education or at least some college education. Subjects also provided weight and height, which were used to calculate body mass index (BMI; weight in kilograms divided by height in meters squared) and two items addressing fear of falling and fall history.

Of the 926 subject with 3 year follow-up data, 638 completed a questionnaire six years following surgery that addressed level of perceived LLD, function, and satisfaction. The six year timeframe was selected as it represented a midpoint following surgery and would provide information on longer-term results of surgery. The questionnaire included a single item asking whether the patient perceived a difference in leg length and used a 3-level response (feels same length, feels slightly uneven, and feels severely uneven). We combined the last two responses to produce a binary variable indicating whether patient perceived any LLD. Hip function was assessed using the patient administered version of the Harris hip score questionnaire, a validated 9-item disease-specific measure of pain and functional status¹⁵. These items use an ordinal response set. The items are summed and converted to a 0 to 100 scale. A score of less than 70 indicates poor outcome, >70 to 79 is fair, 80 to 89 good and 90 to 100 excellent.^{15,16} We chose the Harris hip score to evaluate function after THR as it is a reliable, valid and responsive and has been widely used to evaluate hip function after THR.^{15,16}

Satisfaction with surgery was assessed using a previously validated satisfaction scale.^{13,14} This scale consisted of four independent questions addressing satisfaction with pain relief, ability to do house and yard work, ability to participate in recreational activities, and overall results of surgery. Each item had four responses (very satisfied, somewhat satisfied, somewhat dissatisfied, very dissatisfied), which were summed. The satisfaction scale was transformed to a 0–100 scale wherein 0 indicated least satisfaction and 100 indicated maximum satisfaction.¹⁴

Data analysis

SPSS version 14.0 was used to conduct the analyses.¹⁷ Univariate analyses were conducted to describe sample characteristics. Associations between the dichotomized primary LLD variable and the dependent variables (total scores of satisfaction, Harris hip function) were conducted using Wilcoxon tests due to the skewed nature of the data.

To measure the effect of perceived LLD on individual items from the function and satisfaction scales, we collapsed the Likert response scales into binary variables. We dichotomized satisfaction with score < 80 indicating less than full satisfaction and ≥ 80 , indicating full satisfaction based on the verbal anchors of the Likert scale in the questionnaire. That is, a score greater than 80 indicated, on average, that the patient was very satisfied. Harris hip score was dichotomized with ≤ 70 , indicating poor function. Logistic regression was used to examine independent effect of perceived LLD on satisfaction following THR and poor function (Harris hip score) adjusting for age, gender, BMI, Charlson co-morbidity index, level of education, type of fixation (cemented versus uncemented or hybrid), and WOMAC (Western Ontario and McMaster Universities) pain subscale. Forward and backward stepwise regressions were used to confirm the stability of the model.

RESULTS

A total of 638 subjects met our inclusion criteria (mean age 72 years [SD=5]). Seventy four percent of subjects were between 65–76 years of age at time of surgery, thirty one percent were living alone, and more than half (62%) were females. Ninety-eight percent were Caucasian and eighty-nine percent had a primary diagnosis of osteoarthritis. Almost twenty three percent of the subjects had a BMI greater than 30; seventeen percent had 2 or more co-morbidities (Table 1). The most prevalent co-morbidities were high blood pressure (52%) and asthma/bronchitis (12.5%). Sixty-one percent of the subjects had a hybrid type of prosthesis (cemented femur, uncemented acetabulum). Thirteen percent subjects were on medications for pain and discomfort and ten percent were on anti-inflammatory drugs. Twenty one percent of our subjects were college graduates.

Thirty-two percent of subjects perceived a LLD and sixty eight percent did not. We found median function (Harris hip) score among those who perceived an LLD was 83 compared to a score of 92 among those who did not perceive an LLD ($p < 0.001$). The median satisfaction score among those who perceived an LLD was 92 compared to 100 among those did not perceive an LLD ($p < 0.001$).

Bivariate analysis was used to examine the association between LLD and select functional items from the Harris Hip Scale and the two fall-related questions. Crude odds ratios (OR) showed that subjects who perceived LLD were three times more likely than those who did not report LLD to report a limp (OR 3.05; 95% CI 2.1–4.3), twice as likely to use assistive devices (OR 1.98; 95% CI 1.4–2.9), and two and half times more likely to use a banister while climbing stairs (OR 2.5; 95% CI 1.7–3.5). Subjects with LLD were also more than twice as likely to report fear of falling (OR 2.45; 95% CI 1.64–3.6) and 1.92 times more likely to fall (OR 1.92; 95% CI 1.27–2.9).

We also examined the association between LLD and select aspects of satisfaction with surgery. In bivariate analyses, subjects who perceived LLD were almost three times as likely as those who did not report LLD to be less than fully satisfied with relief of pain (OR 2.93; 95% CI 1.16–7.40), nearly four times more likely to be less than fully satisfied with their ability to do housework (OR 3.89; 95% CI 2.01–7.53), three times more likely to be less than fully satisfied with their ability to do recreational activity (OR 3.21; 95% CI 1.90–5.43)

and four times more likely overall to be fully satisfied with the results after surgery (OR 4.44; 95% CI 1.96–10.07).

Logistic regression was used to identify the independent effects of LLD on functional status and satisfaction with surgery. The principal outcome variables were summary scores for Functional Status (Harris Hip Score, dichotomized at 70 which indicated poor function) and satisfaction with the results of surgery (dichotomized at 80 which indicated being less than fully satisfied). Bivariate associations are shown in Table 2.

Next, we examined the independent effect of LLD on the outcomes, adjusting for significant bivariate associations. Subjects who perceived LLD were 2 times more likely to report poor function (OR=2.00; 95% CI= 1.85–3.36). Other predictors of poor function included pain in the index hip (OR= 15.04; 95% CI= 7.51–30.11) and less than high school education (OR=1.40; 95%CI= 1.07–1.83). With respect to satisfaction, subjects who perceived LLD were 2 times more likely to be less than fully satisfied with surgical results (OR=2.24; 95% CI= 1.40–3.70) and subjects who reported pain were 12 times more likely to be less than fully satisfied (OR= 13.39; 95% CI= 6.91–26.00)

DISCUSSION AND CONCLUSIONS

We have examined the prevalence of self-reported LLD in a population based cohort of patients surveyed six years following elective primary THR and found 32% of subjects perceived a LLD. Patients who reported LLD were twice as likely to report worse function and were twice as likely to report less than complete satisfaction with surgery. This rate of LLD is consistent prior literature which reports radiographically documented LLD varies on average between 1 to 16 mm and perceived LLD varies between 6% and 32%.^{5,7}

Long-term effects of LLD on function and satisfaction of patients after unilateral primary THR are not well understood. Edeen et al¹⁸ interviewed and examined 68 patients who had undergone THR to determine the clinical significance of LLD after THR on patient satisfaction, use of orthoses, and presence of gait abnormalities. Edeen reported that more than half of the patients with postoperative limb length inequality were bothered by their LLD. Additionally the magnitude of LLD was found to be correlated with awareness of inequality, abnormal gait, use of ambulatory assistive devices, need for a shoe lift, and prior leg length inequality. In 1978, Williamson and Reckling¹⁹ found that 27% of patients with post-operative lengthening had complains about their leg discrepancy and required a shoe lift. Turula et al²⁰, reported that 6% of patients who had undergone THR were subjectively aware (of the LLD) and had a marked limp with a lengthening greater than 1.4 cm. The authors concluded that a large limb inequality may contribute to low back pain, limp and mechanical loosening of prosthesis.²⁰ While some studies report poorer outcomes in patients whose leg lengths were significantly worse than those of patients who considered their operated leg to be of equal length,⁵ White et al¹⁰ reported there was no correlation between the occurrence of LLD after THR and functional outcomes and patient satisfaction.

Konyves et al⁵ assessed LLD and function using Oxford hip score (OHS), a clinician-focused outcome measure, in patients before, and 3 and 12 months after THR. They found that patients who perceived true lengthening reported poorer function (18% worse) at 12 months compared to those who perceived equal leg length. In our cohort, subjects who perceived LLD had a median score of 83 on the Harris hip scale and 92 on the satisfaction scale, compared to median scores of 92 on the Harris Hip and 100 on the satisfaction scale in the subjects who did not perceive a LLD. These differences are clinically important^{15,16} and document a statistically significant relation between perceived LLD, function, and satisfaction. Hence, subjects who perceived LLD had poor function and were less satisfied six years after unilateral THR compared to those who did not perceive LLD.

THR is performed to re-establish unassisted gait with functional independence and pain relief. In our study, subjects were three times more likely to report a limp if they had the perception of LLD. These patients also reported the need for assistive devices and environmental assistance (use of banisters) for ambulating and ascending and descending stairs. Patients were also less satisfied with their pain relief and ability to do their household and recreational activities due to a perceived LLD.

One of the leading causes of patient dissatisfaction after THR is a limp.^{5,7,21} A limp can be caused by a loosening of the implants, mechanical problems (heterotrophic ossification, abductor disturbance), biologic problems (sepsis, neuromuscular imbalance, contractures), and extra pelvic causes such as degenerative pathology in the spine, knee, and ankle. An important cause of postoperative limp is LLD. Consistent with the findings of this study, Edeen et al¹⁸ found a noticeable limp in almost 41% subjects with leg length inequality. Moreover these subjects had greater leg length inequality and required an assisted device. The results of our regression analyses illustrated that perceived LLD remained a strong predictor of function and satisfaction after adjusting for other covariates. Among the predictors of poor function, hip pain was the most important with an adjusted odds ratio of 15, reinforcing the fact that an increased level of hip pain is related to decreased function. Pain also remained the most significant predictor of less than full satisfaction with surgery (adjusted odds ratio of 13), followed by perceived LLD with an adjusted odds ratio of 2.24.

There are limitations of this study. Radiographs were not available to confirm existence of LLD. However, the intent of the study was to describe the impact of patient-perceived LLD, not true LLD, on function and satisfaction. Also, while patients reported the presence of a LLD, there was no way to determine which leg was longer, though data suggest the operated leg is often the longer limb.⁵ There was no information available regarding current use of a heel lift. Thus, the impact of a heel lift on function could not be determined.

The study has several strengths. This is a large prospective cohort of patients who have undergone a primary THR. The measures used are well validated and responsive. Of particular importance is the fact that the primary outcomes are specific to hip disorders and in the case of the satisfaction scale, designed specifically for patients following THR. The functional outcome measure is a patient-oriented measure versus a clinician-oriented measure and thus aligns well with the purpose of this study, to assess patient's perspective of LLD and its impact on outcomes.

In conclusion, subjects who perceived LLD reported poor function. These patients were more likely to report difficulty in gait, as noted by their reports of limping while walking and were more likely to report the use of an assistive device or external support while climbing stairs. These patients were more likely to be less than fully satisfied with pain relief, with ability to engage in activities of daily living (ADL's) and with ability to engage in recreational activities. Regardless of whether limb length inequality is clinically or radiographically measured, perceived LLD influences function and satisfaction up to six years after surgery. These results suggest the need for providers to assess patient perspectives regarding LLD and to address these concerns in the clinical encounter and with interventions such as training to promote equal weight distribution among the limbs. Further studies should be conducted to determine whether interventions such as equal weight distribution training will reduce the perception of LLD to improve function and satisfaction following surgery.

Acknowledgments

Support: NIH K24 AR 02123 and NIH P60 AR 48872

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Table 1

Demographic characteristics of subjects after total hip replacement (N=638)

Characteristic	Number (%)
Age at Surgery*	65–75 451 (73.6)
	75–85 156 (25.4)
	>85 6 (1.0)
Female *	381 (62.2)
Caucasian	594 (97.5)
Education#	Graduated college 125 (20.9)
	Some college 146 (24.4)
	High School Graduate 231 (38.6)
	Less than high school 96 (16)
Primary Diagnosis@	Osteoarthritis 547 (89.2)
	Rheumatoid Arthritis 22 (3.4)
	Avascular necrosis 33 (5.2)
Lives Alone	198 (31)
Body Mass index (BMI) > 30	140 (23.3)
Type of Prosthesis:\$	Cemented 60 (10.7)
	Un-cemented 160 (28.4)
	Hybrid 343 (60.9)
Perceived LLD	201 (32.0)
Co-morbidities ≥ 2*	103 (16.8)
Associated Conditions (can check more than one)	
	Stroke 31 (4.9)
	Congestive heart failure 31 (4.9)
	High blood pressure 332 (52.2)
	Kidney disease 12 (1.9)
	Ulcer/Stomach 43 (6.7)
	Asthma/Bronchitis 80 (12.5)
	Diabetes 72 (11.3)
	Heart attack 22 (3.4)
	Anemia/Others 30 (4.7)

*
n=613,#
n=598,@
n=602,\$
n=563

Table 2

Bivariate Associations with Function and Satisfaction Using Logistic Regression

Poor Function	Crude (OR)	(95% Confidence Interval)
Age ($\leq$ 75 yrs vs. over 75)	0.80	(0.50–1.26)
Female	0.55 *	(0.34–0.89)
Caucasian	0.39	(0.05–3.03)
Primary Diagnosis Osteoarthritis	1.38	(0.70–2.73)
Rheumatoid Arthritis	0.54	(0.21–1.42)
Avascular necrosis	0.70	(0.30–1.70)
Living alone	0.69	(0.45–1.09)
Co-morbidities $\geq$ 2	0.79	(0.60–1.04)
Body Mass Index (BMI) >30	1.73	(1.07–2.80)
Type of Prosthesis (cement vs. not)	1.41	(0.62–3.25)
Education (high school vs. college or grad)	1.70 *	(1.07–2.63)
Perceived LLD	2.77 *	(1.78–4.30)
Pain	14.40 *	(7.63–27.14)

Dissatisfaction	Crude (OR)	(95% Confidence Interval)
Age ($\leq$ 75 yrs vs. over 75)	0.90	(0.60–1.40)
Female	0.91	(0.58–1.41)
Caucasian	0.75	(0.17–3.38)
Primary Diagnosis Osteoarthritis	1.24	(0.65–2.38)
Rheumatoid Arthritis	0.42	(0.17–1.05)
Avascular necrosis	0.61	(0.23–1.40)
Living Alone	1.17	(0.74–1.84)
Co-morbidities $\geq$ 2	0.86	(0.66–1.13)
Body Mass Index (BMI) >30	1.56	(0.97–2.50)
Type of Prosthesis	0.84	(0.42–1.70)
Education (high school vs college or grad)	1.20	(0.78–1.85)
Perceived LLD	2.87 *	(1.85–4.43)
Pain	14.34 *	(7.61–27.00)

*
p < 0.05