

Leg Length Adjustment Using Intraoperative Radiograph : An Additional Process to Reduce Leg Length Discrepancy in Total Hip Arthroplasty

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ABSTRACT

The postoperative leg length inequality of primary THA was evaluated in thirty-five patients (44 hips). They were divided into 2 groups on the basis of additional intraoperative radiograph for final leg length adjustment. In Group I, seventeen patients (20 hips), leg length adjustments were done using preoperative templating and intraoperative clinical testing. In Group II, eighteen patients (24 hips), leg length adjustments were done using the same methods, but an intraoperative radiograph was added for the final leg length adjustment. It was evident in all the affected legs that shortening were only from hip diseases. The AP radiographs of both hips were evaluated at the three-month follow-up interval and compared with that of the preoperative period.

In Group I, the leg length differences averaged 1.3 cm. (range, -3.0 to -0.2 cm.) preoperatively and 0.8 cm. (range, -0.8 to +2.0 cm.) postoperatively. Eleven patients (64.7%) has postoperative leg length differences within 1 cm and the difference was more than 1 cm in six patients (35.3%). The average operative time was 131 min. (range, 105 to 165 min.). No infections had occurred. Three patients had complained about the postoperative lengthened leg.

In Group II, the average leg length inequality was 1.7 cm. (range, -3.7 to -0.7 cm.) preoperatively and 0.3 cm. (range, -0.5 to +0.6 cm.) postoperatively. The average operative time was 161 min. (range, 135 to 190 min.). One patient had a superficial infection. No patient had complained about leg length inequality.

There was no significant difference between the preoperative leg length inequality of Group I and Group II ($p = 0.187$). The difference of postoperative inequality was significant between Group I and Group II ($p = 0.026$). The operative time of Group II was significantly longer than that of Group I ($p = 0.000001$).

This study demonstrated that intraoperative radiograph for leg length adjustment during THA reduced the leg length inequality with some additional operative time. Because the number of patients in the series was small, the findings should be considered preliminary.

INTRODUCTION

Leg length equalization is an important part of all surgical protocols for total hip arthroplasty (THA). Although relief of pain and improvement of function are the main objectives of hip replacement, the maintenance or re-establishment of equal leg length is highly desirable. Even an excellent clinical result with respect to pain relief, function, component fixation, range of motion, and radiographic appearance can become a surgical failure because of patient dissatisfaction due to excessive leg lengthening or shortening.

Friberg¹ reported that postoperative leg lengthening of more than 0.5 cm. could cause unilateral hip symptoms and that they mostly disappeared after correction of the inequality. Love and Wright² found that eight of 40 patients (18%) who underwent unilateral total hip replacement had lengthening of the operated leg by 1.5 cm. or more. Turula et al³, in a study of the leg length inequalities of 55 total hip replacement patients, found that unilateral replacements had an average lengthening of 9 mm. (range, -20 to +16 mm.) and that the leg length differences in patients with bilateral replacements averaged 12 mm. (range, +2 to 23 mm.). A study of 150 total hip replacement patients by Williamson and Reckling⁴ found that only six had a shorter leg and the average lengthening of the remaining 144 was 16 mm. Three percent of the patients with a longer leg had an associated partial sciatic nerve palsy. Forty-seven of these patients (27%) wore a shoe lift on the nonoperative side to balance their gait.

Several reports^{5,6,7} have suggested a variety of de-

vices for intraoperative leg length adjustment. Each device measures from a fixed point on the pelvis to a second point distal to the hip, usually on the femur. The accuracy of these devices rests heavily on the surgeon's ability to reposition the leg accurately before each measurement. Theoretically, changes in adduction - abduction of the leg, even if flexion - extension are similar, will significantly change the leg length after the measurement.

In addition to conventional preoperative and intraoperative techniques for correction of the limb length difference, we include intraoperative radiograph in total hip arthroplasty to minimize leg length inequality.

MATERIALS AND METHODS

Between May, 1995 and March, 1997, we reviewed 35 patients (44 hips) who had primary total hip arthroplasties. The leg length shortening in these patients was secondary to hip diseases and there was no evidence of other skeletal maldevelopment that caused leg length discrepancy. Nine patients had bilateral arthroplasties, so the length of the previous operated limb was considered as the unaffected leg. There were 22 men and 13 women. The average age at the time of operation was 49.7 years (range, 30 to 70 years). The types of arthroplasty were cemented THA in 6 cases, cementless THA in 22 cases, and hybrid THA in 7 cases.

The preoperative planning included a standard AP radiograph of both hips. The radiograph was taken with the patient lying down on the table with great toes pointing straight up and the distance of X-ray beam was 40 inches. We used a 10% magnified template to choose the size, the position of implant, and the amount of femoral resection. Measurement of the distance between the bi-ischial line and the most medial projection of lesser trochanter in both sides were done and the difference of both distances was

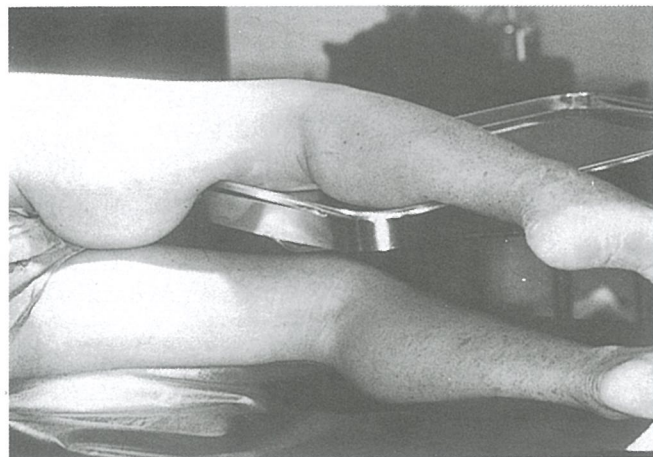


Fig. 1 The patient's position was true lateral with preadjustment of the height of the Mayo stand for holding of the operated hip during taking of the radiograph.

used to correct the leg length inequality (LLI). With the patient in true lateral position, a standard posterior approach of the hip was performed. For the assessment of intraoperative leg length, we used a modular femoral prosthesis with short, medium or long neck and the trial femoral component was inserted into the canal starting from the short neck. The difference in vertical distance of each modular neck was 5 mm. We used a shuck test and palpation of malleoli for evaluation of leg length differences in all cases. In some cases, we added intraoperative X-ray for final leg length adjustment on the basis of the availability of the portable X-ray machine in the operative room. After placing the trial prosthetic component and taking a radiograph (Fig 1), we measured the radiographic difference of the vertical distance between the lesser trochanter and the bi-ischial line bilaterally (Fig 2). If the

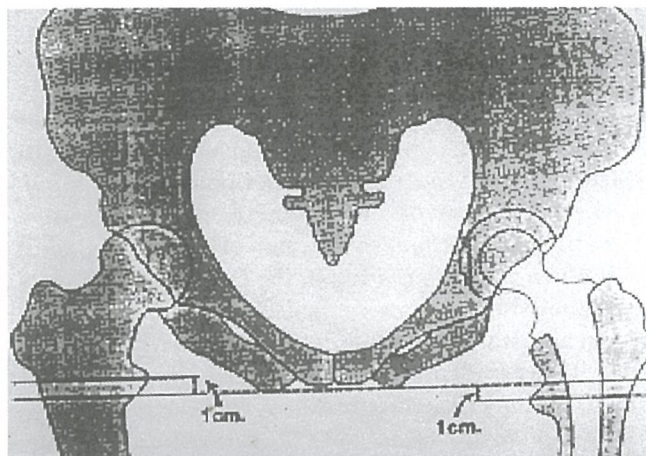


Fig. 2 After having the intraoperative film, a line was drawn between the ischial tuberosities and the vertical distance from the line and the most medial projection of the lesser trochanter bilaterally was measured. If there was any inequality, leg length adjustment would be done.

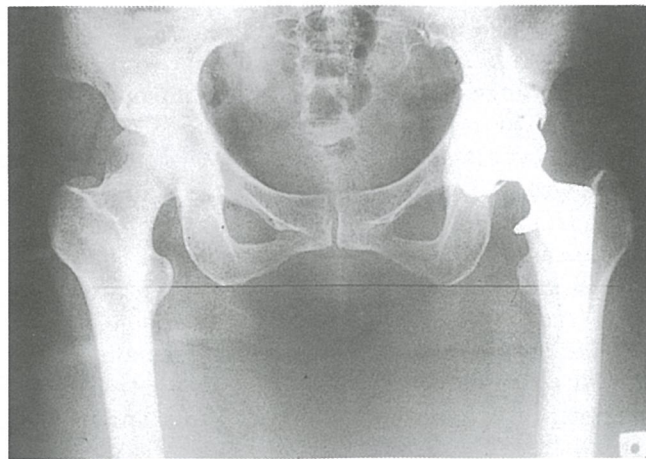


Fig. 3 Example of a case that we used intraoperative radiograph for leg length adjustment during THA.

operated limb was shortened, we changed to the longer neck. If it was lengthened we recut the femoral neck. We evaluated the LLI from the postoperative radiograph after a three-month period.

With additional intraoperative radiograph we divided patients into 2 groups. Group I, without intraoperative radiography, consisted of 17 cases and Group II, with intraoperative radiography, consisted of 18 cases.

RESULTS

Of the seventeen patients in Group I, 10 were men and 7 were women. The average age was 49.9 years (range, 30 to 70 years). Nine hips were left and 8 hips were right. Three patients had bilateral arthroplasties. There were 5 cemented hips, 8 cementless hips, and 4 hybrid hips. The average preoperative LLI was 1.3 cm. (range, -3.0 to -0.2 cm.) and the average postoperative LLI was 0.8 cm. (range, -0.8 to +0.2 cm.). Eight cases (47.1%) had postoperative LLI of less than 0.5 cm. Three cases (17.6%) had postoperative LLI of between 0.5 and 1.0 cm. and 6 cases (35.3%) had postoperative LLI of more than 1.0 cm. The average operative time was 131 min. (range, 105 to 165 min.). Three patients complained about the lengthened leg and one of these had postoperative back pain. There were no other complication at the three-month follow up.

Of the eighteen patients in Group II, twelve were men and 6 were women. Six patients had bilateral arthroplasties. The average age was 49.5 years (range, 39 to 65 years). Eleven hips were right and 7 hips were left. There were one cemented hip, 14 cementless hip, and 3 hybrid hips. The average LLI was 1.7 cm. (range, -3.7 to -0.7 cm.) preoperatively and 0.3 cm. (range, -0.5 to +0.6 cm.) postoperatively. Sixteen cases (88.9%) had postoperative LLI of less than 0.5 cm. and 2 cases (11.1%) had LLI between 0.5 and 1.0 cm. The average operative time was 161 min. (range, 135 to 190 min). No patient complained of about the lengthened leg. One patient had a superficial infection 6 weeks postoperatively. He was treated with debridement and intravenous antibiotics for 2 weeks.

There was no significant difference between the preoperative leg length inequality of Group I and Group II (t -test, $p = 0.187$). The difference between the postoperative leg length inequality of Group I and Group II was significant ($p = 0.026$). The operative time of Group II was significantly longer that of Group I ($p = 0.000001$).

DISCUSSION

Woo and Morrey⁸ reported the average LLI of 333 total hip arthroplasties to be 1.0 cm. Williamson and Recking⁴ reported that the average lengthening of 150

arthroplasties was 1.6 cm. In our study, the average postoperative discrepancy of Group I was 0.8 cm. Compared with previous studies of LLI, our results were better than the range of those results. However, the average discrepancy of Group II (0.3 cm.) is a major improvement. None of the patients in Group II had the clinical problem of LLI, which was the objective result of our study. Most of the patients in Group II (88.9%) had postoperative LLI of less than 0.5 cm but only 47.1% of patients in Group I had the same result. Three patients who had complained of lengthened limb had discrepancies of more than 1.4 cm. (1.5, 2.0, and 2.0, respectively). Back pain occurred in one of the patients, whose discrepancy was 2.0 centimeters. We think that the LLI of more than 1.4 cm. may cause patient's complaints.

The difference between the average operative time of patients in Groups I and II was 30 minutes. This difference was regarded as the time we spent for the intraoperative radiographic process, because some time-consuming problems always occurred during this process. We believe that, with experience, it should take only about 15 minutes. The major problem that caused the increased time was the technician's experience in adjustment of the radiographic quality and the direction of the beam to the draped patient in order to have a good film of both hips. If this process is performed carelessly, it may increase the infection rate. However, we could not determine the cause of the superficial infection that occurred in a patient in Group II.

Intraoperative radiography can be added to any of the leg length equalization methods during total hip arthroplasty. If the patient is in lateral decubitus position, the AP roentgenographic process will be easy. Other benefits of intraoperative radiography are the assessment of the position, the fixation of acetabular component, and detection of the fracture line in the patients in whom the cementless fixation was chosen. In case any of these unsatisfactory outcomes is detected, the correction can be made during the operation.

CONCLUSION

The intraoperative radiography for leg length adjustment during total hip arthroplasty is a simple, effective method and can be added to any of the conventional methods. It increases the accuracy of the process at the cost of some additional time. With careful sterile technique, this method will rarely increase the infection rate. Improvement of the roentgenographic process may decrease the operative time. Because the number of cases in our study is small, the findings should be considered preliminary.

Table 1 : Group I (patients were operated without intraoperative radiograph)

No	Sex	Age	Side	Type	Diagnosis	LLI (cm.)		Operative time (min.)	Complications
						Preop	Postop		
1 CK	M	70	L	Hybrid	AVN	-0.6	0.6	125	-
2 CH	F	51	R	CML	AVN	-1	0.4	120	-
3 SJ	M	38	L	Hybrid	Post traumatic arthritis	-1.4	-0.8	140	-
4 SH	M	41	R	Hybrid	Post traumatic arthritis	-3	1.5	165	Lengthened leg
5 TK	F	39	L	CML	AVN	-0.9	2	110	Lengthened leg
*6 BK	M	65	L	CM	AVN	-0.3	-0.5	115	-
7 PS	M	50	L	CML	AVN	-0.2	-0.2	130	-
*8 TT	M	39	R	CML	AVN	-1.8	0.3	115	-
9 TS	M	39	L	CML	Post traumatic arthritis	-0.9	1	150	-
10CM	F	58	R	CM	AVN	-1.3	0.3	125	-
*11LP	F	39	R	CML	Post traumatic arthritis	-2	-0.4	130	-
12SM	M	30	L	CML	Post traumatic arthritis	-1.8	-0.6	160	-
13TC	M	62	L	CM	Neglected Fx fem.neck	-1.3	1.5	105	-
14CC	F	56	R	Hybrid	Neglected Fx fem.neck	-0.2	2	150	LLI, back pain
15CJ	F	60	L	CM	AVN	-0.6	0.5	135	-
16PB	F	49	R	CML	AVN	-2.2	1.4	140	-
17PP	M	62	R	CM	AVN	-1.8	0.4	115	-

Table 2 : Group II (patients were operated with intraoperative radiograph)

No	Sex	Age	Side	Type	Diagnosis	LLI (cm.)		Operative time (min.)	Complications
						Preop	Postop		
1BH	M	44	R	CML	Post traumatic arthritis	-1.6	-2.4	145	-
*2BJ	F	48	R	CML	AVN	-2	0.2	160	-
*3AP	F	49	R	CML	AVN	-2.4	-0.1	170	-
*4 PP	F	41	R	CML	AVN	-1.3	-0.3	170	-
5 PB	M	60	L	CM	Neglected Fx fem.neck	-2.8	-0.4	160	-
6 PM	M	58	R	Hybrid	Post traumatic arthritis	-1.8	0.2	145	-
7 NS	M	60	R	Hybrid	AVN	-0.4	0.6	165	-
8 MP	M	40	R	CML	Failed angle blade	-3.6	-0.3	190	-
9 ST	F	46	L	CML	AVN	-0.7	0	155	-
10 FS	F	65	L	Hybrid	Failed angle blade	-0.7	-0.5	190	sup.infection
*11SF	M	44	L	CML	AVN	-1.4	0.1	140	-
12JS	M	39	R	CML	Post traumatic arthritis	-3.7	0	160	-
13SN	M	40	R	CML	Failed bipolar prothesis	-1.6	0.4	185	-
14PT	M	49	L	CML	AVN	-0.8	0.3	155	-
15AT	M	49	L	CML	Pist traynatic artgrutis	-0.9	0.6	150	-
16VI	F	48	R	CML	Tuberculosis	-1	0.1	160	-
17PC	M	58	R	CML	AVN	-1.6	0.5	135	-
18VB	M	53	L	CML	Post infectious arthritis	-1.4	0.2	170	-

* Patient had bilateral THA and the previous operated leg was concerned as the unaffected leg.

CM : cemented THA

CML : cementless THA

Hybrid : hybrid THA

LLI : leg length inequality

REFERENCES

1. Friberg O. Clinical symptoms and biomechanics of lumbar spine and hip joint in the leg length inequality. *Spine* 1983 ; 8 : 643-651.
2. Knight WE. Accurate determination of leg lengths during total hip replacement. *Clin. Orthop* 1977 ; 123 : 22-28.
3. Love BRT, Wrioth K. Leg length discrepancy after total hip joint replacement. *J Bone Joint Surg (Br)* 1983 ; 65 : 103.
4. McGee HMJ, Scott JHS. A simple method of obtaining equal leg length in total hip arthroplasty. *Clin. Orthop* 1985 ; 194 : 269-270.
5. Turula KB, Friberg O, Lindholm TS, Tallroth K, Vankka E. Leg length inequality after total hip arthroplasty. *Clin. Orthop* 1986 ; 202 : 163-168.
6. Williamson JA, Reckling FW. Limb length discrepancy and related problems following total hip replacement. *Clin. Orthop* 1978 ; 134 : 135-138.
7. Woo RYG, Morrey BF : Dislocations after total hip arthroplasty. *J Bone Joint Surg (Am)* 1982 ; 64 : 1295-1306.
8. Woolson ST. Leg length equalization during total hip replacement. *Orthopaedics* 1990 ; 13(1) : 17-21.
9. Woolson ST, Harris WH. A method of intraoperative limb length measurement in total hip arthroplasty. *Clin. Orthop* 1985 ; 194 : 201-210.