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INTEROBSERVER VARIABILITY IN LIMB LENGTH DISCREPANCY IN THR ON RADIOGRAPH - A MULTICENTRIC STUDY.

Orthopaedics

Darshan C K MBBS, MS, Mysore Medical College, Irwin Road ,Yadavgiri,Mysore, Karnataka ,India.

Manohar Rao H.R.* MBBS, MS Mysore Medical College, Irwin Road ,Yadavgiri, Mysore, Karnataka, India. *Corresponding Author

Supreeth E R MBBS , MS, SR , Shimoga Institute Of Medical Sciences , Shivamoga.

Ravi G R MBBS, MS, Mysore Medical College, Mysore.

ABSTRACT

Introduction: Restoration of limb length is one of the most important aims after total hip replacement . The measurement is often done by various radiological methods ,but its measurement is often difficult and variable. We studied to check if measurements of limb length discrepancy has inter-observer variability using standard anteroposterior radiograph.

Material and methods: Forty patients (40 hips) underwent measurement of limb length discrepancy on standard AP radiographs. The measurement was done by two observers from two different institutions (On digital X-ray AP view of hip, a line is drawn at the level of & parallel to inter teardrop area and intersecting the lesser trochanter on each side. Compare 2 points of intersection & measure difference to determine the amount of limb discrepancy).

Results: There was excellent inter-observer agreement for radiological measurments kappa=0.867 (good aggrement) for pre-operative radiographic measurements and kappa=0.811(good aggrement) for post-operative radiographic measurements.

Conclusions: Our data show use of radiological measurement of Limb Length Discrepancy (using intertear drop as pelvic reference and lesser trochanter as femoral reference) has excellent interobserver agreement and hence is more reliable than manual measurement of Limb Length Discrepancy.

KEYWORDS

1.1 Introduction

Measurement of leg length discrepancy is an integralimportant part in planning a successful total hip arthroplasty surgery. Numerous clinical and radiological methods for measuring LLD are described within the literatureliketape measurements, Orthoroentgenogram, CR-based teleoroentgenogram, slit scanogram , microdose digital radiography , CT scanogram , ultrasound and MRI scanogram [1]. Evaluating of degree of precision, validity, intra and inter-observer reliability additionally because the degree of correlation among these various methods in groups of patients and healthy subjects has shown variable results and outcomes [2,3,4,5,6].

Accuracy of this method is defined because the variation of the measurement using the imaging method compared with the particular measure, whereas reliability of the technique is that the variation between observers and with observer in obtaining these measurements. One has to consider the accuracy, magnification, radiation dose, cost, need for special equipment, convenience, and talent to image the whole extremity when choosing the imaging technique for assessing LLD[1].

In our study we've got chosen pelvic radiographs,because the method for the measurement of limb length discrepancies pre and postoperatively because it has good accuracy, cost effective ,lesser radiation exposure compared to other modalities and it's readily available in all told tertiary centres.

Different methods are want to determine LLDs from pelvic radiograph. As a pelvic reference, both ischial tuberosities and therefore teardrops are used, and as a femoral reference, the lesser trochanter and centre of the femoral head are used here[7]. As there's deformation of femoral head in patients of osteonecrosis of femoral head and displastic hip we've got used teardrop as pelvic reference and lesser trochanter as femoral reference in our study.

1.2 Objectives of the study

To assess the inter-observer variability in estimating leg length discrepancy pre and post op in Total hip replacement using digital X-ray.

2. Materials and Methods

2.1 Source

The study was carried out on 40 hips of 40 patients of total hip replacement who had chronic symptoms of degenerative arthritis were operated in the Orthopaedic Department of JSS HOSPITAL and Mysore Medical College & Research Institute , Mysuru during sept 2018 to jan 2020 fulfilling the inclusion criteria.

2.2 Type of study A multicentric Prospective study.

2.3 Methods of collection of data

After obtaining valid consent, the complete data is collected from the patients by taking history, detailed clinical examination and relevant investigations. All cases with Total Hip Replacement Were evaluated for limb length using the proposed criteria by two different observers of each institution . Written informed consent was obtained from all the patients who were subjected to the proposed research work.

2.4 Area of study Department of Orthopaedics, JSS Hospital and Mysore Medical College & Research Institute , Mysuru.

2.5 Methodology

We evaluated all cases undergoing THR for degenerative arthritis. Leg length was calculated using digital x-rays by 2examiners of different institution (who were blinded) preoperatively and postoperatively. Radiographs were exchanged via a ZIP file or a DICOM file.

Leg length: On digital X-ray a line was drawn at the level of & parallel to inter teardrop area and intersecting the lesser trochanter on each side. Compare 2 points of intersection & measure difference to determine the amount of limb discrepancy [8].

2.5.1 INCLUSION CRITERIA

1. Patients of age more than 20yrs & of either sex
2. X Ray of the patient's hip with well established arthritic changes

2.5.2 EXCLUSION CRITERIA

1. Patients less than 20yrs age
2. Patients unwilling to consent for the study
3. Patients medically unfit for major surgery
4. Patients with clinically detectable focus of active infection

2.5.3 Analysis of data

We evaluated 40 cases undergoing THR for degenerative arthritis at JSS and MMCRI for functional outcome using Harris hip score and LLD using digital x-rays by 2 different examiners. Postoperative patients are evaluated for radiological outcome. The statistical data

analysis is done by IBM SSPS software version 23.0

Pictures a & b depicting x-rays, where measurements were taken on a digital x-ray using a computer software

Fig 1

3. RESULTS

There was excellent inter-observer agreement for radiological measurements kappa=0.867 (good aggrement) for pre-operative radiographic measurements and kappa=0.811(good aggrement) for post-operative radiographic measurements.

Cohen's Kappa statistic (κ)	Strength of agreement
< 0.00	Poor
0.00–0.20	Slight
0.20–0.40	Fair
0.41–0.60	Moderate
0.61–0.80	Substantial
0.81–1.00	Almost perfect

Table: Interpretation of Cohens Kappa for statistical strength of agreement.

4. DISCUSSION

Several authors have reported the results of LLD measurement employing a type of imaging techniques like Orthoroentgenogram , CR-based teleoroentgenogram , slit scanogram , microdose digital radiography , CT scanogram , ultrasound and MRI scanogram [1].

The three distinct techniques for assessing LLD using standard radiography include orthoroentogenogram, scanogram, and teleoroentgenogram. orthoroentogenogram requires three distinct exposures centered over the hip, knee, and ankle [13x]. This imaging method differs from a scanogram(13x 18x)therein a extended cassette is required for the orthoroentogenogram, with an extra burden of cost, storage, and special equipment.The teleoroentgenogram(13x)may be a full-length standing AP radiograph of the lower extremity. It consists of one radiographic exposure of both lower limbs, with the xray beam centered at the knee from a distance of roughly 6 feet (180 cm) while the patient stands erect with both patellae pointing directly anteriorly. The disadvantage of teleoroentgenogram is in acute painful conditions and in severe deformities if hip patient cannot stand on the affected limb.

Computed radiography (CR) could be a relatively recent advance within the measurement of leg-length discrepancy that's gaining popularity [37x, 38x]. this imaging modality requires three radiographic exposures; one each centered over the hip, knee and ankle joints which are then stitched at the CR reader console, using customized software. The mean radiation dose was 1.6 to 3.8 times greater and greater cost for the CR-based scanogram study than the roentgenogram.

Microdose digital radiography is another type of computer-aided imaging that substantially reduces the radiation exposure to patients in compared with conventional radiographic techniques [3x]. In an exceedingly study of 25 children with LLD, Altongy et al. [3x] reported interobserver difference in measurement of leg length and LLD was 4 mm and 6 mm respectively for orthoroentgenograms and 6 mm and eight mm for microdose digital radiographs.

CT Scanogram and MRI has very high intraobserver and interobserver reliability in various studies . Both modalities don't seem to be available in tertiary centres and bear a financial burden to the patients. Hence pelvic radiograph was chosen because of the method in our study .

Two radiological techniques predominate within the literature and are widely utilised in clinical practice. Within the methods described by Williamson and Reckling distance between most inferior point of Ischia and lesser trochanter is measured, whereas in method described by Woolson et al distance between inferior point of acetabular tear drop and lesser trochanter is measured.[9,10].Neither Woolson's nor Williamson's method takes account of hip flexion or abduction deformity at the time of the x-ray (which tends to scale back the measured LLD) or any causes of LLD which doesn't involves the hip[9].

Heaver et al reported that inter ischial line was best pelvic landmark for measurement of LLD, whereas Meermans et al reported teardrop line to be better[11,12].Meermans et al further reported that centre of femoral head should be taken as femoral indicator rather than lesser trochanter[12]. There was substantial interobserver agreement when the lesser trochanter was used as a femoral reference (kappa = 0.66-0.70) and excellent interobserver and intraobserver agreement for all other measurements (kappa = 0.84-0.93)[12].

Tipton et al reported that LLD calculated on AP radiograph of the pelvis aren't equivalent to LLD calculated on full length radiographs of limb and hence taking only pelvic radiograph to assess LLD isn't adequate[13].He reported a intraobserver agreement, when the interteardrop line was used produced values of 0.66 for tear drop to LT and 0.62 for tear drop to centre of femoral head. The interobserver agreement was strong for the bi-ischial line, 0.69 and 0.78 for bi-ischial to LT and bi-ischial to centre of femoral head, respectively[13].

There is weak correlation between preoperative clinical and radiological LLD. Keršič et al in their study of 119 primary THA patients reported a LLD of 5-8 mm between preoperative clinical and radiological LLD but, this difference decreased to 1-2 mm postoperatively[14]. Sayednoor et al also supported these findings in their study[15].

In a study by Martin Kjellberg et al[16],computed tomographic scanogram (CT-Scan) was accustomed to evaluate its accuracy by comparing it with LLD measurement on radiograph. They found excellent interobserver reliability (mean ICC 0.83) and intraobserver reproducibility (ICC 0.90 and 0.88) of the LLD measurements on plain radiographs. There was a moderate to excellent agreement, but with wide variation of measurements among the four observers, when plain radiographic measurement was compared with CT-scanogram (ICC 0.58, 0.60, 0.71, and 0.82).

A study by Renwen et al[17], showed that in patients undergoing THA for developmental dysplasia of hip, the preoperatively predicted LLD values and therefore the postoperatively measured LLD values were comparable, yielding a mean absolute difference of 3.7mm (range, 0.1 to 8.6mm). The intraclass correlation coefficient (ICC) of the 2 parameters exhibited strong reliability (ICC=0.911, 95%CI, 0.795 to 0.955). The Bland-Altman plot also showed good conformity between the 2 parameters.

Sabharwal et al[18] reported on the intraobserver and interobserver reliability among five blinded observers with varying degrees of experience to assess LLD using CRbased supine scanograms and standing teleoroentgenograms of 70 patients. The intraobserver reliability for all five observers was high for scanogram (ICC, 0.975–0.995) still as teleoroentgenogram (ICC, 0.939–0.996).

There is no universal agreement for takingreference points to accurately measure limb lengths. Various authors have found out that the measurements from plain radiographs are vulnerable to error, thanks to variations in positioning of the pelvis relative to the plane of the film and therefore the divergence of the X-ray beams.

The abduction/adduction deformitiesof the femur with relevance to the pelvis also cause substantial error within the measurement of the length and offset changes.A radiograph cannot detect angular deformities of the lower limb and will underestimate the LLD in patients with discrepancies in foot height[19,20]. These points should be improved so as to realize more accurate measurements.

5. CONCLUSION

In our study, there was excellent inter-observer agreement for radiological measurements suggesting that radiological measurement is an accurate for measuring LLD. We recognize that our study has

some limitations. First, LLD was evaluated supported the plain pelvic radiographs rather than the CT scans, which are utilised in other studies to eliminate the variables of pelvic tilt that exists while taking radiographs[21,22]. Various authors have noticed that the linear measurements and calculations from plain X-rays are vulnerable to error, thanks to variations in positioning of the pelvis relative to the plane of the film and therefore the divergence of the X-ray beams[23]. Secondly, our study comprises of small study group.

A.1ANNEXURE 1: MASTER CHART

SL NO	AGE	SEX	DIAGNOSIS	SIDE	PRE-OP LLD EXAMINER 1	POST-OP LLD EXAMINER 1	PRE-OP LLD EXAMINER 2	POST-OPLLD EXAMINER 2
1	34	M	AVN	L	4.3	5.4	4.3	5.4
2	57	F	AS	L	2.4	3.5	2.4	3.4
3	21	M	AVN	L	2.2	4.4	2.2	4.4
4	58	F	OA	R	3.9	3.7	3.9	3.7
5	26	M	OA	R	3.7	4.5	3.8	4.5
6	53	M	AVN	L	3.1	4.1	3.1	4.1
7	55	M	AVN	L	2.9	4.4	2.9	4.4
8	61	F	OA	L	3.7	4.3	3.7	4.3
9	57	M	AVN	L	3.2	3.4	3.1	3.4
10	36	M	AVN	L	2.8	4.2	2.8	4.2
11	27	M	AS	R	4	6	3.9	6
12	37	F	OA	L	1.8	3.1	1.8	3.2
13	50	M	TB	L	4.1	4.3	4.1	4.3
14	48	F	OA	L	3.9	4.2	3.9	4.2
15	65	M	AVN	R	5	7	5	7
16	34	F	OA	R	3.6	4.2	3.6	4.2
17	45	F	TB	R	4.1	4.6	4.1	4.6
18	43	F	OA	L	4.5	4.9	4.5	4.9
19	32	M	OA	L	3.3	4.5	3.3	4.4
20	17	M	OA	R	3.8	5	3.8	5
21	50	M	OA	R	4.3	5.4	4.4	5.4
22	32	M	AVN	L	2.4	3.5	2.4	3.5
23	24	M	OA	L	2.2	4.4	2.2	4.5
24	64	F	TB	L	3.9	3.7	3.9	3.7
25	69	M	OA	R	3.7	4.5	3.7	4.5
26	58	M	OA	R	3.1	4.1	3.1	4.1
27	70	M	OA	L	2.9	4.4	2.9	4.4
28	66	F	OA	L	3.7	4.3	3.7	4.3
29	69	M	OA	R	3.2	3.4	3.2	3.4
30	59	F	AVN	R	2.8	4.2	2.8	4.2
31	62	M	AVN	L	4	6	4	6.1
32	49	F	OA	R	1.8	3.1	1.8	3.1
33	67	F	OA	L	4.1	4.3	4.1	4.3
34	58	F	OA	L	3.9	4.2	3.9	4.1
35	55	M	OA	R	5	7	5.1	7
36	69	F	TB	R	3.6	4.2	3.6	4.2
37	60	M	OA	L	4.1	4.6	4.1	4.6
38	62	F	AVN	R	4.5	4.9	4.5	4.8
39	57	M	TB	L	3.3	4.5	3.3	4.5
40	60	M	AVN	R	3.8	5	3.8	5

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