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The Limb Length Difference in Post-Hip Arthroplasty
(Review of Articles)

Abstract
Leg Length Discrepancy (LLD) after Total Hip Arthroplasty (THA) is a prevalent complication that affects the patient's satisfaction with joint replacement surgery. It is the most common reasons for a patient's complaint of a doctor after a joint replacement. Patients will tolerate limb shortness more efficiently than their longevity. The LLD will create pain and limpness for the patients that result in premature aseptic loosening and back pain. Therefore, the surgeon should try to avoid this complication with the help of preoperative templating and various other methods during the operation. The present study examined the reasons for LLD and its preventive procedures in pre/intra-operation.
Keywords: Pelvic joint replacement, Leg Length Discrepancy (LLD), Hip joint arthroplasty, Total hip arthroplasty, limb length discrepancy

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Introduction

The Total Hip Arthroplasty (THA) (replacement) aims to alleviate pain, increase patient mobility and activity, restore normal and stable hip anatomy, and ultimately restore limb length [1,2]. The most frequent patient's complaint of orthopaedic surgeons is Leg Length Discrepancy (LLD) after hip arthroplasty [3]. Patient's satisfaction occurs when their pain is reduced, and other expectations such as limb performance and length are met; which is achieved in the context of a stable hip with well-fixed components [4]. Patients are mainly concerned before a THA surgery about pain reduction and LLD. However, younger patients are worried about their sexual activity or productivity after the operation. Patients more perceive lengthening in the leg, compared to its shortening, which reduces the hip scores after hip replacement surgery. [5] This study is a literature review that examines the LLD after pelvic joint replacement and investigates various methods to reduce this complication.

Prevalence and importance of LLD after hip replacement

Patients can easily tolerate an LLD of up to 1 cm. The prevalence of LLD after THA is not specified and ranges from 1% to 27%, therefore an LLD more than 2 cm will affect the patient's life and lead to pain, limpness, nerve palsy, and eventually premature aseptic loosening (6,7). LLD is associated with increased oxygen consumption, increased heart rate, increased quadriceps muscle activity in longer limbs and plantar flexor muscles in shorter limbs [1,2,4].
In the study of Eden et al., 68 patients underwent THA surgery, all of whom had post-op LLD with a prevalence of 32%. Patients of this group had an average LLD of 14.9 mm, and 68% of patients were.

unaware of their LLD. In addition, the average difference in leg length was 7.2 mm [6]. Another study reported an LLD rate of 96% for a group of patients from which only 12% were able to feel it after the operation. In the AAOS survey in 2008, it is stated that while 95% of patients could feel leg length equality for six weeks, only 4.5% of patients felt LLD six months after the surgery. It should also be pointed out that some patients continue to experience LLD despite the equal anatomical length of both limbs.

Another study on 90 THA patients reported an LLD rate of 62%, where the patients' perceptions of their LLD condition plunged from 43% in the third month to 18% in the 12th month. This study has reported the leading cause of LLD as femoral component misplacement in 98% of the cases.

Preoperative evaluation:

The equal limb length can be achieved in the pre/post-surgery by the patient medical history and his radiological evaluation or appropriate templating, respectively. It is advised to review patient medical history for the presence of childhood diseases such as Slipped Capital Femoral Epiphysis (SCFE), congenital hip dislocation (CHD), neuromuscular disorders, spine deformities, previous history of limb surgery and trauma.

Then we calculate the true and apparent lengths of both limbs in the examinations. The true length of the limb (Fig.1) is calculated from the upper anterior iliac spine on each side to the inner ankle, and the apparent length (Fig.2) is calculated from the navel to the inner ankle.

it is recommended to pay attention to the joints adjacent to the hip, namely the knee and the spine in our examinations since their contractures will end in LLD [7,8]. The discrepancy in apparent length is due to contractures around the hip or lumbar pathology that cause pelvic obliquity. Contraction abduction (Fig.3) results in the elevation of apparent length and lowering of the pelvis of the involved limb and contraction adduction (Fig.4) causes shortness of apparent length and elevation of the pelvis in the involved limb.

Fig.1 Measuring the true length

Fig.2 Measuring the apparent length

Table 1. Pelvic position per true and apparent length of the limb	
The pelvis is balanced, and the length of the limbs is equal	The true and apparent length of limbs are equal
The pelvis is balanced, but the lengths of the limbs are different	The apparent and true lengths of both limbs differ equally
P.O. is observed	The apparent lengths of both limbs are the same, but their true lengths are different
the lengths of the limbs are different and compensatory P.O. is observed	The apparent length of both limbs is not equal, but their true length is the same

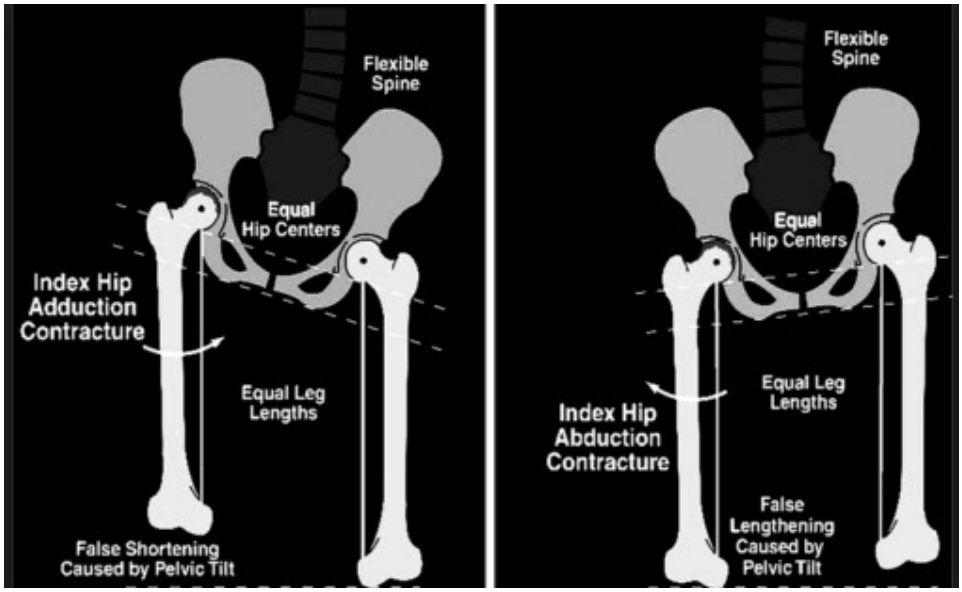

Fig. 3 and 4 - Contraction around the hip

The Box and Block Test (BBT) (Fig.5) helps diagnose whether we are dealing with a flexible or a fixed pelvic obliquity (P.O.). In cases of a flexible P.O., the tilt of the pelvis is corrected by placing blocks [(1)]. (Table.1)

Chronic lumbar spine pathologies lead to fixed P.O., which requires the surgeon to diagnose them before surgery and inform the patient that it is not possible to equalize the apparent length of two limbs since it shortens the true length of both limbs and consequently destabilize the hip or cause nerve damage. The contractures around the hip usually cause a flexible P.O.

An LLD in a damaged hip joint is a combination of the true LLD due to joint destruction and the apparent LLD due to contractures around the joint. If done correctly and with a proper templating, the hip replacement operation Usually leads to equality of the true length in the two limbs, which over time is balanced by removing the contractures around the hip pelvis.

Fig.5 The Box and Block Test (BBT)

Pre-op radiological evaluation:

This stage includes a photo of the pelvic and lateral surfaces of the hip, in which both the hip and the proximal femur should be visible, and hip must be in full internal rotation. In case of a lower limb trauma, a scenography is performed as well.

In the pelvic radiography, the fixed pelvic landmarks (two sides of the obturator foramen, the two sides of the acetabulum teardrop) and the proximal femur (both sides of the lumbar contraction) are connected as

reference lines. Their differences are considered as the true LLD in radiography.

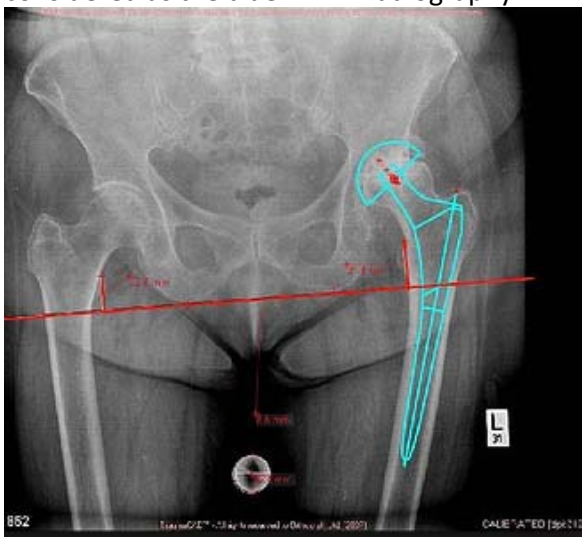

Fig.6 Templating

Preoperative templating:

Pre-op templating (Fig.6) is done by determining the level of femoral neck osteotomy and the position of the acetabular cup offset, it helps the surgeon to restore the centre of rotation for the hip, femoral neck-shaft angle, femoral balance, and finally correct the LLD before surgery [1,4]. To determine the level of neck osteotomy, we need to specify whether the healthy hip is also the normal hip (large trochanter tip is near the centre of the femoral head), the healthy hip is on the side of varus neck (Fig.7) (centre of the head is lower than the tip of trochanter), and finally, whether the healthy hip is on the side of the valgus neck (Fig.8) (the centre of the head is higher than the tip of the trochanter).

Therefore, the level of osteotomy of the neck is based on the opposite side hip to avoid raising or shortening the leg as a result of post-op LLD. If the opposing side hip is in varus, the neck cut will be lowered to prevent excess length (Fig.8). If the opposite side of the neck is in the valgus, the neck cut is lifted (Fig.10) to avoid short legs [9]. Therefore, the lower edge of the cup should be in front of the teardrop to the edges for templating.

Fig.7 Hip varus

Fig.8 Hip valgus

Fig.9 THA in the hip valgus (centre of the head above the tip of trochanter)

Fig.10 THA in the hip varus (centre of the head below the tip of trochanter)

Intraoperative evaluation:

The height of the neck osteotomy should be measured from the lecocanter during the surgery; it should be equal to the size of the osteotomy that was templated before surgery. The limb length of both sides should be measured after trial reduction and before insertion of the main component. The knees of the two sides should be placed adjunctly, and the difference of foot distance between them is evaluated. In other common methods, the distance between the two reference points in the pelvis and the femur is measured. The large trochanter on the femoral side is measured at another point in the pelvis to measure the change in limb length. There are around 20 methods for assessing limb length during surgery which has been reported in the literature.

In the study of Ranawat et al. after exposing the inferior posterior part of the acetabulum in the posterior approach, a pin is inserted into the infracotyloid groove in the ischium. Its insertion point is marked on the trochanter grater. Then the pin is inserted in the previous position, and the trochanter grater is marked, if two marks overlap, it means that the length is the same before and after the joint replacement [10].

In another method, a suture is made just above the incision and measured as a reference to assess limb length [2,7]. Some doctors use computer navigation to evaluate limb length during surgery, which requires the surgeon to accurately define the reference points for the computer, which is expensive and time-consuming. Finally, it is possible to check the placement of components by imaging during surgery.

If the femoral offset is reduced during hip replacement, it should be restored to normal state so that the soft tissue tension is adequate. Therefore, after implantation of the trial, it is checked with the shuck test (traction in the hip extension that opens 2-4 mm). If the soft tissue tension is not suitable and opens

more than 4 mm, the femoral offset should be restored. Otherwise, if a longer neck is used for better stability, the length of the limb will be increased [4].

Reasons for LLD after hip replacement:

1 - Not paying attention to the anatomy of the patient (the healthy side is either varus or valgus). 2 - Placing the cup lower than the teardrop (Fig.11) 3 - Retroverted cup (Fig.12) or excessive inclination that causes instability during the operation and forces the surgeon to use longer neck or place the stem in a higher position for stabilization of the hip, which in turn causes the LLD [1,7].

Fig.11: The cup is lower than the teardrop is on the right side.

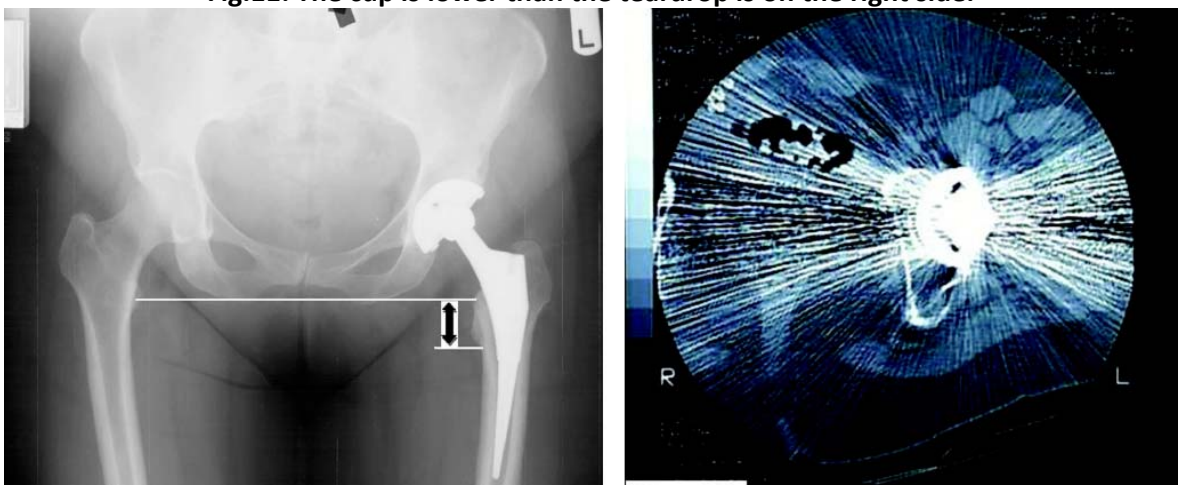

Fig.12 Hip instability due to retrograde cap and its compensation with a longer neck

Symptomatic LLDs have persistent pain, low back pain, instability, and neurological symptoms that do not respond to supportive care and should be carefully evaluated for orientation and position of the cup and stem, sine any malposition will result in the revision

of indication. In a study by Parvizi et al., 21 cases of symptomatic LLD were revisioned due to component malposition, the results were 15 cases of increased limb length, and the mean Harris Hip Score increased from 53 to 83 in the last follow-up [11].

The effect of anaesthesia on LLD:

Chapman et al., have reported the prevalence of LLD in the regional and general anaesthesia as 87% and 47.6%, respectively. In spinal anaesthesia, the laxative soft tissue increases the chances of growing LLD after hip replacement. Therefore, orthopaedic surgeons are advised to perform a preoperative templating and intraoperative evaluation in regional anaesthesia [12].

Treatment of symptomatic LLD after joint replacement:

LLD can be considered symptomatic when it affects the final function and patient satisfaction [7]. The clinical symptoms of symptomatic LLD are different and can cause limpness, fatigue and pain [14]. The LLD is divided into true and apparent categories. A pronounced LLD is caused by pelvic deviation and most often responds to supportive therapies such as physiotherapy and stretching exercises and orthoses. True or structural LLD is caused by the bad cup or stem position and is corrected by the revision operation. In some cases, it is necessary to replace one or both components of the joint replacement [7].

Summary

The post pelvic joint replacement LLD is one of the most common reasons for patient complaints and dissatisfaction with orthopaedic surgeons which can be reduced by proper pre-op, into operational planning, and evaluation and measurement of limb length during surgery. Finally, it is worthy of knowing that the functional hip replacement is the main cause of LLD with symptoms such as lumbosacral scoliosis, P.O., and contractures around the hip that heal over time and do not require reoperation.

Generally, it is not possible to remove the LLD after hip replacement, however, with proper pre-op templating, intraperitoneal checking and positioning of the components, and measuring and comparing the length of the two limbs it may be feasible to avoid a symptomatic LLD that requires revision operation.

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