Leg length inequality after primary total hip arthroplasty

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Abstract

This paper presents an overview of our current understanding of the problem of leg length inequality after primary total hip replacement. We discuss the definition, explore why some patients are affected by this condition and others are not, and review the techniques of measurement on X-ray. We review three key papers from the literature, techniques available for the surgeon to prevent this problem, describe the clinical assessment of a patient with LLI, and their conservative or surgical management. We report on our lessons learnt from the management of these patients and give some thought to the future.

Keywords Complications of primary total hip arthroplasty; leg length discrepancy; leg length inequality; management of leg length inequality; primary total hip replacement; surgery for leg length inequality

Introduction

This paper is written by a hip surgeon who has had a special interest in patients with leg length inequality (LLI) for more than 10 years. More than 20 patients, about half of those referred to this service, have had revision surgery for this complication. All patients had already failed prolonged conservative treatment. Not all patients required surgery. Many just wanted an explanation. Those who did require surgery underwent meticulous counselling and planning before their operation. From the outset our understanding of this subject was poor and it has improved with each patient treated. The literature was not particularly helpful. It is confused, with conflicting views on this complex subject by many authors. Some have used complex scoring systems that were unable to detect the problems with these patients. In other papers, the wrong measurements have been used for analysis. As our understanding of this subject improved we were able to reconcile the apparent differences between many of the papers in the literature.

All surgeons will at some point have to deal with patients with LLI following primary hip replacement. In this paper we will cover the definition of leg length inequality, why some patients are affected more than others, how to measure LLI on X-rays and technical problems with the current techniques, how to prevent LLI in your practice, the clinical features of a patient with LLI, the conservative management of LLI patients, the patient who fails conservative management, the planning of the revision surgery and the results of revision surgery in these patients. We include our lessons learnt from our interest in these patients.

What is leg length inequality?

The total hip replacement (THR) is one of the most successful operations of the century in terms of clinical outcome as well as cost-effectiveness.[1] Whilst Charnley developed the modern type of THR in the 1950s for patients with severe pain and disability, the indications for THR have now extended to include younger, more active patients with higher expectations than before. Consequently, complications such as leg length inequality, which were recognized when the operation was pioneered in the 1950s, but considered less significant, have come to greater prominence.

Incidence of LLI following THR, while dependent on definition, has been noted to be as high as 74% by Nercessian et al.[2] It is a controversial topic, complicated by the lack of consensus on what constitutes an 'unacceptable value' of LLI. Furthermore, there is no gold standard of measurement, or how it should be managed. LLI has been implicated in affecting gait and posture, as well as contributing to low back pain, neurological symptoms, aseptic loosening of hip prostheses and stress fractures. Authors disagree on the extent (if any) to which LLI causes these symptoms and what magnitude of LLI is necessary to generate these problems. Some investigators have tried to quantify a clinically important LLI, accepting as much as 2 cm, whereas others have defined an important discrepancy as one that affects function. The literature does agree that steps should be taken to reduce LLI to as near to zero as possible (Figure 1).

Some patients are at higher risk of developing symptomatic LLI

Some patients are not clinically affected by LLI while other patients appear sensitive to quite minor inequalities. For this reason, we have to question why clinical presentations vary between patients for the same magnitude of LLI. Historically it was thought that short stature patients were more likely to complain of their LLI than taller patients. The argument was that

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1 cm of LLI to a patient of under 5 foot was significant whereas the 1 cm of LLI in someone over 6 foot would not be noticed. As a percentage of their height, the 1 cm was lost in the overall 6 foot of the taller patient. In fact, it is likely that the 1 cm LLI should be looked at as a percentage of the patient's femoral length and its effect on the rectus femoris muscle rather than patient's total height. This muscle is attached at one end to the pelvis and at the other to the tibia. Therefore a modest percentage increase in the femoral length will lead to stretching, dysfunction of this muscle, a positive kick test and may be responsible for the unhappiness in short statue patients.[3] The kick test utilises the tension in the quadriceps muscles of the hip and knee to assess correct leg length. Assuming the lateral decubitus position, the operated leg is placed in an additional 20° of extension from the preoperative rest position, with the knee in a flexed position. If the leg is long then the tibia will spontaneously kick forward on releasing the ankle.

Other parameters which have been highlighted as possibly making patients sensitive to LLI are pre-existing back problems, short femoral offset, low body mass index as well as height, narrow femoral canal, female patients, uncemented stems and pre-existing short abductors. If the patient has short abductors they are unable to tilt their pelvis up on the side of an LLI, which is required for them to compensate for it. They develop a bizarre gait, pivoting on the opposite hip as their fulcrum. It is therefore not surprising that they are unhappy with their LLI.

Measuring LLI

LLI can be assessed clinically with a tape measure, however multiple studies have shown that this can be inaccurate up to 10 mm. When measuring LLI on pre- and postoperative radiographs two methods are commonly used.

1. Williamson et al.[4] in 1978 described using the inter-ischial line as the reference line and measuring the perpendicular distance to the most medial projection of the lesser trochanter on an anteroposterior (AP) pelvic radiograph.
2. Woolson et al.[5] in 1999 proposed using a line drawn between the lowest point of the acetabular tear drop as a reference, and measuring the perpendicular distance to the most prominent part of the lesser trochanter on an AP pelvic radiograph.

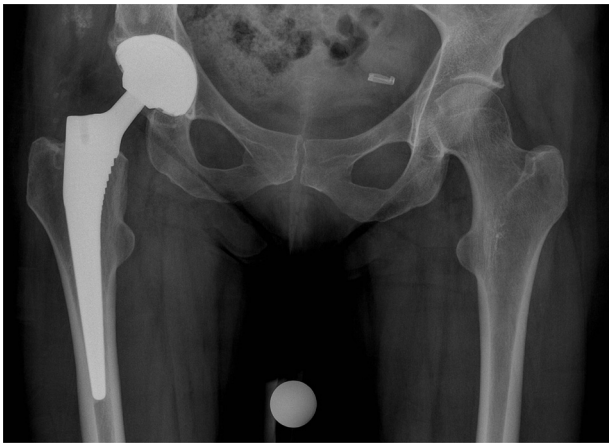

Figure 1 X-ray example of a patient with leg length inequality.

Both methods try to eradicate pelvic obliquity or tilt from the measurements. Woolson commented that the teardrop is a more discrete radiological landmark than the inter-ischial line, which can vary with projection. Both measurements are easily made on the radiographs that can be requested in the clinic setting and provide the surgeon with a starting measurement before undertaking more detailed measurements such as CT scanogram. Woolson quoted an inter-observer 'variation' of 0.5 mm, however he does not support this with any data. Other studies have looked at multiple different methods of radiological measurement with adequate intra-observer reproducibility. The radiological measurements of Woolson and Williamson alone provide only a good estimate or guide to limb length[4,5] (Figure 2).

A validated measurement method has also been described to separate the components of LLI for the femoral and the acetabular components.[6,7] Using the centre of the femoral heads (CFH) as a reference, measurement to two further points, the acetabular tear drop (TD) and the lesser trochanter (LT) allows the surgeon to describe the individual contribution to any given LLI following THR made by both the femoral and acetabular components, as well as the resultant or overall LLI. This detail of understanding of the magnitude of the contributing factors allows the surgeon to accurately plan any revision surgery when needed. Whichever method is used, the lesser trochanter to the teardrop is always the overall leg length distance. These methods of measuring LLI rely on the quality of the radiographs taken, the positioning of the patient, the repeatability of that positioning, and the patient having a normal anatomy. Rigid departmental protocols are encouraged to decrease variation and remove errors caused by difficulties in measurements. The use of standardized measurement markers, placed at the time of the radiograph, at the level of the lesser trochanters allows magnification to be calculated and improved accuracy of measurements once the radiograph is calibrated.

Difficulties using plain X-rays for measurement lie not only with intra-observer error but also with difficulties in correct and reproducible identification of the bony landmarks. This can happen if cement from acetabular components obscures the teardrop or if rotation of the femur gives different views of the projected lesser trochanters. For some patients identifying the most medial projection of the lesser trochanter becomes very inaccurate. The shape of the lesser trochanter means that small differences in projection alter its outline dramatically and may make measurements inaccurate. Flexion of either the hip joint or the pelvis will also lead to errors in measurement as the distance between the lesser trochanter and the reference line will be misrepresented. Abduction and adduction of the measured limb will cause similar difficulties in accurate measurement. Further problems arise with abnormal anatomy (Figure 3) including DDH or previous corrective proximal femoral or pelvic surgery (Figure 4) and may lead to identification of the teardrop and lesser trochanter being impossible. Therefore these simple methods of LLI measurement cannot be undertaken.

Although difficulties are encountered when using measurements on plain X-rays they do provide the surgeon with useful information, which can help direct further investigation of LLI if required. They also allow reassurance to the surgeon when postoperative leg lengths are correct.

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