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Hip Surgeons and Leg Length Inequality after primary hip replacement.

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We are very grateful to the British Hip Society for allowing us to survey their members and particularly to the 153 individuals who took the time to respond to this survey.

Abstract

This study reports the results of two separate surveys of British Hip Society (BHS) members relating to leg length inequality (LLI) after primary total hip replacement (THR). The first survey investigates the members' opinions on the effect of LLI on the outcome of THR and explores the acceptable limits of LLI. It reports that 97% of all surgeons completing the survey believed that LLI can affect the outcome of THR. Despite this, 89% of surgeons agreed that 15mm of LLI after primary uncomplicated THR was always acceptable. From this survey, 90% of surgeons felt that LLI more than 22.74mm was never acceptable.

The second survey reports on the intra-operative techniques currently used by BHS members to minimise LLI after THR. All surgeons reported using at least one intraoperative technique for assessing leg length with a median of five techniques. Over 50% of surgeons use two or more tests. Despite the multiple published papers on various methods of assessing leg length intraoperatively, the problem of LLI post THR persists. This study reports current practice. It highlights the need for further research to develop a simple intra-operative technique with high accuracy and reproducibility.

Introduction

Ensuring equal leg lengths during hip replacement surgery is technically difficult. Fortunately the majority of patients who have leg length inequality (LLI) following total hip replacement (THR) are unaware of it or tolerate it well, but occasionally patients can be very distressed by even a relatively small difference in leg lengths following surgery. Post THR LLI is now a well-recognised complication and a common cause for litigation against surgeons after THR. Despite universal agreement that LLI should be minimized at the time of surgery, there is currently no agreement as to what is a clinically acceptable LLI after primary hip replacement. There is a broad consensus in the literature that any residual LLI of less than 10mm on AP radiographs is clinically acceptable, but there is no agreement over an upper limit that would be considered clearly unacceptable [1]. There are no universally employed surgical techniques which reliably solve this problem and there is no published information on which methods surgeons currently use to minimise LLI during THR.

This study reports the results of two separate surveys of British Hip Society (BHS) members relating to LLI after primary hip replacement. The first survey investigates the members' opinions on the effect of LLI on the outcome of THR and explores the acceptable limits of LLI after primary hip replacement. The second survey reports on the intra-operative techniques currently used by BHS members to minimise LLI after THR.

Survey 1. Survey on consensus of opinion on LLI following THR

A survey of the current opinion of members of the British Hip Society (BHS) on the effect of LLI on outcome of surgery, and a consensus on currently acceptable values after hip replacement

Methods

With BHS approval, an email was sent out to 394 members of the BHS explaining the aim of the work and containing a link to the survey using the Survey Monkey email platform. The survey referred to an “uncomplicated primary total hip replacement in a patient with single joint osteoarthritis who has no other confounding factors”. The survey was not incentivised and all answers were anonymous. All surveys were included in the analysis including incomplete responses. A reminder email was sent after one month.

A five-question survey was used (Figure 1). The survey began by asking if the surgeon believed that LLI had a bearing on outcomes of THR. A positive response then led to a question of magnitude of LLI which would cause a problem. Surgeons were also asked if they felt that there was a value of LLI which would be considered excessive.

Results

A total of 153 (39%) of BHS members responded.

- 97% of surgeons felt that post operative leg length inequality has a bearing on outcomes following THR.

- 89% of surgeons felt that there is a value of post operative LLI less than which would always be considered within the bounds of acceptable practice
- 90% felt that there is a value of post-operative LLI more than which would always be considered excessive.

Question 3 received 129 answers. Four values entered were in excess of 1 metre and it was assumed that these values were entered in error and have not been included in the analysis. The mean response to this question was 10mm. The range was from 2mm to 25mm (figure 2).

When asked if there was a limit more than which the LL would always be considered excessive, there were 130 replies. Again, there were four excessively large values in excess of 1.5metres that were presumed to be errors and excluded from analysis. The mean response to LLI that would always be considered excessive was 20mm, with a range of 2mm to 50mm (figure 3).

Discussion 1.

LLI is a common complication of THR. Depending on the definition of LLI, it ranges from 5% [2, 3] to almost 95% [4] of primary hip replacements. Despite recent advances in materials and refined surgical technique in arthroplasty surgery, LLI following total hip replacement still remains a significant problem for both patient and surgeon. Leg lengthening is more common and is more poorly tolerated than shortening [2]. However there is no published consensus in the literature regarding what constitutes a significant LLI after THR [3, 5, 6] or whether this LLI is associated with poorer outcomes. In this survey of

members of the British Hip Society, 97% of surgeons agreed that LLI does have a bearing on the outcome of THR.

89% of surgeons agreed that there was a value (15mm median) less than which was always within the bounds of acceptable practice. The mean was 10mm however the maximal value for this question was 25mm. 91% of surgeons felt that a mean of 20mm LLI was not acceptable however the maximal value reply for this question was 50mm LLI after THR.

It is clear from the above that there is still wide variation as to what surgeons consider to be acceptable LLI after THR.

The survey was sent to members of the British Hip Society in an attempt to only include surgeons performing large numbers of THRs. This survey received a response rate of 39%, which is in the published range for an electronic survey [7]. It is possible that the surgeons who responded had particularly strong opinions (either positive or negative) about the importance of leg length inequality following THR and therefore their responses may not be entirely representative of the opinions of all arthroplasty surgeons.

The results do not provide concrete values of acceptable leg length inequality following THR. However this is the first study of its kind aiming to generate a body of opinion from an expert group.

Conclusions from survey 1.

This is the first study to publish consensus data for LLI following THR. It reports a strong agreement that LLI following THR can affect outcome with 97% of those who completed the survey reporting that LLI can affect the outcome of hip replacement. Despite this, 89% of surgeons agreed that 15mm of LLI after primary uncomplicated THR was always acceptable. From this survey, 90% of surgeons felt that LLI more than 22.74mm was never acceptable.

Survey 2. Methods used to assess intra-operative LLI.

In an attempt to minimise LLI and its associated complications, surgeons employ a range of techniques pre- and intra-operatively, of both direct and indirect types. Direct methods involve measurement between two points, and indirect methods rely on testing soft tissue tension during surgery. The indirect methods are particularly subjective and depend on several factors including anaesthetic type, patient positioning, pre-existing comorbidities and whether the patient had a pre-existing LLI. In the hands of an experienced arthroplasty surgeon both of these techniques can give very accurate results.

Sir John Charnley, the pioneer of modern hip replacement, originally recommended a direct method of intraoperative comparison of leg lengths by palpating the medial malleoli through surgical drapes [8]. However, Charnley carried out his hip replacements with the patient supine on the operating table. Now that the majority of surgeons perform THRs in the lateral position, other palpable landmarks have been utilised such as palpating each knee to

assess LLI. This technique may be used in conjunction with two other indirect methods of assessing limb length intra-operatively; the Shuck test and the Kick (or drop) test (<https://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&ved=0ahUKEwisYK4rvLRAhWqJsAKHTwNBwYQtwIIjAC&url=https%3A%2F%2Fwww.youtube.com%2Fwatch%3Fv%3D9CACuwhze0&usg=AFQjCNEk8WovpLzeA-6--WlukuTBt1MKBg>). The Kick test utilises the tension in the quadriceps muscles of the hip and knee to assess correct leg length. The operated leg is placed in an additional 20 degrees of extension from the pre-operative 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 [9]. If it is the correct length it will come to rest exactly where it is placed by the surgeon.

The Shuck test is a distraction test on the artificial hip joint

(https://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwjowPudr_LRAhUMDsAKHTmBAWsQtwIIjAA&url=https%3A%2F%2Fwww.youtube.com%2Fwatch%3Fv%3DxYstP0-fhR4&usg=AFQjCNEqAt5ZcNckcEdVryVuuikJh4fHbQ&bvm=bv.146094739,d.ZGg). The artificial hip joint is held in position by the muscles and tendons.

Once the trial hip prosthesis is in place, the Shuck test indirectly measures leg length by testing the tension in the soft tissues around the hip joint. For the right hip, the surgeon supports the leg at the knee with his right arm. The leg is abducted and internally rotated about 20degrees. With a swab around the artificial femoral component neck or using the fingers of the left hand around the femoral neck, the surgeon applies traction in line with the femoral neck

with his left hand and assesses the amount of distraction of the trial femoral head from the acetabulum. The hip should be able to be distracted from the acetabular component if the hips are the correct length. If the hip cannot be distracted at all the hip is too long. This test measures leg length indirectly by assessing soft tissue tension [8, 9]. A variety of other direct measurement techniques have also been described in the literature for use intra-operatively to minimise LLI. Most utilise fixed points on the femur and pelvis to measure limb-length with a Steinman pin into the ilium and using a caliper to measure the distance to a point marked on the greater trochanter. Shiramizu et al developed this technique further with an L-shaped caliper to allow measurement of the long axis of the femur [10], and Ranawat et al [11] utilised a pin in the posterior inferior rim of the acetabulum. Beverland has described the use of the Belfast caliper to reproduce leg length and offset at hip replacement [12]. Despite the many published techniques there is no universal agreement on how best to measure leg length during hip replacement.

The aim of this study was to identify which intraoperative techniques are currently utilised by arthroplasty surgeons attending the British Hip Society annual scientific meeting.

Methods

A questionnaire was distributed to a session at the British Hip Society in March 2014 (Figure 4).

Results

300 questionnaires were distributed and 129 (43%) returned.

Question 1 - Approximately how many total hip replacements do you perform per year?

Surgeons performed a median of 110 THRs per year with a range of 10 to 400. (Figure 5).

Question 2 - What proportion of A) cups and B) stems you insert are cemented?

Cemented cups and cemented stems were the most commonly used implants. 57% of surgeons use cemented cups more than 50% of the time, and 68.3% use cemented stems more than 50% of the time.

Question 3 - Which of the following techniques do you routinely use to assess for leg length during a primary THR?

The most commonly employed technique to measure LL at the time of surgery is by comparing leg length at the knees. This was always used by 90% of surgeons. The Shuck test and a “general feeling of happiness” are both commonly used (always used by 81% and 80.2% respectively). 69.6% of surgeons always measure the height of the collar to the tip of the greater trochanter, 68.6% the neck cut on the calcar, 62.2% the Kick Test and 56.6% assess short rotator apposition. Only 9.9% of surgeons report using a skin suture technique. (Figure 6)

Overall, the 128 surgeons reported “always using” a combined total of 612 techniques, a median of five techniques employed per surgeon.

Fifteen surgeons reported using commercial devices, with the number of users shown in table 1.

Discussion 2.

The aim of this questionnaire-based study was to find out which intra-operative techniques are currently used by surgeons to minimise LLI. A three-question questionnaire was distributed at the British Hip Society (BHS) Annual Scientific Meeting in Exeter 2014 and 129 responses were analysed. The results demonstrate that surgeons are addressing this problem using a median of five techniques in combination intra-operatively. All surgeons use at least one intraoperative technique. The two most popular of these are measuring leg length during hip replacement, by the surgeon using the technique of comparing each leg length at the knees, and the Shuck test. The Shuck test is a test of soft tissue tension which itself is dependent on the leg length. The least utilised technique reported is the skin suture technique. The skin suture technique measures the difference in the distance from a fixed point on the skin to a bony landmark on the femur before and after insertion of the artificial hip joint. A variety of commercial devices were also reported.

Cemented cups and cemented stems were the most commonly used implants. 57% of surgeons use cemented cups more than 50% of the time,

and 68% use cemented stems more than 50% of the time. These figures differ from data taken from the 2015 NJR data which suggests that 31.8% of THRs were fully cemented, 41.2% were cementless and 23.1% were a hybrid or reverse hybrid. The higher use of cemented stems and cups in this study compared to the NJR may be due to the demographics of the surgeons attending the BHS. The questionnaire may have been completed by anyone from junior registrar to senior consultant level. It is not possible to tell from this data whether individual surgeons vary in their implant choice according to patient characteristics.

The fact that more than one technique is used suggests that no one technique is completely accurate and that surgeons feel that employing a combination of techniques gives better results than just using one. This is supported by the literature. Mehra [13] reported that using two methods to minimise LLI was more accurate than one. Rice et al compared using three intraoperative measurements to assess leg lengths - the Shuck test, pelvic pins with calibrated calliper, and assessment of length at the knees with electrocardiogram dots. He showed that the Shuck method best correlates to postoperative radiographic LLI, although all methods were positively correlated [14].

This questionnaire-based study has limitations. It was kept deliberately short, with closed questions for ease of analysis. This may have led to losing qualitative data. An option for adding free text comments was included to try and minimise this.

The questionnaire did not ask about surgical approach. Measuring length at the knees only applies to surgeons operating in the lateral position. Surgeons using an antero-lateral approach in the supine position may measure length at the ankles instead. This question should have included an option for measuring length at the knees and ankles or included a question about approach.

LLI is a problem for both patients and surgeons and is in the top five reasons for claims against hip surgeons in the UK. A review of claims against the United Kingdom National Health Service Litigation Authority showed 100 individual claims for LLI post THR between 1995 and 2010. The mean pay out per case was £84,000 and the highest £595,000 [15]. Post THR LLI is now the commonest cause of litigation against orthopaedic surgeons in the United States, with average settlements in excess of \$700,000 [16].

Conclusions from survey 2.

All surgeons reported using at least one intraoperative technique for assessing leg length with a median of five techniques. Over 50% of surgeons use two or more tests. Despite the multiple published papers on various methods of assessing leg length intraoperatively, the problem of LLI post THR persists. This study reports current practice. It highlights the need for further research to develop a simple intra-operative technique with high accuracy and reproducibility.

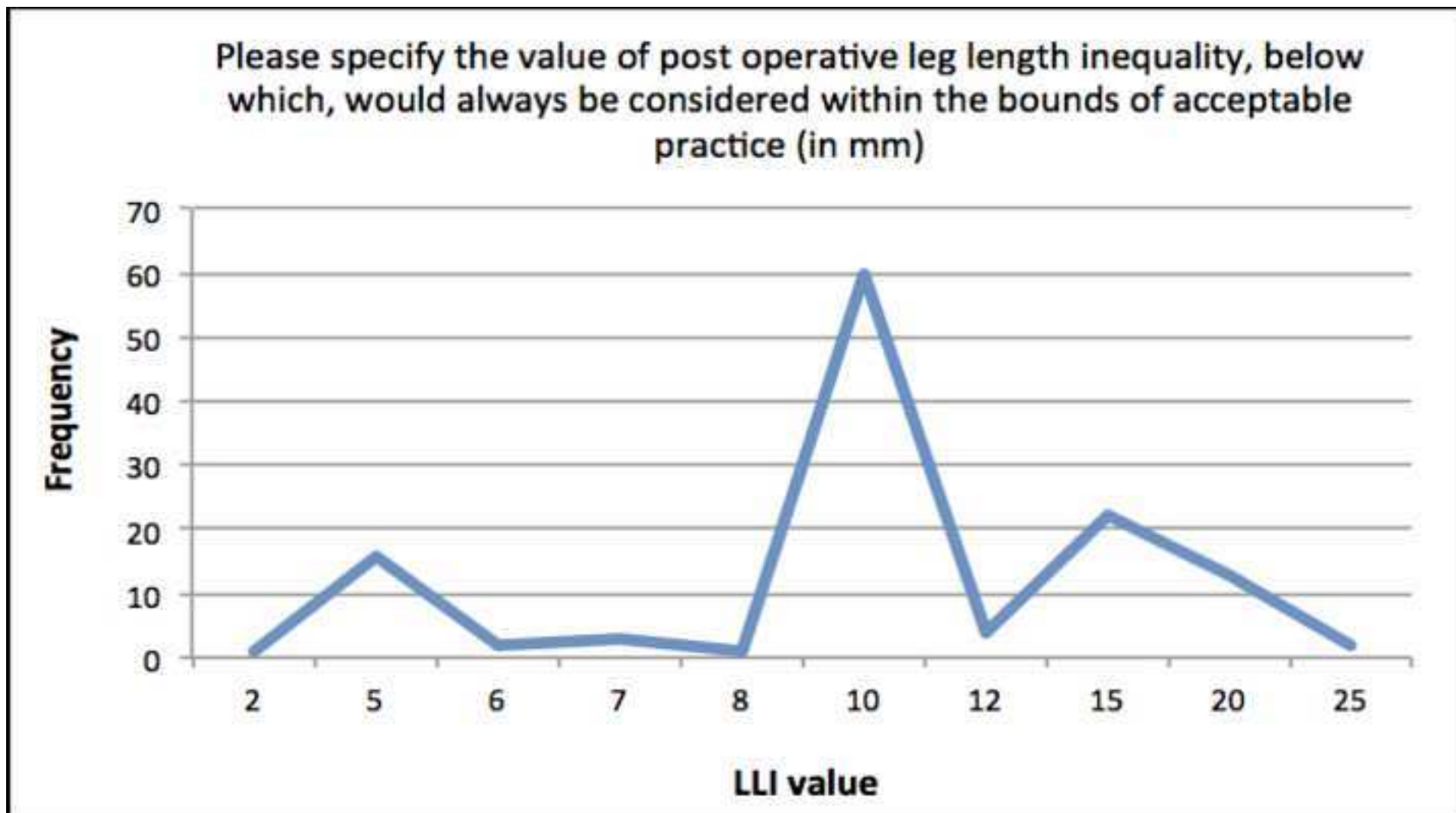
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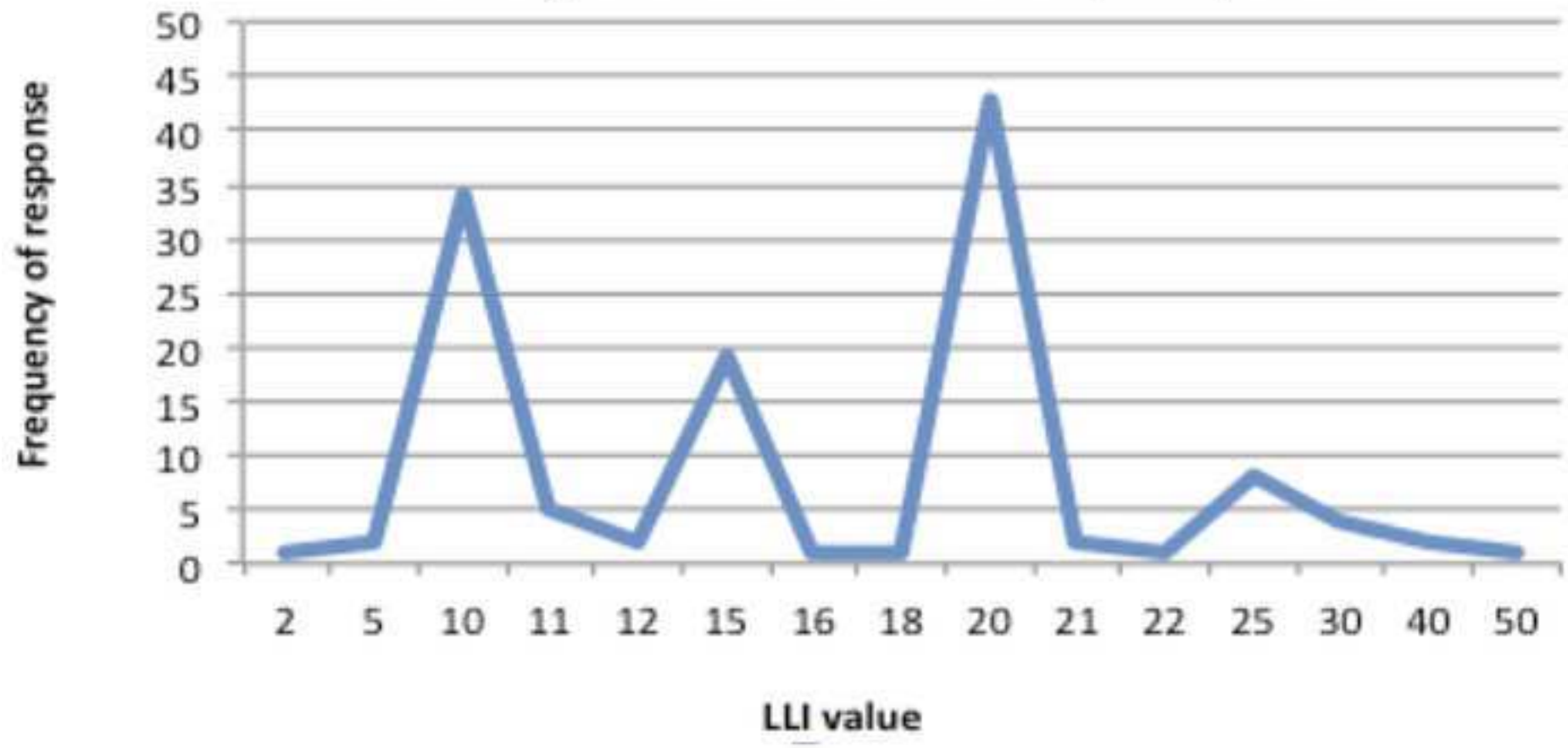
Table 1. Commercial devices used.

Burns jig	2
Iliac pin	5
Charnley pin	2
Judd pin	1
Supra-acetabular pin	1
Belfast calliper	1
Smith & Nephew leg length / offset guide	3

Question 1	Do you feel that post operative leg length inequality has a bearing on outcomes following total hip replacement?
Question 2	Do you feel that there is a value of post operative leg length inequality, below which would always be considered within the bounds of acceptable practice?
Question 3	If yes, please specify (in mm)
Question 4	Do you feel that there is a value of post operative leg length inequality, above which would be considered excessive?
Question 5	If yes, please specify (in mm)



Please specify the value of leg length inequality, above which, would always be out of bounds of acceptable practice



1. Approximately how many total hip replacements do you perform per year?
2. What percentage of A) the cups and B) the stems you insert are cemented?
3. Which of the following techniques do you routinely use to assess for leg length during a primary THR?

Surgeons were asked to indicate whether they use each technique always, sometimes, or never.

- a. Measurement of leg length at knees.
- b. Measure the remaining length of the calcar after cutting the femoral neck.
- c. Measurement of the height of femoral stem collar to tip of the greater trochanter.
- d. The Kick test.
- e. The Shuck test.
- f. Use of a skin suture for measurement.
- g. Assessment of short rotator apposition.
- h. Assessment of a general feeling of happiness.
- i. Other technique. Please specify and name any commercial device used.

