Abstract

Background: Significant limb length discrepancy (LLD) after total hip arthroplasty (THA) is associated with limb, unremitting pain, neurological complications, and recurrent dislocations and has been a major cause of patient dissatisfaction and litigation against operating surgeon. The authors present a prospective study involving a double-stitch technique to prevent postoperative LLD after THA. Materials and Methods: Fifty patients undergoing primary THA over a period of 2 years were included in the study and were divided into two groups of 25 each. In Group I, double-stitch technique was used for intraoperative adjustment of preoperative radiological LLD, whereas in Group II, palpation and comparison of level of patella was used for assessment of LLD. Postoperative LLD and hip outcome scores were obtained and compared. Results: Postoperative radiological LLD (mean ± standard deviation) was 2.72 ± 2.07 mm (range −5 mm to +6 mm) in Group I and +4.28 ± 7.2 mm (range −15 mm to +12 mm) in Group II. Nine patients in Group I and 2 patients in Group II had no true clinical leg lengths discrepancy postoperatively. Postoperative radiological LLD within 5 mm could be achieved in 24 patients in Group I and in 9 patients in Group II. Conclusion: The study indicates that double-stitch technique is a simple and effective method in reducing postoperative LLD following THA.

Keywords: Double-stitch technique, limb length discrepancy, primary total hip arthroplasty

Introduction

The objectives of total hip arthroplasty (THA) include pain relief, improved mobility, stability, and when possible, equality of limb length. Significant limb length discrepancy (LLD) is not an uncommon problem after THA and can pose a substantial problem for the patient as well as orthopedic surgeon. Although many cases are asymptomatic, significant LLD has been associated with complications including limp, unremitting pain, neurological complications, or recurrent dislocation. The incidence of LLD after primary THA has been reported to range from 1% to 27% ranging from 3 to 70 mm with a mean from 3 to 17 mm. Most often the limb is lengthened rather than shortened after THA and ≥1 cm LLD is noted in up to 50% of cases having LLD; however, only 15%–20% of these patients reportedly require a shoe correction for leg length equalization.

Although asymptomatic leg length inequality of 20 mm or more is relatively common even in the general population who have not undergone hip replacement arthroplasty postoperative LLD of more than 10 mm is less likely to be acceptable. Surgeons performing THA should aim to minimize LLD, and therefore, should adopt a reliable method of doing so. Thus, a reproducible technique which is easy to apply and effectively reduces postoperative LLD without increasing operative time is desirable. The techniques reported in literature are either too complicated or are dependent on subjective recreation of initial position of the limb at the time of measurement after insertion of implants. The authors describe a double-stitch technique which is simple and easy to apply. We performed a prospective study in our institute to evaluate the efficacy of this technique in reducing postoperative LLD after THA.

Materials and Methods

A prospective study on 50 patients undergoing primary THA was performed in our institute between 2015 and 2017. Patients having bleeding disorder,
malignancy, local infection, and fracture of proximal femur/acetabulum; patients not giving consent for procedure; and patients with contralateral hip involvement where surgery was not planned for the other hip were excluded from the study.

Patients were subjected to detailed clinical and radiological examination and modified Harris Hip Score and Oxford Hip Score were calculated for every patient. Both preoperative as well as postoperative true and apparent leg length were measured both radiologically and clinically by direct tape measure method. Distance between anterior superior iliac spine and medial malleolus of each limb after squaring of the pelvis was taken as true length. Difference between leg lengths was taken as true clinical LLD. For radiological measurement of LLD, an anteroposterior view of the bilateral hip and pelvis with the limbs in 15° of internal rotation after squaring pelvis was taken in every patient. Vertical distance from a line connecting the inferior margins of the two teardrops to the most medial margin of the lesser trochanter was measured and the difference in these measurements between the two sides was taken as the radiological LLD. Radiological LLD was taken as actual LLD on which intraoperative corrections were planned. Patients were randomly divided into two groups of 25 patients each, depending on their day of admission. In Group I, all surgeries were performed by one senior surgeon of the institute and double-stitch technique was used for limb length equalization. In Group II, surgery was performed by other equivalent surgeons and patellar palpation method was used for intraoperative limb length assessment.

Patient was placed in lateral decubitus position under appropriate anesthesia. A standard posterior approach was used in all the patients undergoing THA. In Group I, before the dislocation of the hip, the limb was positioned in extension, aligned with the axis of the body and parallel to the ground so that this position can be reproduced during the surgery. If full extension and neutral abduction was not possible due to fixed deformity, then the limb was kept in whatever best position was possible and a note was made of it. A suture (silk no 1) was passed in the skin on lateral side of the pelvis around 5 cm proximal to greater trochanter along the long axis of the femur [Figure 1]. The longer limb of the suture was reflected proximally and the second stitch was applied 5 cm proximal to the first stitch along the same axis [Figure 2]. The longer limb of the suture was clamped by a straight forcep, at a distance approximately 15–20 cm away from the tied skin point. Applying a standard tension, in order to just straighten the suture but not to move the tied point of the skin and distort the skin area, the tip of the forcep was placed on the lateral greater trochanter area. The point where the tip of the forcep was touching the femur was marked by diathermy [Figure 3]. All this was done keeping in mind that when a line is drawn through the points of double stitches, it should pass through the distal
reference point and in line with the long axis of the femur. This will help us to reproduce the same route of suture and position of the limb during intraoperative measurements. After exposure of hip joint and dislocation of femoral head, acetabulum was prepared with the help ofreamers of the appropriate size and acetabular component was inserted. Femoral canal was rasped and the trial head and neck were placed on femoral rasp and head was relocated. Now with the limb placed in same position as before in which initial measurements were taken; the amount of lengthening or shortening was measured with the help of suture. Any preoperative LLD was taken into account and adjusted. The goal in all patients was to correct only the radiological LLD.

If the limb was too short, a prosthetic head with longer neck was tried. If the length was too long, the femoral rasp was driven further distally or a head with shorter neck was used. The LLD was reassessed after final placement of femoral component. Once the limb length was equalized/adjusted, the range of motion and stability was assessed followed by closure in layers over a negative suction drain.

In Group II, steps of standard posterior approach were followed and after insertion of acetabular and femoral components and reduction of hip joint, length of the limb was assessed by patellar palpation method.10 As before in Group I, adjustments were made on size of implants to achieve the desired limb length.

In the event of bilateral hip pathology with LLD, the objective was to achieve a normal limb length in the limb operated first and achieve length equal to the first operated limb during second THA. The final outcome in such cases was taken up only after the second THA. In cases where the second THA was planned at much later stage beyond the scope of the present study, such cases were not included in the present study.

Patients were given perioperative broad-spectrum antibiotic cover. Adequate analgesics were administered as per requirement. Quadriceps strengthening exercises were initiated as soon as possible. Weight-bearing was started as soon as the patient got relief from pain; usually within 3–4 days. Postoperative limb length was measured clinically and radiologically and LLD, if any, was calculated and recorded. Patients were followed up regularly initially after a period of 15 days; thereafter after 3 months. Final followup was done at 6-month postoperatively. All the patients were evaluated at final followup using Modified Harris Hip Score, Oxford Hip Score, and final LLD. The data so collected were analyzed with the IBM SPSS 16 (Microsoft Excel version 2007, Washington, USA).

This study was approved by the Institutional Ethics Committee and was performed in accordance with ethical standards.

Results

The mean age was 48.72 years (range 22–81 years) in Group I and 50.02 years (range 26–80 years) in Group II. Both the groups had an identical male/female distribution with a ratio of 0.92 in each group. Avascular necrosis was the most common indication for THA with 36% cases in Group I and 40% cases in Group II, followed by secondary osteoarthritis (32% and 28%). Primary OA was seen in 16% of cases in Group I and 20% of cases in Group II. Preoperative true clinical LLD (mean ± standard deviation [SD]) in Group I and II was −18.32 ± 6.34 (range −32 mm to −8 mm) and −15.32 ± 11.96 mm (range −40 to +25), respectively. Preoperative radiological LLD (mean ± SD) was 9.84 ± 5.35 mm (range −22 mm to −1 mm) in Group I and −9.36 ± 7.94 mm (range −25 to +10 mm) in Group II. Preoperative mean Modified Harris Hip Score was 52.52 in Group I and 53.44 in Group II, whereas mean Oxford Hip Score was 14.46 in Group I and 15.24 in Group II [Table 1].

Postoperative true clinical LLD (mean ± SD) was +1.80 ± 2.32 mm (range −5 mm to +5 mm) in Group I and +5.4 ± 12.2 mm (range −20 to +16) in Group II. Postoperative radiological LLD (mean ± SD) was 2.72 ± 2.07 mm (range −5 mm to +6 mm) in Group I and +4.28 ± 7.2 mm (range −15 mm to +12 mm) in Group II. Nine patients in Group I and 2 patients in Group II had no true clinical leg lengths discrepancy postoperatively. Radiological LLD within 5 mm could be achieved in 24 patients in Group I and in 9 patients in Group II [Table 2].

### Table 1: Limb length discrepancy

| Variable | Group I (cases) | Group II (control) |
|----------|----------------|--------------------|
| Preoperative true clinical LLD (mean±SD) | −18.32±6.34 | −15.32±11.96 |
| Preoperative radiological LLD (mean±SD) | −9.84±5.35 | −9.36±7.94 |
| Postoperative true clinical LLD | +1.80±2.32 | +5.4±12.2 |
| Range (mm) | −5—+5 | −20—+16 |
| Postoperative radiological LLD | +2.72±2.07 | +4.28±7.2 |
| Range (mm) | −5—+6 | −15—+12 |

SD=Standard deviation, LLD=Limb length discrepancy

### Table 2: Comparison of radiological limb length discrepancy

| LLD=Limb length discrepancy | Group I (n) | Group II (n) | P |
|----------------------------|------------|-------------|---|
| ≤5 mm | 24 | 9 | <0.0001 |
| >5 mm | 1 | 16 | |

| LLD=Limb length discrepancy | Group I (n) | Group II (n) | P |
|----------------------------|------------|-------------|---|
| ≤5 mm | 24 | 9 | <0.0001 |
| >5 mm | 1 | 16 | |

LLD=Limb length discrepancy
postoperative Modified Harris Hip Score at 3 months and 6 month was 83.76 and 96.08 in Group I and 83.64 and 91.44 in Group II. Mean postoperative Oxford Hip Score at 3 and 6 months was 44.21 and 47.21, respectively, in Group I and 43.21 and 45.21, respectively, in Group II. There was no correlation between postoperative LLD and hip outcome scores (Pearson’s coefficient (r) = −0.258 to −0.59, $P = 0.05$). In Group I, only two patients had perception of LLD and none of these patients needed a shoe raise, whereas in Group II four patients had perception of LLD and all of them needed a shoe raise. Complications such as sciatic or peroneal nerve palsy were not observed in Group I whereas one of the patients of Group II had a foot drop, which did not improve till the last followup.

**Discussion**

Correcting limb length inequality without compromising hip stability is one of the major challenges in hip arthroplasty, significant LLD after THA being a common cause of patient dissatisfaction.² Although we could not completely eliminate LLD, we were able to reduce it significantly and achieved good postoperative outcome by using double-stitch technique.

Mean preoperative radiological LLD was $-9.84$ mm (range $-32$ to $-8$ mm), whereas postoperative radiological LLD was observed to be $2.72$ mm ranging from $-5$ to $+6$ mm in the patients operated with double-stitch technique, which is comparable with range and mean of LLD in the studies done by Ranawat et al.¹¹ (Steinman pin in infracotyloid groove, mean $2.62$ mm, range $-7$ to $+9$ mm) and González Della Valle et al.¹² (preoperative templating, mean $2.8$ mm, range $-6$ to $+10$ mm). Further, there are some studies in literature with small mean LLD but with a very wide range. Jasty et al.¹³ (preoperative templating and intraoperative calipers) have reported a mean postoperative LLD of $5.4$ mm with a wide range of $-70$ mm to $+4$ mm. Similarly, in a study done by Woolson and Harris¹⁴ (intraoperative caliper device), mean LLD was $<10$ mm but had a wide range of LLD from $-20$ to $+20$. In literature, we found only two studies with range of LLD less than the present study. In a study done by Barbier et al.¹⁵ (length and offset optimization device), range of LLD was $0.04$ mm to $6.96$ mm with mean of $2.31$ mm, while in a study done by Naito et al.¹⁶ (shuck test and Steinman pin), range of LLD was $0$–$2$ mm with a mean of $0.5$ mm.

Various types of techniques described to minimize postoperative LLD can be broadly divided into four categories: (1) based on the preoperative templating to define the correct neck cut, the correct neck length of the femoral component, and the correct depth of femoral component insertion; (2) based on measurement of the distance between pelvic and femoral reference points; (3) based on intraoperative clinical tests such as the shuck test, the drop kick test, and leg-to-leg comparison; and (4) based on the navigation system's measurements.¹⁷ Template techniques used to ensure equal limb length require accurate restoration of acetabular center of rotation which may not be entirely possible during final seating of components.¹²,¹６,¹⁸,¹⁹ Similarly, recreation of depth of insertion of the femoral stem may not be as accurate. Clark et al. in their study have also concluded that template technique should be combined with some reliable intraoperative method to obtain optimal length.¹,²,⁴,¹⁹,²⁰

Intraoperative techniques involving adjustable calipers and/or Steinman pin are invasive procedures requiring additional skin incision.¹¹,¹³,¹⁶,¹²¹ Further, they require accurate repositioning of the limb for the measurement to be accurate which is at best subjective in these techniques. Sarin et al. have also reported that flexion/extension/adduction/abduction error in limb positioning can result in significant discrepancy in intraoperative limb length measurement. Further, these techniques involve measurements which are made significantly away from hip center of rotation, thus resulting in magnification of error in measurement.²¹

Papadopoulos et al. described a technique of single suture which was applied on lateral pelvis for intraoperative limb length assessment, but as there is only one pelvic and one femoral reference point, accurate femur repositioning is not possible.¹⁷ Double-stitch technique as used in the present study takes into account femur repositioning objectively while measuring changes in length intraoperatively. Limb is repositioned in the axis of line joining first stitch, second stitch, and femoral reference point. This three-point relationship makes femur repositioning objective, reliable, and accurate. Another advantage of this technique is its applicability in preoperative fixed flexion deformity of the hip. Different tension on the suture resulting in different measurements is another limitation of single suture technique, whereas in the double-stitch technique, extratension on suture causes buckling of part “A” of the suture [Figure 2], thus making it easy to control tension on the thread while measuring length.

Double-stitch technique takes only 1 or 2 min to apply sutures in contrast to methods dependent on pin and caliper, these sutures need not to be removed and reposited again. There is no need for a separate incision, extracaliper device or specialized instrumentation and measurement can be taken with the help of a measuring scale which is easily available in operation theater. Pelvic and femoral reference points are kept close to joint center and measurements are taken close to bone surface which minimizes rotational and magnification errors so that errors in measuring LLD are minimized.

The limitation of this study is that the sample size was small. Further, although preoperative and postoperative measurements were taken by examiner other than operating surgeon, it was not a double-blinded study. As all surgeries were done by posterior approach, its applicability in
anterior approach is yet to be tested. Another limitation of the technique may be difficulty in application in supine position, especially in the presence of fixed flexion deformity of hip. However, it compares favorably with most of the other techniques reported in literature and gave consistent results in the final outcome.

When literature is replete with studies on various techniques to reduce LLD and ideal technique is yet to come, double-stitch technique proves itself to be promising, effective yet easy way of controlling LLD. We recommend double-blinded randomized controlled trials with larger sample size for more information.

Conclusion

The double-stitch technique during the posterior approach in primary THA is advantageous as it reduces postoperative LLD effectively. However, a comparative study with a larger sample size may be more informative.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Clark CR, Huddleston HD, Schoch EP 3rd, Thomas BJ. Leg-length discrepancy after total hip arthroplasty. J Am Acad Orthop Surg 2006;14:38-45.
2. Desai AS, Dramis A, Board TN. Leg length discrepancy after total hip arthroplasty: A review of literature. Curr Rev Musculoskelet Med 2013;6:336-41.
3. Knutson GA. Anatomic and functional leg-length inequality: A review and recommendation for clinical decision-making. Part I, anatomic leg-length inequality: Prevalence, magnitude, effects and clinical significance. Chiropr Osteopat 2005;13:11.
4. McWilliams AB, Grainger AJ, O’Connor PJ, Redmond AC, Stewart TD, Stone MH, et al. A review of symptomatic leg length inequality following total hip arthroplasty. Hip Int 2013;23:6-14.
5. Harris Hip Score – Orthopaedic Scores. Available from: http://www.orthopaedicscore.com/scorepages/harris_hip_score.html. [Last accessed on 2017 Oct 09].
6. Nilsdotter A, Bremander A. Measures of hip function and symptoms: Harris hip score (HHS), hip disability and osteoarthritis outcome score (HOOS), oxford hip score (OHS), lequesne index of severity for osteoarthritis of the hip (LIISOH), and American Academy of Orthopedic Surgeons (AAOS) hip and knee questionnaire. Arthritis Care Res (Hoboken) 2011;63 Suppl 11:S200-7.
7. Woolson ST, Hartford JM, Sawyer A. Results of a method of leg-length equalization for patients undergoing primary total hip replacement. J Arthroplasty 1999;14:159-64.
8. Gurney B. Leg length discrepancy. Gait Posture 2002;15:195-206.
9. Petis S, Howard JL, Lanting BL, Vasarhelyi EM. Surgical approach in primary total hip arthroplasty: Anatomy, technique and clinical outcomes. Can J Surg 2015;58:128-39.
10. Rice IS, Stowell RL, Viswanath PC, Cortina GJ. Three intraoperative methods to determine limb-length discrepancy in THA. Orthopedics 2014;37:e488-95.
11. Ranawat CS, Rao RR, Rodriguez JA, Bhende HS. Correction of limb-length inequality during total hip arthroplasty. J Arthroplasty 2001;16:715-20.
12. González Della Valle A, Shullitel G, Piccaluga F, Salvati EA. The precision and usefulness of preoperative planning for cemented and hybrid primary total hip arthroplasty. J Arthroplasty 2005;20:51-8.
13. Jasty M, Webster W, Harris W. Management of limb length inequality during total hip replacement. Clin Orthop Relat Res 1996;333:165-71.
14. Woolson ST, Harris WH. A method of intraoperative limb length measurement in total hip arthroplasty. Clin Orthop Relat Res 1985;194:207-10.
15. Barbour O, Ollat D, Versier G. Interest of an intraoperative limb-length and offset measurement device in total hip arthroplasty. Orthop Traumatol Surg Res 2012;98:398-404.
16. Naito M, Ogata K, Asayama I. Intraoperative limb length measurement in total hip arthroplasty. Int Orthop 1999;23:31-3.
17. Papadopoulos DV, Koulouvris P, Aggelidakis GC, Tsantes AG, Lykissas MG, Mavrdontidis A, et al. Intraoperative measurement of limb lengthening during total hip arthroplasty. Indian J Orthop 2017;51:162-7.
18. Halai M, Gupta S, Gilmour A, Bharadwaj R, Khan A, Holt G, et al. The exeter technique can lead to a lower incidence of leg-length discrepancy after total hip arthroplasty. Bone Joint J 2015;97-B:154-9.
19. Hofmann AA, Bolognesi M, Lahav A, Kurtin S. Minimizing leg-length inequality in total hip arthroplasty: Use of preoperative templating and an intraoperative x-ray. Am J Orthop (Belle Mead NJ) 2008;37:18-23.
20. Knight JL, Atwater RD. Preoperative planning for total hip arthroplasty. Quantitating its utility and precision. J Arthroplasty 1992;7 Suppl:403-9.
21. McGee HM, Scott JH. A simple method of obtaining equal leg length in total hip arthroplasty. Clin Orthop Relat Res 1985;194:269-70.
22. Shiramizu K, Naito M, Shitama T, Nakamura Y, Shitama H. L-shaped caliper for limb length measurement during total hip arthroplasty. J Bone Joint Surg Br 2004;86:966-9.
23. Sarin VK, Pratt WR, Bradley GW. Accurate femur repositioning is critical during intraoperative total hip arthroplasty length and offset assessment. J Arthroplasty 2005;20:887-91.