DOI: 10.26717/BJSTR.2018.04.001012

Lan Li. Biomed J Sci & Tech Res

ISSN: 2574-1241

Research Article

Open Access

Gender is Associated with Leg Length Discrepancy after Total Hip Arthroplasty

XiaoXiao Song[1], Chen Yao[1,2], Qiangqiang Li[1,2], Dongyang Chen[1] , Lan Li*[3] and Qing Jiang*[1]

[1]Department of Sports Medicine and Adult Reconstructive Surgery, Drum Tower Hospital, School of Medicine, Nanjing University, China

[2]Department of Sports Medicine and Adult Reconstructive Surgery, Drum Tower Hospital, Nanjing Medical University, China

[3]School of Mechanical Engineering, Southeast University, China

Received: April 19, 2018; **Published:** April 27, 2018

***Corresponding author:** Qing Jiang, MD, PhD. Department of Sports Medicine and Adult Reconstructive Surgery,Drum Tower Hospital, School of Medicine, Nanjing University, No. 321 Zhongshan Road, Nanjing , China

Lan Li, PhD. School of Mechanical Engineering, Southeast University, No. 2 Southeast UniversityRoad, Nanjing , China

Abstract

Background: Leg length discrepancy after total hip arthroplasty (THA) is one of the most common complications. Patients with obvious limb-length change often have functional disability and an accompanying dissatisfation. Purpose to detect the association between gender and the Leg length discrepancy (LLD) after THA

Methods: We retrospective reviewed 158 consecutive patients who underwent primary THA surgery at our institution from May 2016 to July 2017. LLD was measured for all cases on pevilc AP radiograph. Then, we compared LLD between the male and female groups.

Results: The incidence of LLD in our study was 94.9% (150/158) with a mean discrepancy of 7.5mm(range from 0 to 46.3mm). The abduction angle, anteversion angle, percentage of cup in safe zone were not statistical significant difference between the two groups. The LLD was significantly more often in the range of -10mm to 10mm in the female than male groups (84.1% versus 64.7%, p=0.019), however, the association was not found between the other three range classifications and gender.

Conclusion: Male gender is an independent risk factor for marked LLD. Identification of these patients allows the treating surgeon to pay more attention on the intraoperative osteotomy. Further, before surgery, we should emphasize the high probility of LLD after THA, especially to male patients.

Keywords: Leg Length Discrepancy(LLD); Total Hip Arthroplasty (THA); Gender; Prothesis Position

Abbreviations: LLD: Leg Length Discrepancy; THA: Total Hip Arthroplasty; LA: Lateral Approach; DAA: Direct Anterior Approach; OCM: Minimally Invasive Antero Lateral Approach; SD: Standard Deviation; OA: Osteoarthritis; RA: Rheumatoid arthritis; FNF: Femoral Neck Fracture; FHN: Femoral Head Necrosis; DDH: Development Displasia Hip

Introduction

Leg length discrepancy after total hip arthroplasty is one of the most common complications [1]. The incidence of LLD in the literature was reported range from 93% to 99.5% and being lengthened was more common [2,3]. Several studies have showed that minor LLD (<5mm) after THA can seldom be perceived and 10 mm inequality of limb length can be tolerated by most of patients[4]. Patients with moderate LLD (10-20mm) may have mild discomfort but readily manageable by shoe correction. Patients with severe LLD (>20mm) often have functional disability and an accompanying dissatisfation. Those known adverse effect associated with LLD including spinal imbalance and back pain[5], sciatic nerve injury[6], gait disorders[3], dislocation, decreased anterior acetabular coverage [7] and increased rate of revision surgery and disfunction [8]. In order to improve intraoperative accuracy and to minimize the LLD, there are around 20 different methods were reported in the literaure, mainly contain many intraoperative navigation devices and multiple kinds of bone landmark [9-12].

However, the computer navigation system was not only cumbersome and expensive but also increase surgical time. And bone landmark for reference was not accurate and unreliable. In the literature, some patient-related factors, including previous trauma, skeletal dysplasias, soft tissue contractures, and previous surgery to the lower limbs were reported to be associated with leg length inequality [13-15]. But all these factor are relatively rare and little clinical value. Another study demonstrated that the preoperative hip flexion measured under general anaesthesia can be used to predict leg-length change after THA [16]. At our institution, we found a strange penomenon that male patients tend to have a more obvious LLD than females patients. Hence, we performed this study to investigate the association between gender and the LLD after THA. We hypthesis that the LLD in the male group is more obvious than the female group.

Materials and Methods

Ethics Committee approval was obtained. 180 consecutive patients who underwent primary THA surgery at our institution from May 2016 to July 2017 by three different surgeons were identified. Inclusion criteria were patients with osteoarthritis, rheumatoid arthritis, development dysplasia of hip, femoral head necrosis, and femoral neck fracture. Exclusion criteria were patients with ankylosing spondylitis or a history of contralateral limb THA and patients who received a revesion surgery or simultaneous bilateral THA. Finally, 158 patients were included in this study.

Implant Position and LLD

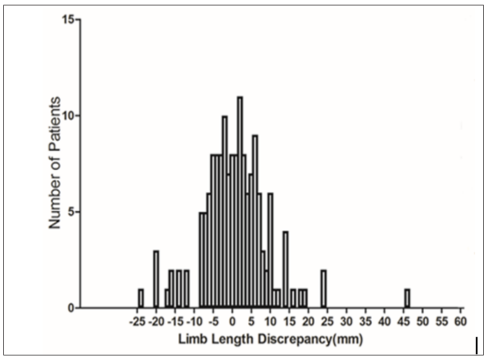

Figure 1: This Figure Shows the Distribution of Average LLD of the Sample for this Study.

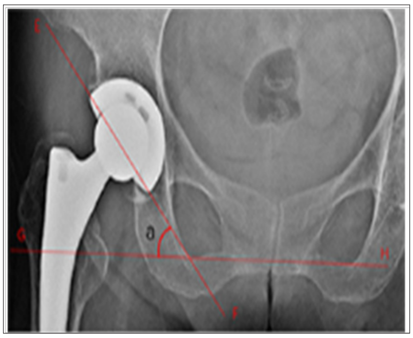

Figure 2: Method of Measurement with Acetabular Inclination Angle (a).
Note: Inclination angle was determined by an angle of a horizontal drawing across the bottom of the ischium tubercle and a line connecting the superior and inferior edge of the acetabular component

All those radiographic parameters were measured on a pelvic AP radiograph via our institutional picture archiving and communication system (PACS, Sectra Imtec AB, Linköping, Sweden).The LLD were calculated by subtracting the distance from the most prominent medial point of the greater trochanter to the line transecting inferior aspect obturator foramina, which is the best method for measuring LLD (Figure 1) [17]. We studied four LLD range classifications in increments of 10mm. In addition, we also assessed the position of the acetabular component and femoral stem. The cup abduction angle was determined by an angle of a line between the inferior border of the ischial tuberosities and a line drawn transecting the widest point of the edge of the cup (Figure 2).

The anteversion angle was calculated on the pelvic AP radiograph based on Abdel et al mentioned method(Figure 3). At our institution, the target goal for abduction angle is 30 degree to 50 degree, for anteversion angle is 5 degree to 25 degree. When the two angles were reached, we thought the acetabular component is in a safe zone. Two independent examiners did the measurement on the first postoperative pelvic AP. Once the measurement results differed by 20%, the third author re-examined it.

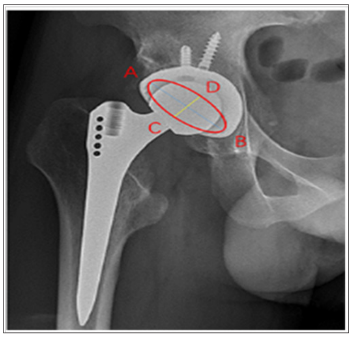

Figure 3: Method of Measurement with Acetabular Anteversionangle (b).
Note: The anteversionangle were calculated based on Abdel et al mentioned method. The long (A to B, AB) and short (C to D, CD) axes of the ellipse of the acetabular component are drawn. The angle ofanteversion is calculated through the formula AV = sin_1 (CD/AB).

Statistical Analysis

We compared LLD, acetabular component, and femoral stem position between male and female groups. Continuous scales were compared with Mann-Whitney's U test and categorical variableswere compared with Fisher exact probability test and Pearson's $\chi 2$ test. A p-value <0.05 was considered significant.

Results

There were no significant differences in age, body mass index, length of incision, diagnosis of hip disorder, Crowe classification, surgical approach and surgeon between male and female groups (Table 1). Of those patients, the operated limb after THA was lengthened in 107 cases (67.7%) with a mean discrepancy of 8.2mm, range from 1 to 46.3mm and was shortened in 41 cases (25.9%) with a mean discrepancy of 7.1mm, range from 0.6 to 24mm and not changed in 10 cases (6.3%) after THA. 51.3% patients (81/158) have a leg-change less than 5mm, 76.6% patients (121/158) have a leg-change less than 10mm and 96.8% patients (153/158) have a leg-change less than 20mm (Figure 4). The abduction angle, anteversion angle, percentage of cup in safe zone and stem in neutral position were not statistical significant difference between the two groups (Table 2). The LLD was significantly more often in the range of -10mm to 10mm in the female group than in the male group(82.8% versus 65.0%, p=0.01, Table 3), however, the association was not found between the other three range classifications and gender.

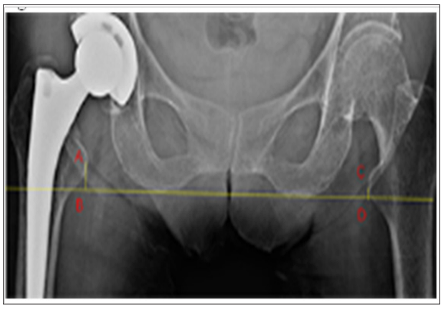

Figure 4: Method of Measurement with LLD.
Note: The LLD were calculated by subtracting the distance from the most prominent medial point of the greater trochanter to the line transecting inferior aspect obturator foramina.

Table 1: The Demographic Data between Male and Female Group.

	Male	Female	p-value
Age	65.9±13.4	68.2±12.3	0.28
BMI(kg/m^2)	23.6±4.9	23.3±4.8	0.64
Length of incision(cm)	12.1±3.2	12.3±3.2	0.57
Surgical approach			0.43
LA	33	61	
OCM	14	15	
DAA	13	23	
Surgeon			0.19
N1	26	36	
N2	17	22	
N3	15	39	
Diagnosis			0.24
OA or RA	3	5	
FNF	21	47	
FHN	24	24	
DDH	10	21	

Table 2: The Association between Gender and Prothesis Position.

	Male	Female	p-value
Abduction angle			0.23
30 to 50	46	86	
<30 or >50	11	12	
Anteversion angle			0.98
5 to 25	74	107	
<5 or >25	16	23	
Safe zone			0.79
In	63	87	
Out	24	36	

Table 3: The Association between Gender and Four LLD Range Classification.

Range classification	Male	Female	p-value
Range 1			0.44
-5 to 5	29	55	
<-5 or >5	30	44	
Range 2			0.01
-10 to 10	39	82	
<-10 or >10	20	17	
Range 3			0.66
-15 to 15	53	91	
<-15 or >15	6	8	
Range 4			0.29
-20 to 20	56	97	
<-20 or >20	3	2	

Discussion

The incidence of LLD is high up to 99% in some literature and vary from 3 to 70mm[9]. Mild LLD (<5mm) after THA could be perceived by patients, but most patients can tolerate the LLD of up to 10mm which has been reported in 16%-32% patients [19]. Lengthening or shortening by more than 10mm was related to a series of problems, such as sciatic nerve injury, gait disorders, dislocation and increased rate of revision surgery. The accompanying discomfort and complications of LLD is the major cause of litigation [19]. Although LLD can not be eliminated, it can be minimized if the risk factors of marked LLD could be identified preoperatively.Unfortunately, we only found one study to explore the LLD-related factors which is published in five years ago. In the study [16], 85 patients (92 hips) diagnosed with DDH were included.

Preoperative passive hip flexion was measured for all patients under general anaesthesia. Of those, 16 had a transverse subtrochanteric shortening osteotomy, whereas the remaining 76 hips had no femoral osteotomy. Finally, they found that in these 16 hips, LLD was significantly greater in the high (>60 degree) than low (<60 degree) flexion groups (31vs. 13mm, p<0.01), and in these remaining 76 hips, LLD was also significantly greater in the high than low flexion groups (25vs. 19mm, p=0.016). This study showed us that the preoperative hip flexion may predict the limb-length change after THA. But, the sample size was small and the author only studied patients diagnosed with DDH which might reduce the outcome reliability and limit its application.In our study, we included 158 consecutive patients (59 males, 99 females). The results demostrated that the LLD was significantly more often in the range of -10mm to 10mm in the female than in the male groups (82.8% versus 65.0%, p=0.01).

Gender is an important factor associated with the outcomes of THA. A recent study [20], exploring the impact of gender on 30-day complication after THA, found that female gender is a protective factor for mortality, sepsis, cardiovascular and renal complications after THA. In a meta-analysis, Kevin et al. [21] demonstrated that the risk of revision following primary THA procedures is higher in men than in women. They explained that increased muscular strength in males could lead to increased torsional forces on femoral component, and the anatomical difference in hip structure, such as a shorter femoral neck, a thinner femoral shaft, a lower femoral offset, and a lower cercicodiaphyseal angle might also result in differential risk of revision. We found the male gender is a risk factor for marked LLD (<-10 or >10mm). The explanation for this relationship was the following two potential reasons.

First, stronger muscle among males may limit the visual filed of operation, influence the osteotomy, result in obvious leg-length change after THA. In addition, anatomical difference in hip structure, such as bigger femoral head and longer femoral neck might also contribute to the difference of LLD between the two groups [19]. To our knowledge, this is the first study to explore the association between gender difference and leg-length change after THA. For the first time, male gender was confirmed to be an independent risk factor for marked LLD after THA. Further, we did not find the association between gender and the acetabular component and femoral stem position. However, there were also some limitations. First, it was a retrospective study rather than a prospective randomized trial nor matched case control study. But, the baseline characteristics were similar between the man and woman groups (Table 1). Second, the sample size was small (59 males and 99 females). Third, the LLD were all manually measured on the computer, which may lead to measuring error. However, we believed that the errors were admissible, because two independent examiners did the measurement and a third observer adjust the errors.

Conclusion

This study provide evidence for an increased risk for marked leg length discrepancy following THA among males. Identification of these patients allows the treating surgeon to pay more attention on the intraoperative osteotomy. Further, before surgery, we should emphasize the high probility of LLD after THA, especially to male patients.

Acknowledgement

This work was supported by the Projects of International Cooperation andExchanges NSFC (81420108021), National Key Technology Support Program(2015BAI08B02), Excellent Young Scholars NSFC (81622033), JiangsuProvincial Key Medical Center Foundation, Jiangsu Provincial Medical Talent

Foundation and Jiangsu Provincial Medical Outstanding Talent Foundation. We thank the patients and their families who donated their blood samples for this study.

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