Spinopelvic alignment does not change after bilateral total hip arthroplasty in patients with bilateral Crowe type-IV developmental dysplasia of the hip

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ABSTRACT

Objective: This prospective study aimed to evaluate the changes in the sagittal alignment after total hip arthroplasty (THA) in patients with hip osteoarthritis (OA) secondary to Crowe type-IV developmental dysplasia of the hip (DDH) and whether THA would contribute to the relief of low-back pain (LBP).

Methods: A total of 27 patients (2 men and 25 women) with bilateral hip OA secondary to Crowe type-IV DDH were enrolled in this study. Their mean age at the time of surgery was 40.36±12.35. All patients underwent simultaneous, bilateral THA between January 2015 and December 2016. Clinical assessment included Oswestry disability index (ODI) score and Harris hip score (HHS), and pelvic incidence (PI), sacral slope (SS), lumbar lordosis (LL), and pelvic tilt (PT) were measured from radiographs.

Results: Preoperatively, all the patients had hip and low-back pain. Preoperative and final follow-up ODI scores were 48.3 and 3.9 (p=0.000), respectively. HHS changed from 43.54 to 92.68 (p=0.000). PT and PI significantly changed from -20.4°±20.4° to 3.2°±16.7° (p=0.001) and from 26.6°±35.1° to 47.4°±17.9° (p=0.001), respectively. There were no significant differences regarding the SS and LL measurements. Age or limb-length discrepancy was not significantly associated with the spinopelvic alignment measurements.

Conclusion: Restoring the function of the hip with THA is shown to improve hip-associated LBP, but the accompanying hyperlordosis does not change. THA in patients with bilateral Crowe type-IV hips relieves hip pain as well as associated LBP. Hyperlordosis of the lumbar vertebra does not change after surgery, but PI and PT changes are observed; this improvement might have a role in the relief of LBP.

Level of Evidence: Level IV, Therapeutic study

Introduction

Developmental dysplasia of the hip (DDH) is characterized by the abnormal development of the hip joint leading to anatomic alterations that affect both the femur and the acetabulum (1). If not diagnosed or treated properly during childhood, it may lead to early onset of degenerative changes of the hip joint. The development of hip osteoarthritis (OA) leads to hip flexion contracture, and lumbar lordosis increases to establish an upright position (2-5). Because of this compensatory change, patients with hip OA secondary to DDH may experience low back pain (LBP) along with the hip pain with a prevalence of 21.2% to 49.4% (3, 4). According to Offiersky and MacNab (6), once the hip OA is corrected, the spinal symptoms would also be relieved because of the improved spinopelvic alignment. Therefore, we designed a retrospective study with the hypothesis that restoring the hip center and normal hip function should relieve hip pain and restore the spinal alignment as well as the related LBP.

Materials and Methods

A total of 27 patients with bilateral hip OA secondary to Crowe type-IV DDH were enrolled in this retrospective study. Their mean age at the time of surgery was 40.36±12.35. All the patients underwent simultaneous, bilateral total hip arthroplasty (THA) for DDH-induced secondary HO between January 2015 and December 2016.

The institutional review board approval was obtained for this study from the Committee of Dr. Sadi Konuk Training and Research Hospital (number: 2014-09.12), and informed consent was taken from all the patients before participating in the study. The exclusion criteria included previous lumbar spine surgery, previous hip surgery, pronounced degenerative appearance of the spine, history of fractures in the lower limbs, lower limb radicular pain, established symptomatic spinal stenosis, and history of disorders that can affect postural control (e.g., Parkinson’s disease).

For all patients, standing anteroposterior (AP) and lateral lumbosacral radiographs and pelvis AP radiographs were obtained before surgery and at the latest follow-up. All radiographs were obtained with a film to focus a distance of 115 cm and X-ray film in contact with the body while the patients were standing (7). In these standard radiographs, the pelvic incidence (PI),...
sacral slope (SS), lumbar lordosis (LL), and pelvic tilt (PT) were measured by an experienced spinal surgeon who was blinded to the functional results of the patients.

Figures 1 and 2 show:

- **Pelvic incidence (PI)** (8): A line connecting the midpoint of the superior plate of S1 and the axis of the femoral heads is defined as the pelvic axis. PI is defined as the value of the angle between the pelvic axis and the line perpendicular to the superior plate of S1. This measurement can be simplified as midpoint from the sacral plate to the femoral head axis. Mean incidence angles in healthy men and women are reported to be 53.2±10.3 and 48.2±7, respectively.

- **Sacral slope (SS) angle** (8): The value of the angle between the superior plate of S1 and a horizontal line. Mean slope angles in healthy men and women are reported to be 41.9±8.7 and 38.2±7.8, respectively.

- **Lumbar lordosis angle (LLA)** (8): The angle between the superior endplate of L1 and the superior endplate of S1. Mean lordosis angles in healthy men and women are reported to be 61.4±10.2 and 56.1±10.6, respectively.

- **Pelvic tilting (PT)** (8): PT represents the angle between the line connecting the midpoint of the sacral plate to the femoral head and the vertical line to floor. Mean tilting angles in healthy men and women are reported to be 11.9±6.6 and 10.3±4.8, respectively.

Clinical assessment included Oswestry low back pain score (OLBP score) and Harris hip score (HHS), which were obtained preoperatively and at the latest follow-up. OLBP score is one of the most commonly used outcome questionnaires for LBP. It is divided into 10 sections, and each section is scored on a 0-5 scale. The index is expressed in percentage, and 0%-20% is interpreted as minimal disability and 81%-100% indicates that these patients are either bedridden or exaggerating their symptoms.

At the final follow-up, mean duration after surgery was 29.4±7.52 months with a minimum follow-up time of 24 months. There were 2 men and 25 women, and all the patients were operated bilaterally under regional anesthesia by the senior author. An anterolateral approach (Modified Hardinge) was used in all patients, and elevation of the entire gluteus medius and minimus was avoided. If these muscles could not be elevated, only a 1-2 cm portion of the gluteus medius was released, and it was later repaired with nonabsorbable sutures.
All the acetabular cups were placed with 2 screws in the true acetabulum (EP-FIT Press-Fit Acetabular Cup System, Smith & Nephew, Memphis, TN) and only size 03 femoral implants (SL-PLUS Cementless Femoral Hip System, Smith & Nephew, Memphis, TN) could be implanted because of the hypoplastic nature of the femoral canal. Hips of most of the patients (76%) were implanted with an acetabular shell of size 46 mm (min: 40, max: 50, and med: 46). Once the femoral canal was prepared, we planned the osteotomy site at the distal end of the trochanter minor, and a prophylactic cable was placed distal to the planned osteotomy site. A transverse shortening osteotomy was then performed according to the preoperative templates. After the osteotomy, the distal femoral canal was broached again, and the osteotomy site was reduced with the help of the Ti grit-blasted rectangular stem. If the osteotomy site was not stable after the insertion of the femoral stem, a trochanteric cable plate and cables (Aysam Med, Samsun, Turkey) were used to increase the stability along the osteotomy site.

On the first postoperative day, the patients were allowed to start range of motion exercises, but they were allowed to toe touch only for 6 weeks. Within this period, they were allowed to mobilize in a wheelchair for daily activities. After 6 weeks, control radiographs were obtained, and if the osteotomy site revealed callus formation, the patients were allowed to bear weight, as tolerated.

**Statistical analysis**

Normally distributed data were evaluated using paired sample t-test, and the others were evaluated using Wilcoxon signed-rank test. Correlation between age and spinal alignment parameters was measured by Pearson’s correlation analysis.

Data were analyzed using the IBM Statistical Package for Social Sciences version 23.0 (IBM SPSS Corp.; Armonk, NY, USA), and statistical significance was set at p<0.05.

**Results**

Mean shortening was 3.6±0.9 on the right side and 3.5±1 on the left side. Mean pre- and postoperative leg length discrepancies (LLD) were 1.2±0.9 and 0.9±0.7, respectively. Of the patient group, 14 patients (52%) had a shorter right lower extremity. All the patients had hip pain and suffered from concomitant LBP at baseline. When they were classified according to their OLPB scores, 5 patients (18.5%) had crippling LBP, 16 (59.2%) had severe disabilities related with LBP, 2 (7.4%) had moderate disability, and 4 (14.8%) had minimal disabilities. OLPB scores at preoperative period and at final follow-up were 48.3±15.1 and 3.9±5 (p=0.000), respectively. Preoperative and final follow-up HHS scores were 43.5±12.5 and 92.7±10.1 (p=0.000), respectively.

Regarding the spinopelvic alignment metrics, PT and PI significantly changed from -20.4±20.4° to 3.2±16.7° (p=0.001) and from 26.6±35.1° to 47.4±17.9° (p=0.001), respectively. In contrast, there were no significant differences for the SS and LL measurements (SS, 46.9±11.9° to 44.1±11.3°, p=0.335; LL, 65.9±12.9° to 61.2±14.1°, p=0.084). None of the patients had lumbar scoliosis preoperatively.

Correlation analysis of age or LLD with spinopelvic alignment measurements were non-significantly related using the Pearson correlation analysis. In other words, we could not find a threshold for age that could be related with irreversible changes in the spinal alignment.

There were 3 complications; 2 patients required acetabular cup revision because of aseptic loosening and another required revision surgery because of instability and subsequent nonunion at the osteotomy site.

**Discussion**

DDH is the most common cause of secondary hip OA. When end-stage OA leads to significant pain and loss of function, THA is the preferred treatment modality. For patients with DDH, increasing LBP can be so disturbing that THA is desired for the relief of hip and back pain (9, 10). LBP that is associated with hip OA is the result of posterior facet overloading, and this is related to hyperlordosis, which compensates the flexion deformity of the hips to allow an upright position (2, 4, 6, 11, 12). Restoring hip function with THA has been shown to improve hip associated LBP, although the accompanying hyperlordosis does not change (13-15). Therefore, we designed our study to evaluate whether the spinopelvic alignment changes after THA in patients with Crowe type-IV DDH-related hip OA and whether THA surgery would contribute to the relief of LBP in these patients.

Our findings showed that significant improvements in HHS and Oswestry disability index scores were achieved as expected. However, we could only show significant changes in the PT and PI values. PT was defined as the angle formed between the anterior pelvic plane and a vertical line connecting the anterior and superior iliac spines, and it was considered negative in case of pelvic retroversion and positive in case of pelvic anteverision (16). In case of DDH, the hip center shifts posteriorly (1). Thus, mean preoperative PT angle in our series was −20.38° as expected. After the surgery, pelvic anteverision was normalized with the implantation of the THA; thus, PT changed to 3.23°. The same was true for PI, which is the angle between the line perpendicular to the sacral plate at its midpoint and the line connecting this point to the axis of the femoral heads. As the axis of the center of the femoral head changes, PI values should change, especially for Crowe type-IV hips, like we observed in our study group.

As previously mentioned, increased hyperlordosis is thought to be a compensatory mechanism that is required to allow an upright position. Although Eyvazov et al. and Bredow et al. had shown that spinal alignment did not change after THA surgeries, both studies reported on unilateral hip OA in patients with normal preoperative pelvic parameters (15, 17). We believe that the altered patient anatomy in this study shows some degree of improvement in our patient population after THA application because of the expected change in the anatomical position of the hip centers. However, only a mean of 4.7° change occurred (p=0.084) in LL and a mean of 2.8° change for SS (p=0.335). There may be several reasons for this. According to Ben-Galim, this may be owing to the radiographic technique rather than true clinical appearance (13). They explained this with the difference between the posture that the patients were instructed to stay in during radiographic examination and their true walking posture or gait pattern. Second, we speculated that longstanding DDH, even in younger patients, resulted in a stiffer spine that could not accommodate the change in the hip center, and we could not find a threshold for age that is associated with these irreversible changes. Although biomechanical overload due to DDH had been overcome and related LBP had resolved, this was not sufficient to change the alignment. Similarly, Radcliff et al. did not report any significant change in the spinopelvic alignment after unilateral THA with a mean follow-up of 9 months (14).
Eguchi et al. also did not find any significant improvement in 12 patients with bilateral hip OA after a mean follow-up of 126.9 days (18). Recently, Miranda et al. evaluated the effect of THA on the radiological parameters of lumbosacral sagittal balance and reported that there was no significant difference between the radiographic variables of sagittal lumbopelvic balance between the preoperative and postoperative measurements (9). They postulated that unidentified pathological mechanisms may exist, which may be associated with the change in LBP.

One limitation of our study was lack of long-cassette AP and X-rays in lateral standing position that could be used to evaluate the changes in global balance. Furthermore, we did not have preoperative or postoperative dynamic lumbar X-rays, and we did not evaluate the lumbar mobility. The patients were not assessed using magnetic resonance imaging to clarify the etiology of the LBP because the authors did not think that this was mandatory, as none of the patients presented with neurological impairments. The third limitation was the limited sample size, but when the rarity of bilateral Crowe type-IV hips was taken into consideration, the sample size could be accepted as the strength of this study.

In conclusion, THA in patients with bilateral Crowe type-IV hip OA relieves hip pain as well as associated LBP. LL does not change after surgery, but PI and PT do; this improvement might have a role in the relief of LBP.

Ethics Committee Approval: Ethics committee approval was received for this study from the Committee of Dr. Sadi Konuk Training and Research Hospital (number: 2014.09.12).

Informed Consent: Informed consent was obtained from all the individual participants included in the study.

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