The Journal of Arthroplasty xxx (2016) 1–5

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

Original Article

Treatment of Crowe Type-IV Hip Dysplasia Using Cementless Total Hip Arthroplasty and Double Chevron Subtrochanteric Shortening Osteotomy: A 5- to 10-Year Follow-Up Study

Xigong Li, PhD, MD [a], Yang Lu, PhD [a], Junying Sun, PhD, MD [b, *], Xiangjin Lin, MD [a], Tiansi Tang, MD [b]

[a] Department of Orthopaedic Surgery, First Affiliated Hospital of Zhejiang University, Hangzhou, China
[b] Department of Orthopaedic Surgery, First Affiliated Hospital of Suzhou University, Suzhou, China

ARTICLE INFO

Article history:
Received 28 May 2016
Received in revised form
27 July 2016
Accepted 28 July 2016
Available online xxx

Keywords:
hip
dysplasia
arthroplasty
cementless
shortening
osteotomy

ABSTRACT

Background: The purpose of this study was to evaluate the functional and radiographic results of patients with Crowe type-IV hip dysplasia treated by cementless total hip arthroplasty and double chevron subtrochanteric osteotomy.
Methods: From January 2000 to February 2006, cementless total hip arthroplasty with a double chevron subtrochanteric shortening osteotomy was performed on 18 patients (22 hips) with Crowe type-IV dysplasia. The acetabular cup was placed in the position of the anatomic hip center, and subtrochanteric femoral shortening osteotomy was performed with the use of a double chevron design. The clinical and radiographic outcomes were reviewed with a mean follow-up of 6.5 years (5-10 years).
Results: The mean amount of femoral subtrochanteric shortening was 38 mm (25-60 mm). All osteotomy sites were healed by 3-6 months without complications. The mean Harris Hip Score improved significantly from 47 points (35-65 points) preoperatively to 88 points (75-97 points) at the final follow-up. The Trendelenburg sign was corrected from a positive preoperative status to a negative postoperative status in 12 of 22 hips. No acetabular and femoral components have loosened or required revision during the period of follow-up.
Conclusion: Cementless total hip arthroplasty using double chevron subtrochanteric osteotomy allowed for restoration of anatomic hip center with safely functional limb lengthening, achieved correction of preoperative limp, and good functional and radiographic outcomes for 22 Crowe type-IV dislocation hips at the time of the 5- to 10-year follow-up.

Total hip arthroplasty (THA) in the treatment of patients with untreated Crowe type-IV developmental dysplasia of the hip (DDH) presents a broad spectrum of technical challenges to the arthroplasty surgeon because of dramatic anatomic abnormalities, including high location of the hip center, poor acetabular bone stock, altered proximal femoral anatomy, and soft-tissue contracture [1-6].

To address these problems during THA for Crowe type-IV DDH, femoral shortening with a subtrochanteric osteotomy was advocated by several surgeons [1,3,5-12]. The proposed advantages of this technique include restoration of the anatomic hip center without sciatic nerve stretching, restoring the abductor mechanism, decreasing limb-length discrepancy, and correcting proximal femoral anteversion at the time of shortening. Various types of subtrochanteric osteotomy have been chosen for the treatment of patients with severe grades of DDH [1,3,5,9,13].

Double chevron subtrochanteric osteotomy initially described by Becker and Ramon [1] has been modified by our team and performed in THA for patients with Crowe type-IV DDH in our department [13]. As we gained experience with this technique, we believed that this subtrochanteric osteotomy could facilitate complex THA in the situation of severe DDH and provide torsional

No author associated with this paper has disclosed any potential or pertinent conflicts which may be perceived to have impending conflict with this work. For full disclosure statements refer to http://dx.doi.org/10.1016/j.arth.2016.07.050.

Ethical statement: This study was approved by our institutional committee for clinical research, and informed consent was obtained from the patients participating in the study.

* Reprint requests: Junying Sun, PhD, MD, Department of Orthopaedic Surgery, First Affiliated Hospital of Suzhou University, Shizi Street 188, Suzhou 215006, China.

http://dx.doi.org/10.1016/j.arth.2016.07.050
0883-5403/

stability of the osteotomy site. Despite of favorable preliminary clinical and radiographic results, to our knowledge, no one has reported the midterm and long-term results of cementless THA with double chevron subtrochanteric shortening osteotomy. The purpose of this study was to report the 5- to 10-year clinical and radiographic results of patients with Crowe type-IV DDH treated by cementless THA combined with double chevron subtrochanteric shortening osteotomy.

Materials and Methods

Between January 2000 and February 2006, 18 consecutive patients with the diagnosis of Crowe type-IV DDH were treated with cementless THA and double chevron subtrochanteric osteotomy in 2 institutions. Patient demographics, preoperative clinical data, surgical data, and postoperative clinical data were collected prospectively on a routine basis for all patients. No previous hip operation was recorded in this group of patients. There were 15 females and 3 males, with a mean age of 53 years (41-76 years) at the time of the index procedure. The indications for arthroplasty were severe pain and/or considerable difficulty in walking and performing daily activities. Eight patients had the procedure on the right side, 6 had the procedure on the left side, and 4 had the procedure bilaterally. No patients were lost to follow-up, with a mean follow-up of 6.5 years (5-10). This study was approved by our institutional committee for clinical research, and informed consent was obtained from the patients participating in the study.

The surgical techniques for cementless THA combined with double chevron subtrochanteric shortening osteotomy were carried out as previously described (Fig. 1) [13]. Briefly, a lateral Hardinge approach was used in all hips. The acetabular notch was exposed for identification of the true acetabulum and evaluation of the bone stock. The true acetabulum was prepared with the reamers, and placement of the cup at the level of the true acetabulum was therefore achieved. Structural bone grafting of the true acetabulum, with use of the excised femoral head, was carried out in 4 patients with <70% coverage of the cup by native bone. Porous-coated acetabular components were used in all hips, including a Duraloc Sector cup (DePuy, Warsaw, SA) in 8 hips, a Press-Fit SII cup (LINK, Hamburg, Germany) in 10 hips, a Reflection cup (Smith & Nephew Richards, Memphis) in 4 hips. The median outside diameter of the acetabular component was 46 mm (42-48).

After the femoral canal preparation, a transverse osteotomy was performed at the level of 2- to 3-cm distal to the lesser trochanter. The amount of femoral shortening was determined by overlapping the proximal and distal fragments of the femur. The measured overlapping part was resected from the distal fragment. Meanwhile, the rotational alignment of both the proximal fragment and the distal fragment is adjusted to allow approximately 15° of anteversion of the femoral component. Finally, the geometry of the previous transverse osteotomy was remodeled to that of double chevron osteotomy. The final femoral stem was inserted into the femur across the osteotomy site. A variety of cementless femoral stems were used; an anatomic medullary locking stem (DePuy, Warsaw) was used in 4 hips, a Summit stem (DePuy Warsaw, USA) in 4 hips, a Ribbed stem (LINK, Hamburg, Germany) in 10 hips, and a Synergy stem (Smith & Nephew Richards, Memphis) in 4 hips. In 8 hips, the medullary canals of the femoral shafts were so narrow for the smallest stem that the femurs had to be split anteriorly and posteriorly for 4-10 cm. Cerclage wires were tightened to allow adequate expansion of the femoral canal for insertion of the final femoral stem. The diameter of the femoral head was 22 or 28 mm. The bearing combinations included cobalt–chromium metal-on-ultrahigh-molecular-weight polyethylene (UHMWPE) in 10 hips and ceramic-on-UHMWPE in 12 hips.

Antibiotic prophylaxis and low-molecular-weight heparin were administered routinely during the hospital stay. Early passive mobilization was encouraged postoperatively. Six weeks after surgery, the patients were allowed partial weight bearing. Gradually progressive weight bearing was permitted upon radiographic evidence of osteotomy union.

The hip function was assessed with the Harris Hip Score [14], which was classified into 4 categories: excellent (90-100 points); good (80-89 points); fair (70-79 points); and poor (<70 points). The gait patterns of the patients were rated as follows: none, slight limp, moderate limp, and severe limp; and the Trendelenburg sign were checked. The leg length was measured from the anterior superior iliac spine to the level of the medial malleolus with the patient lying supine. The presence of intraoperative or postoperative complications was recorded.

For radiographic evaluation, standard anteroposterior radiographs of the pelvis and lateral radiographs of the affected hip were used. Each radiograph was corrected for magnification by calculating the ratio of the measured diameter of the prosthetic head to the true diameter of the prosthetic head. The change in the hip center was measured by determining the vertical distance from the ischial tuberosity to the center of the femoral head on both preoperative and postoperative anteroposterior pelvic radiographs as previously described [11]. Radiolucent lines or osteolysis surrounding the prosthesis were evaluated on postoperative serial radiographs according to the method of DeLee and Charnley [15] for the acetabular components and the system of Gruen et al [16] for the femoral stems. Loosening of acetabular component was defined as the presence of progressive radiolucent lines of >2 mm in thickness in all 3 zones, at least 4° of angle change or >3 mm of migration. The femoral stems were classified as bone ingrowth, fibrous stable, or unstable according to the system of Engh et al [17]. Healing of the osteotomy was evaluated with the criterion of Eskelinen et al [18]. Heterotopic bone was assessed according to the system of Brooker et al [19]. After confirming normal distributions and equal variances of the data, we used a 2-sided paired Student *t* test to analyze preoperative and postoperative Harris hip scores, with $P < .05$ indicated significance.

Results

The mean Harris Hip Score improved significantly from 47 points (35-65) preoperatively to 88 points (75-97) at the final follow-up ($P = .040$). Preoperatively, Harris hip scores were poor in 22 hips. At the latest follow-up evaluation, Harris hip scores were excellent in 10 hips, good in 9 hips, and fair in 3 hips. Preoperative limp was graded as severe in 16 hips, moderate in 5 hips, and slight in 1 hip, whereas limp at the latest follow-up was graded as none in 9 hips, slight in 9 hips, and moderate in 4 hips. Each hip had improvement of limp and Harris Hip Score by at least 1 grade. The Trendelenburg sign was positive in all hips preoperatively. At the final follow-up, it was negative in 12 hips but still positive in 10 hips (Table 1).

The mean amount of femoral subtrochanteric shortening was 38 mm (25-60). The mean limb-length discrepancy in 14 patients with unilateral hip dysplasia decreased from 45 mm (30-62) preoperatively to 15 mm (0-24) postoperatively. Four patients with bilateral involvements retained no apparent limb-length discrepancy after the index procedure.

Postoperative radiographic assessment demonstrated that the mean hip center was translated distally 62 mm (52-80). At the latest radiographic follow-up, there were no cup migration >3 mm, or change in the inclination angle >4°. All patients had bony ingrowth of the acetabular component and union of the acetabular bone graft within 1 year of the operation. Temporary subsidence of