Original Article

Total hip arthroplasty in the developmental dysplasia of the hip using transverse subtrochanteric osteotomy

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ABSTRACT

Background: We assessed the results of the transverse subtrochanteric femoral shortening osteotomy technique and the cementless THA process applied to Crowe type III and IV patients with developmental dysplasia of the hips.

Methods: We retrospectively evaluated 25 patients (32 hips) between 2006 and 2014.

Results: The mean follow-up time was 5.1 years. The mean preoperative Harris hip score was 49.5, which increased to 87.1 postoperatively. The mean preoperative leg-length discrepancy was 3.6 cm; the mean postoperative discrepancy was 0.5 cm.

Conclusion: THA with subtrochanteric femoral shortening osteotomy technique is an effective technique for treating developmental dysplasia of the hip.

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1. Introduction

Total hip arthroplasty (THA) in patients with developmental hip dysplasia poses technical difficulties as compared with primary THA due to anatomical changes in the hip.¹ This presents a challenge for the surgeon performing arthroplasty.² The degree of dislocation and degree of dysplasia are effective determinants of the surgical techniques to be applied.^{1,2}

The Crowe classification is the commonly used classification system for developmental dysplasia of the hip and is based on the magnitude of subluxation of the femoral head, as indicated by the proximal migration observed on an anteroposterior radiograph of the pelvis.³ The Crowe classification includes four types: I (<50% subluxation), II (50–75% subluxation), III (75–100% subluxation) and IV (100% subluxation).³

The dislocated femoral head must be reduced into the original acetabulum. This decreases hip joint reaction force and improves the abductor lever arm, prolonging the survival of the acetabular

component.^{4,5} Positioning of the acetabular component to the true acetabulum is usually performed with femoral shortening.^{4–6} Various osteotomy and fixation techniques have been described in the literature.^{6–12} Osteotomies allow the surgeon to correct the femoral rotational deformity, facilitate reduction of the hip and also eliminate the limb-length discrepancy.⁴

In the present study, we assessed the mid-term results of transverse subtrochanteric femoral shortening osteotomy and the cementless THA process applied to Crowe type III and IV patients with developmental dysplasia of the hips.

2. Patients and methods

Between 2006 and 2014, we operated on 27 Crowe type IV and 5 Crowe type III cases of developmental dysplasia of the hip (25 patients: 13 right, 19 left) using the subtrochanteric femoral shortening osteotomy technique and cementless THA. In total, 20 were women (27 hips) and 5 were men (5 hips). The mean patient age was 51.4 (range 35–70) years. The indication for THA was severe hip pain and dysfunction, reduced mobility and abnormal gait due to leg length discrepancy. Contraindications for surgery were considered as systemic or local infection, patients with severe systemic diseases or any neuromuscular disease in the affected limb.

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2.1. Surgical technique

All patients were operated on with a posterolateral approach in the lateral decubitus position. All operations were performed using cementless femoral and acetabular components. The sciatic nerve was isolated in all cases before performing the arthroplasty. The joint capsule was exposed and resected, and the femoral head was dislocated and resected. The true acetabulum was determined following the location of inferior capsular adhesion to the acetabulum. After cleaning the soft tissues inside the true acetabulum, the acetabulum was deepened posteromedially with reamers beginning with the smallest reamer. In cases in which the superior coverage of the acetabular component was insufficient, augmentation was performed by structural autografts obtained from the head of the femur, fixing with screws. After implantation of the acetabular component, a femoral intramedullary reaming process was performed. Sequential rasping was then conducted until the appropriate stem size was achieved. Then, the transverse subtrochanteric femoral shortening osteotomy was performed 1 cm distally to the lesser trochanter. After placing the trial femoral head and stem to proximal part of the femur, the femoral component was reduced to the acetabulum. Overlapping the proximal and distal femoral parts of the femur, limb shortening was quantified, with the amount of limb lengthening considered to be <5 cm. Soft-tissue release was required in some cases. After preparation of the distal part of the femur, a femoral stem was implanted. While the femoral osteotomy site was supported by cable-cerclage with autografts or plates, in some cases we decided not to use any supporting material.

Postoperatively, patients were allowed to partially bear weight. Patients who had radiologic signs of union at the osteotomy site were allowed to bear full weight. Clinical evaluation included the Trendelenburg sign and the measurement of preoperative and postoperative leg length. Patients were evaluated at the end of follow-up using the Harris hip score (HHS).¹³ The stability of the acetabular components was assessed radiographically by the method of DeLee and Charnley¹⁴ and the femoral component stability was assessed by the method of Gruen et al.¹⁵ Complications were defined as infection, dislocation, neurologic injury, intra-operative and post-operative complications and revision for any reason. The rate of subtrochanteric osteotomy union was recorded. The study was approved by our Institutional Review Board, and all patients provided informed consent.

3. Results

The mean follow-up time was 5.1 (range 2–7) years. The mean preoperative HHS was 49.5 (range 25–72), which increased to 87.1 (range 74–94) postoperatively. The mean preoperative leg-length discrepancy was 3.6 cm (range 1.0–5.5 cm); the mean postoperative discrepancy was 0.5 cm (range 0–1.5 cm). Subtrochanteric osteotomy was performed in all cases; the mean length of bone removed was 3.2 cm (range 2–4 cm). The mean acetabular cup size was 44 mm (range 40–50 mm). Superior coverage of the acetabular component was insufficient in three (9.3%) cases and required augmentation by a femoral head autograft fixed by screws into the defect. In six (18.7%) hips, the femoral osteotomy site was fixed with cable-cerclage and autografts obtained from resection of the femur for shortening (Fig. 1). In one (3.1%) hip, full healing of the femoral osteotomy site was obtained with bone grafts placed around the osteotomy site without using cerclage wires. In nine (28.1%) hips, the femoral osteotomy site was supported only by a plate without using grafts (Fig. 2). In 11 (34.3%) hips, the femoral osteotomy site was not supported any material (Fig. 3). In five (15.6%) hips, proximal and distal osteotomy sites were supported with cable-cerclage to prevent the growth of the femoral fissures

Fig. 1. (a) A 44 year-old woman with bilateral Crowe type IV developmental hip dysplasia. Transverse subtrochanteric femoral shortening osteotomy was performed for the right side and supported with autograft and cable-cerclage. (b) Postoperative 3rd-year pelvis AP radiography, it is observed that autografts were fully unioned to the femoral sides. (c) Six years postoperatively, both cable-cerclages were removed from the osteotomy sites of the femurs.

Fig. 2. (a and b) Preoperative pelvis AP radiography of a 40-year-old woman with bilateral Crowe type IV developmental hip dysplasia. (c) Transverse subtrochanteric femoral shortening osteotomy was performed and was supported with a plate and screws. (d) Five years postoperatively, a femoral varus angulation deformity has developed on the right side.

Fig. 3. (a) Pelvis AP radiography of a 59-year-old woman with bilateral Crowe type IV developmental hip dysplasia. (b) Transverse subtrochanteric femoral shortening osteotomy was performed without any supporting materials at the osteotomy sites and 4 years postoperatively, it is observed that the osteotomy sites are fully unioned.

that occurred during placement of the femoral stem. The mean time until union of the femoral osteotomy site was 7.3 (range 5–12) months.

All patients had a typical Trendelenburg's limp before THA. At the final follow-up evaluation, 10 hips (31.2%) had a positive Trendelenburg's sign. Radiographically, radiolucent lines <2 mm were detected on the acetabular components in zone 1 in two (6.2%) hips and in zone 2 in one (3.1%) hip. For the femoral component, radiolucent lines <2 mm were detected in three (9.3%) hips in zone 1, in one (3.1%) hip in zone 2, in one (3.1%) hip in zone 6 and in one (3.1%) hip in zone 7. These findings were not evaluated as radiographic loosening criteria and acetabular or femoral component revision was not performed for these patients.

3.1. Complications

No patients encountered nerve damage or infection postoperatively. In one (3.1%) patient, hip fibrous union was detected at the femoral osteotomy site, but no serious complaints occurred. In three (9.3%) hips, dislocation of the hip prosthesis occurred in the early postoperative period. Closed reduction was applied to one of these patients and successful results were obtained with a 3-week abduction brace, but in the other two hips, acetabular component revision surgery was required. Varus angulation deformity of the femoral stem developed in one (3.1%) patient at the end of follow-up

but no serious complaints occurred and revision surgery was not required.

4. Discussion

Cementless THA in congenital hip dislocation is a problematic surgery compared with THA in nondislocated hips, with both higher complication and failure rates being reported.^{4,12,16,17} Acetabular and femoral bone stock deficiency, narrower measures of the femoral canal, excessive anteversion of the femur, valgus neck-shaft angle, posterior location of the greater trochanter, soft tissue contractures, lower limb length discrepancy and the inability of the hip abductor mechanism are the most important problems in patients with hip dysplasia.^{16,18} Such problems cause technical difficulties in THA during the length inequality correction and the placement of the acetabular component in the true acetabulum.^{16,17,19} The results of this study show that high congenital dislocation of the hip can be successfully treated by cementless total hip replacement using the transverse subtrochanteric femoral shortening osteotomy technique. In general, using this technique, we have achieved good clinical and radiologic results.

Nerve palsy (0.8–9%) is reported as a complication after THA.^{10,12,20,21} Leg lengthening of >4 cm was suggested to be an indication for femoral shortening osteotomy to prevent nerve palsy.^{11,12,21,22} In contrast, Egli et al.²³ found no correlation between the amount of lengthening and nerve palsy and concluded that nerve contusion was the reason in most cases. In our series, preoperative mean leg-length discrepancy was 3.6 cm (range 1.0–5.5 cm) and we had no case of postoperative nerve dysfunction. Mean femoral shortening was 3.2 cm (range 2–4 cm) in our series. Previously, this amount was reported as 4.5 cm (range 3–6.5 cm) by Kiliçoğlu et al.,⁴ as 4.2 cm (range 2.5–4.5 cm) by Erdemli et al.²⁴ and as 3.1 cm (range 1.5–5.7 cm) by Makita et al.²⁵

Most authors suggest that the acetabular socket should be implanted in the original acetabulum.^{5,17} Repositioning in the real acetabulum serves to restore the biomechanics of the hip joint and improves the power of its surrounding muscles.^{5,17,19,26} In some cases, the anatomical structure of the acetabulum has become very narrow; thus, positioning the cup can be difficult, but we tried to place the centre of rotation of the new joint to the native acetabulum in all patients. In addition, it is recommended that smaller acetabular components be used in hips with dysplasia.^{12,24,27} Replacement in the native acetabulum enables the surgeon to use smaller-sized acetabular components and reduces the need for grafting.^{12,24,27} The average size of acetabular components used in our study was between 40 and 50 mm (mean, 44 mm). Periarticular soft tissue contractures become obstacles to bringing down the hip to its native acetabulum in highly dislocated hips.⁵ Therefore, it may be necessary to release the soft tissues.⁵ We released the iliopsoas tendon and gluteus maximus from the linea aspera, particularly in Crowe type IV hips and performed capsule resection intraoperatively. Percutaneous adductor tenotomy was applied when hip abduction limitation was determined.

Femoral shortening can be achieved through proximal, subtrochanteric or distal osteotomies.^{4,6,7,25,9,28,29} Most authors in the literature discuss the superiority and advantages of their own osteotomy techniques. However, we believe that the involvement of technical expertise and experience are the main reasons for the success of more than osteotomy type. In general, subtrochanteric osteotomy is preferred over other types of osteotomy.^{4,12,29} Several subtrochanteric osteotomy methods have been described including transverse, oblique, segmental, step-cut and V-shaped.^{1,6–8,29–31} However, the transverse osteotomy is technically much easier to perform than the other methods. Rotational stability at the transverse osteotomy can be provided by the tension-band

technique, metal plates and long-stem prostheses.³² Common complications of a subtrochanteric osteotomy are failure of the union and fracture, which also leads to varus angulation, and loss of rotational stability.^{4,6,29} Intraoperative fracture during insertion of the femoral component ranges from 5% to 20%.^{2,29,33} The medullary canal of the femur distal to the osteotomy site is narrow. In most cases, fissures may develop in the femur distal to the osteotomy site during insertion of the femoral stem.^{7,11,21,24,28,29} In the present study, femoral fissures developed in five (15.6%) hips during the insertion the femoral stem and we determined to use cable and cerclage to support the osteotomy site. We did not encounter any trouble with the subsequent process. In this study, osteotomy sites were supported with plates in nine (28.1%) hips. In six (18.7%), hips osteotomy sites were supported with the tension-band technique, also using autologous grafts. We decided to pass the femoral stem from the osteotomy site at least 4–5 cm and took care to make medullary compression of the distal femur. In this way, we believe that we minimize the risk of instability and non-union at the osteotomy site. In our study, we identified one (3.1%) fibrous union in the femoral osteotomy site. However, varus angulation deformity of the femoral stem was identified in one (3.2%) hip. We decided not to perform revision surgery on these hips because the patients had no serious complaints. Rates of dislocation have been reported as 55–11% of patients with developmental dysplasia of the hip.^{11,20} In this study, three (9.3%) hip dislocations occurred in the early postoperative period.

In summary, because of the abnormal anatomy of the proximal femur and acetabular structure, THA in patients with developmental dysplasia of the hips is very difficult. We determined that the mid-term clinical and radiographic results of THA for patients with Crowe type III and IV developmental dysplasia of the hips with the transverse subtrochanteric femoral shortening osteotomy technique were good in our study. THA with subtrochanteric femoral shortening osteotomy is an effective technique for treating developmental dysplasia of the hip. This technique prevents distraction injury of the sciatic nerve. Furthermore, it provides a high rate of functional recovery, improvement in limb length discrepancy and a higher union rate of the osteotomy site.

Conflicts of interest

The authors have none to declare.

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