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Total Hip Arthroplasty after Previous Acetabular Osteotomy: Comparison of Three Types of Acetabular Osteotomy

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ABSTRACT

To compare surgical results of total hip arthroplasty (THA) following acetabular osteotomy, operative records of 13 hips following Chiari osteotomy (Chiari group), 22 hips following rotational periacetabular osteotomy (RAO; RAO group), 16 hips following shelf acetabuloplasty (Shelf group), and 2475 hips without previous osteotomy (Control group) were retrospectively reviewed. The operative time was significantly longer in the RAO group than in the Control group. Bulk bone augmentation was required more often in the Chiari and RAO groups than in the Control group. An early migration of the acetabular cup occurred in 2 hips in the RAO group. RAO made conversion to THA more complicated than did the Chiari osteotomy or the shelf acetabuloplasty.

Acetabular osteotomy is considered to be an alternative treatment for acetabular dysplasia, particularly in adolescents and young adults because the long-term results of total hip arthroplasty (THA) in such patients remain controversial [1–3]. Various types of acetabular osteotomies have been performed to delay progression of osteoarthritis or treat early osteoarthritis in adolescents and young adults; furthermore, many satisfactory long-term results have been reported [4–9]. However, some patients must undergo conversion arthroplasty because of continued pain or progression of hip arthritis after osteotomy [7,10]. Some authors have reported that THA in patients with previous surgical interventions is a technically demanding procedure because of the effect of previous operations on both bone and soft tissues [11–14]. However, to our knowledge, few reports have described the relationship between the types of osteotomies and surgical difficulty. We compared the operative and clinical results of THA following the 3 main types of acetabular osteotomies, including Chiari osteotomy [15], rotational periacetabular osteotomy (RAO) [16], and shelf acetabuloplasty [17].

Patients and Methods

Patients

Between August 2008 and December 2013, 2614 consecutive primary THAs were performed at our institution. Of those patients, 139 hips had previously undergone an acetabular or femoral osteotomy, whereas the remaining 2475 hips did not undergo either osteotomy. Of those 139 patients who had undergone an osteotomy, we excluded 57 hips that had undergone osteotomy during the patients' childhoods (<16 years), 25 hips that had undergone femoral osteotomies because we consider that high ability of bone remodeling during childhood often modify the results of osteotomy, and 6 hips that had undergone unknown osteotomies. The remaining 51 hips in 49 patients were retrospectively reviewed in this study. Of those patients, 13 hips in 13 patients had undergone Chiari osteotomy (Chiari group), 22 hips in 21 patients had undergone RAO (RAO group), and 16 hips in 15 patients had undergone shelf acetabuloplasty (Shelf group). The patients' details are shown in Table 1. The interval between osteotomy and the conversion THA age in the Chiari, RAO and Shelf groups were 22.4 ± 10.5, 20.7 ± 7.6, and 28.1 ± 10.5 years, respectively. No statistically significant difference was observed in the interval between osteotomy and the conversion THA ($P = 0.05$). All patients had previously undergone an acetabular osteotomy at other hospitals. No patient had hardware around the hip joint at the time of THA. The mean follow-up period for the overall population of the 3 groups was 3.8 ± 1.7 years [range, 2–7 years], and every patient followed up. Operative records of 2475 primary THAs without previous osteotomies during the same period were reviewed as a control. The study was conducted with the approval of the institutional review board of our institution.

Operative Technique and Postoperative Care

From 2004, the direct anterior approach [18–21] was used for all hips regardless of physical size, gender, and severity of hip deformity in our institution, with the patients in the supine position on a standard surgical table. Cementless cups and stems were implanted in all cases. All acetabular components were placed as close to the original

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Table 1
Details of the patients.

	Chiari osteotomy	RAO	Shelf acetabuloplasty	*P*-value
Number of patients (hips)	13 (13)	22 (21)	16 (15)	-
Sex (male/female)	1/12	0/22	3/13	0.1051
Follow-up period (years)	3.5 ± 1.6 [range, 2–7]	3.8 ± 1.9 [range, 2–7]	4.0 ± 1.4 [range, 2–6]	0.7738
Mean age at osteotomy (years)	35.1 ± 9.2 [range, 20–49]	36.1 ± 15.1 [range, 16–59]	26.8 ± 9.3 [range. 17–47]	0.0578
Mean age at THA (years)	57.5 ± 7.6 [range, 44–70]	56.8 ± 11.6 [range, 34–73]	54.6 ± 7.2 [range, 41–78]	0.7430
Interval between osteotomy and THA (years)	22.4 ± 10.5 [range, 4–39]	20.7 ± 7.6 [range, 8–35]	28.1 ± 10.5 [range, 13–43]	0.0540
Body mass index (kg/m^2)	22.6 ± 3.0 [range, 19–30]	23.2 ± 3.1 [range, 20–31]	23.8 ± 4.0 [range, 16–31]	0.8636

acetabulum as possible, and if necessary, each component was secured with screws. In cases where press-fit fixation of the cup was not achieved because of large bone defects of the acetabulum, bulk bone from the femoral head was grafted to the defect.

Postoperative rehabilitation was initiated on the first day after surgery. Both active and passive motion exercises of the involved joint and full weight bearing were allowed for all patients. To prevent early postoperative dislocation, deep flexion with internal rotation and hyperextension with external rotation of the hip joint were prohibited for 3 weeks after the surgery. Subsequently, no precautions were taken to avoid postoperative dislocation.

Method of Evaluation

The function of the hip was evaluated using the Japanese Orthopaedic Association (JOA) hip score [22] before and after surgery. Maximum JOA hip score is 100 points, which is the total of separate scores for pain (40 points), range of movement (20 points), gait (20 points), and activities of daily living (20 points). Radiolucent line and loosening were evaluated using anteroposterior hip radiographs obtained at the most recent follow-up. Loosening of the acetabular component was defined according to the criteria of Hartley et al. [23] and that of the femoral component was defined according to the criteria of Martell et al. [24].

Student's paired and unpaired t-test, chi-squared test, and one-way analysis of variance were used to evaluate differences, and the level of statistical significance applied was $P < 0.05$.

Results

The surgical results in each group are summarized in Table 2. The mean operative time was 57.7 ± 11.7 min in the Chiari group, 72.6 ± 24.8 min in the RAO group, 58.3 ± 20.6 min in the Shelf group, and 50.9 ± 18.5 min in the Control group. The operative time was significantly longer in the RAO group than in the Control group ($P < 0.01$).There were no significant difference in operative time between the Chiari and Control groups ($P = 0.19$), and also between the Shelf group and Control groups ($P = 0.11$). Compared with the mean operative blood loss in the Control group (389 ± 274 g), no significant difference was observed in the Chiari group (406 ± 277 g, $P = 0.82$), in the RAO group (475 ± 412 g, $P = 0.15$), and in the Shelf group (406 ± 146 g, $P = 0.81$). Allogeneic blood transfusion was performed in 1 patient (4.5%) in the RAO group and in 26 patients (1.1%) in the Control group. Bulk bone augmentation to the acetabular defect was performed in 2 hips (15%) in the Chiari group, 7 hips (32%) in the RAO group, no patient (0%) in the Shelf group, and 87 hips (3.5%) in the Control group. The requirement for bulk bone augmentation to the acetabular defect was significantly higher in the Chiari and RAO groups than in the Control group ($P = 0.02$ and $P < 0.01$, respectively).

THA provided significant relief of pain and improvement in function for all patients. Each JOA hip score significantly improved from 16.9 preoperatively to 38.2 at final follow-up for pain ($P < 0.01$), from 8.7 to 16.0 for range of motion ($P < 0.01$), from 10.0 to 18.5 for gait ($P < 0.01$), and from 12.8 to 18.2 for activities of daily living ($P < 0.01$). The preoperative total JOA scores in the Chiari, RAO, and Shelf groups were 48.2, 45.7, and 52.8, respectively. The total JOA scores at final follow-up in the Chiari, RAO, and Shelf groups were 89.3, 90.6, and 92.7, respectively. No significant difference was observed in the total JOA scores preoperatively ($P = 0.214$) and at final follow-up ($P = 0.607$) among the 3 groups.

One hip in the Chiari group was dislocated in the fifth postoperative week and was treated by closed reduction; subsequently, no dislocation occurred. An early migration of the acetabular cup was observed in 2 hips in the RAO group; both hips required acetabular augmentation with bulk bone in primary THA. One cup had migrated during the 1st year postoperatively because of bone graft collapse. The lateral opening angle of the cup increased by 9° without any symptoms. The patient was conservatively treated, and the cup has not migrated since then and was radiographically found to be bone ingrown in the 2nd year. The other cup had migrated in the 7th month postoperatively because of collapse of the bulk bone graft. The cup migrated superiorly and required revision surgery 1 year and 7 months after the initial surgery. There were no other major complications, including symptomatic venous thromboembolism, infection, nerve palsy, or periprosthetic fracture. Radiographic analysis showed neither a radiolucent line nor loosening in either the acetabular cup or femoral stem at the last follow-up in this series.

Discussion

Various types of periacetabular osteotomy have been performed for adolescents and adults with developmental dysplasia, and good long-term results have been reported [4–9]. There are 3 important requirements for the success of joint-preserving surgery [10]: creation of a larger articular surface, preservation of muscle strength, and creation of a favorable condition for THA at a later stage. To our knowledge, no study has investigated the relationship between the types of previous osteotomies and clinical results of conversion THA. This study is the

Table 2
Surgical results.

	Chiari osteotomy (n = 13)		RAO (n = 22)		Shelf acetabuloplasty (n = 16)		Control (n = 2475)
		P-value		*P*-value		*P*-value	
Operative time (min)	57.7 ± 11.7 [range, 38–74]	0.1869	72.6 ± 24.8 [range, 33–138]	< 0.0001	58.3 ± 20.6 [range, 32–116]	0.1141	50.9 ± 18.5 [range, 21–198]
Operative blood loss (g)	406 ± 277 [range, 80–850]	0.8260	475 ± 412 [range, 25–1770]	0.1462	406 ± 146 [range, 80–600]	0.8059	389 ± 274 [range, 20–2600]
Allogeneic blood requirements (number of hips)	0 (0%)	0.7103	1(4.5%)	0.1146	0 (0%)	0.6802	26 (1.1%)
Bulk bone grafting (number of hips)	2 (15%)	0.0215	7 (32%)	< 0.0001	0 (0%)	0.4452	87 (3.5%)