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Cementless total hip arthroplasty for dysplastic and dislocated hips

Displastik ve çıkık kalçalarda çimentosuz total kalça artroplastisi

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Objectives: We evaluated the clinical and radiographic results of exclusively the same type and standard sized cementless total hip prostheses applied to all dysplastic and dislocated hips.

Patients and methods: In this study, we retrospectively reviewed 69 patients' (63 females, 6 males; mean age 45.6 years; range 20 to 72 years) 103 dysplastic or dislocated hips on which cementless total hip arthroplasty was performed between January 1998 and January 2006. The mean duration of follow-up was 7.2 years (range 2.0-10.1 years). Eighteen hips (17%) were type I, 29 hips (28%) were type II, 23 hips (22%) were type III and 33 hips (32%) were type IV according to the Crowe classification. Functional and clinical analyses were performed by Harris hip scores. At the last follow-up, the patients were asked whether they were satisfied or not after the operation.

Results: The average preoperative Harris hip score of 39.3 was progressed to 89.5 at the latest follow-ups (p<0.001). Sixty patients (86.9%) reported that they were satisfied after surgery. We observed 41 (39.8%) complications in total, nine of which were intraoperative. There were no findings of symptomatic septic or aseptic loosening at the latest follow-ups.

Conclusion: Cementless total hip arthroplasty is an effective procedure for dysplastic and dislocated hips.

Key words: Cementless; hip dysplasia; hip dislocation; total hip arthroplasty.

Amaç: Bu çalışmada displastik ve çıkık kalçaların tamamında uyguladığımız aynı tip ve standart ölçülerdeki çimentosuz total kalça protezlerinin klinik ve radyografik sonuçları değerlendirildi.

Hastalar ve yöntemler: Bu çalışmada, Ocak 1998 - Ocak 2006 tarihleri arasında çimentosuz total kalça artroplastisi uygulanan 69 hastanın (63 kadın, 6 erkek; ort. yaş 45.6 yıl; dağılım 20-72 yıl) 103 displastik veya çıkık kalçası geriye dönük olarak incelendi. Ortalama takip süresi 7.2 yıl (dağılım 2-10.1 yıl) idi. Crowe sınıflamasına göre 18 kalça (%17) tip I, 29 kalça (%28) tip II, 23 kalça (%22) tip III, 33 kalça (%32) ise tip IV idi. Fonksiyonel ve klinik değerlendirmeler Harris kalça skorlaması ile yapıldı. Son takiplerinde hastalara ameliyat sonrası memnun olup olmadıkları soruldu.

Bulgular: Ameliyat öncesi 39.3 olan ortalama Harris kalça skoru, son takiplerde 89.5'e yükseldi (p<0.001). Altmış hasta (%86.9), ameliyat sonrası memnun olduğunu belirtti. Dokuzu ameliyat sırasında olmak üzere toplamda 41 (%39.8) komplikasyon gözlemlendi. Son takiplerde semptomatik olan herhangi bir septik veya aseptik gevşeme bulgusu yoktu.

Sonuç: Çimentosuz total kalça artroplastisi uygulaması displastik ve çıkık kalçalar için etkili bir yöntemdir.

Anahtar sözcükler: Çimentosuz; kalça displazisi; kalça çıkığı; total kalça artroplastisi.

Total hip arthroplasty (THA) is an effective method of treatment in cases of dysplastic and dislocated hips to relieve pain and improve function although the complication rates and morbidity are higher than for primary osteoarthritis of the hip.[1,2] Anatomical landmarks including the bone, joint and surrounding soft tissue is altered in these patients. Preexisting anatomical alterations may affect the postoperative biomechanics,[3] surgical outcome and longevity of the prosthesis.[4,5] In patients with low dislocation, the major technical problem is reconstruction of the natural acetabulum. In high dislocated hips, the challenge is to place the acetabular component inside the reconstructed true acetabulum and to insert the femoral implant into the hypoplastic narrow femoral diaphysis.[6,7] Femoral shortening becomes necessary

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to avoid over-stretching the neurovascular structures.

Previous clinical research focused on either small sample sizes[5,8] or results of nonhomogenous groups (different techniques and prosthesis designs or cemented and noncemented components in the same group).[2,5,8-10]

This retrospective case series was designed to evaluate the clinical and radiological results of THA performed with exclusively the same type and standard sized cementless components in a consecutive series of 103 dysplastic hips.

PATIENTS AND METHODS

We retrospectively reviewed 69 (63 females, 6 males; mean age 45.6 years; range 20 to 72 years) patients with 103 developmental dysplastic or dislocated hips on which cementless total hip arthroplasties were performed between January 1998 and January 2006. Eighteen hips (17%) were type I, 29 hips (28%) were type II, 23 hips (22%) were type III and 33 hips (33%) were type IV according to the Crowe classification. The mean duration of follow-up was 7.2 years (range, 2.0-10.1 years; Table I). Eight hips had been operated on before (pelvic, periacetabular and femoral osteotomies). The indications were severe pain that did not respond to conservative treatment and functional impairment. Functional impairment that affected daily activities like putting on socks or shoes, climbing stairs, standing from a sitting position, shortening of walking distance and necessity of walking aids were also evaluated. All consecutive patients deemed suitable for THA with these indications were enrolled in the study. Patients were excluded if they had a history of infection or refused to provide consent.

Thirty-four patients were operated on bilaterally in a sequential manner. Sixteen bilaterally operated patients had Crowe type III and IV hips on both sides.

Surgical technique

In all cases we used bi-coated (porous titanium with hydroxyapatit coating) cementless components with parallel femoral stem shape.

All patients were operated on in lateral decubitus position by the same surgeons. The posterolateral approach to the hip joint was used. After incising the capsule and dislocating and resecting the femoral head, all the capsular excision and necessary soft tissue releases were done. After localizing the true acetabulum, the height was evaluated. If there was a chance to locate the femur without shortening, we continued with preparing the acetabulum. If shortening needed to be done, a subtrochanteric transverse femoral osteotomy was performed before acetabular reaming because visualization and preparation of the true acetabulum was easier after pulling the proximal femur upward with a bone-holding forceps to widen the approach to the true acetabulum. The acetabulum was generally shallow, filled with soft tissues and anterior and superior parts were insufficient. The acetabulum was reamed posteromedially to place the acetabular component to be covered at least 70% with bone. Where this could not be done, we used the femoral head as a structural graft to deepen the acetabulum. We fixed the grafts with one or two screws.

TABLE I

Summary of the data

Parameter	n	%	Mean±SD	Range
Age			45.6±7.8	20-72
Gender				
Female	63	91.3		
Male	6	8.7		
Follow-up period (years)			7.2	2.0-10.1
Type I	18	17		
Type II	29	28		
Type III	23	22		
Type IV	33	33		
Operation side				
Left	20	28.9		
Right	15	21.9		
Bilateral	34	49.2		
Acetabular graft				
Positive	69	92		
Negative	6	8		
Cup angle (degrees)			41	30-50

The femur was prepared in a standard manner of cementless prosthesis. The narrow canal was sometimes hard to ream and rasp but gentle manipulations with patience resolved this problem. When shortening was necessary, the proximal femur with the trial stem and head was placed into the implanted acetabulum and the femur was distracted distally as much as possible by an assistant and the overlapped part nearby the osteotomy line of the proximal femur was marked. Then the second osteotomy was performed parallel to the first one from that mark, transversely again. The resected part was measured and noted. If necessary, derotation was performed easily by rotating the distal femur externally until the patella was neutral. Then the original femoral component was implanted and the stability and the status of the sciatic nerve were evaluated. When the stability was in doubt, internal fixation of the osteotomy line with a low-contact plate and screws was performed.

On the first postoperative day, rehabilitation exercises were begun and the patients were allowed non-weight bearing walking with crutches. Weight bearing was progressively increased according to pain relief and radiographic controls. Parenteral prophylactic antibiotic therapy with first generation cephalosporin was begun half an hour before surgery and continued for two days postoperatively. Thromboembolic prophylaxis with low molecular weight heparin was begun 12 hours before surgery and continued for as long as the hospital stay.

All patients were examined at the 6th week and 3rd, 6th and 12th months and yearly thereafter. Both anteroposterior and lateral radiographs were evaluated at each control.

All patients were evaluated clinically by one of the authors. Preoperative and postoperative leg lengths and existence of Trendelenburg sign were evaluated. Functional and clinical analyses were done with Harris hip scores. At the latest follow-up, the patients were asked whether they were satisfied or not after the operation.

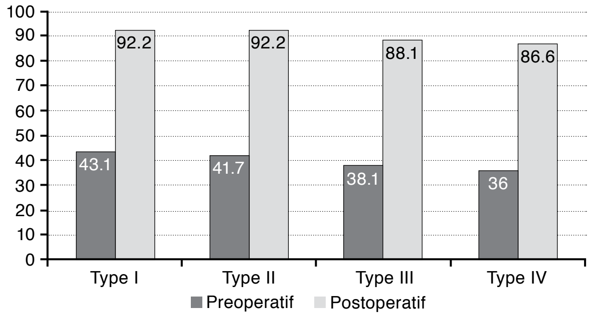

Figure 1. Preoperative and postoperative hip scores of Crowe type I, II, III, and IV hips.

The radiographic analysis was performed by one of the authors who was not involved in surgery and blinded to the clinical results. These patients were reviewed with regards to preoperative status (Crowe type I, II, III or IV). On early postoperative radiographs, the acetabular component location, inclination angle, whether an acetabular graft was used or not, the femoral component's position and filling of the canal were evaluated. On the follow-up radiograms, the position of the cup and femoral stem, acetabular inclination angle, existence of any loosening or subsidence, heterotrophic ossification, union of the acetabular graft and the osteotomy line were evaluated. The stability of the acetabular and femoral components was assessed with the method of DeLee and Charnley[11] and Gruen et al.,[12] respectively. Heterotrophic ossification was classified as defined by Brooker et al.[13] Any complication seen intraoperatively or postoperatively was noted.

Statistical analysis

The Wilcoxon signed rank-sum test was used to compare preoperative and postoperative Harris hip scores. Mann Whitney U-test was conducted to explore the impact of acetabular grafting, femoral shortening and bilateral/unilateral operations on postoperative Harris hip scores. The postoperative Harris hip scores of Crowe type I, II, III, and IV were compared by using One-way ANOVA (Analysis of Variance) and followed by Tukey's HSD post-hoc test.

RESULTS

No cases were lost to follow up. The average preoperative hip score of 39.3 progressed to 89.5 at the latest follow-up ($p<0.001$; Figure 1). Sixty patients (86.9%) answered they were satisfied after surgery.

There was no significant difference between the postoperative Harris hip scores of acetabular grafted and non-grafted hips or unilaterally and bilaterally operated hips ($p=0.502$, $p=0.435$; respectively). There

TABLE II

The correlation of the Harris hip scores between subgroups

Parameter	n	%	*p*
Acetabular graft			0.502
Positive	23	22.7	
Negative	80	77.3	
Operation side			0.435
Unilateral	35	51.8	
Bilateral	34	49.2	
Femoral Shortening			<0.001
Positive	45	34.4	
Negative	58	65.6	

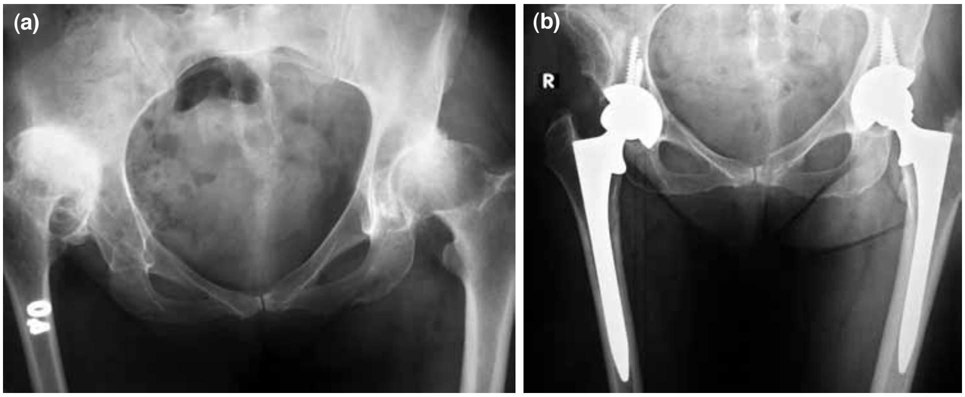

Figure 2. (a) Preoperative pelvic radiograph of a 62-years-old woman disabled from severe pain. **(b)** Bilateral staged total hip arthroplasty was performed with cementless, bi-coated components (postoperative 5th year follow-up radiogram).

was significant difference between femoral shortened and non-shortened hips (p<0.001; Table 2).

There were statistically significant differences at the p<0.001 level in postoperative Harris hip scores for four Crowe types: F (3, 99)= 17.832 (One-way ANOVA). Post-hoc comparisons using the Tukey HSD test indicated that the mean scores of Crowe type I and type II were significantly different from Crowe type III and IV.

All of the acetabular components were placed at the true acetabulum. The anatomical hip center was restored in all of the hips (Figure 2). The average acetabular inclination angle of 41 degrees (range 30-50 degrees) changed in 22 hips with a mean 1.6 degrees (range, –5, 2 degrees) at the latest follow-up. We needed to use structural femoral head autograft in 23 acetabula (22.3%; Figure 3). Two of the grafted acetabula were in Crowe type I, 13 of them were type II, one was type III and seven were type IV hips. At the latest follow-up, all grafts were united but three hips in zone III, two hips in zone II and III and one hip in all zones exhibited a radiolucent line smaller than 1 mm thickness. In one acetabulum, there was a 2 mm-thick line in all zones, but the hip was asymptomatic. One of the cups augmented with structural graft displaced and was revised at the 3rd month of the index operation.

Forty-five hips of 31 patients were shortened with subtrochanteric femoral osteotomy and 10 of them were fixed with low-contact, 4.5 mm plate and screws in order to increase rotational stability (Figure 4). Five of the osteotomies that were not fixed additionally at the first operation did not unite and were treated with internal fixation and in-situ grafting. They all eventually united. The mean union time at the osteotomy line was four months (range 2.5 to 14 months). The average leg length discrepancy was 2.85 cm (range 0-5 cm) preoperatively, and 1.4 cm (range 0-2.4 cm) at the latest follow-up. Trendelenburg sign became negative in

Figure 3. (a) Radiograph of both hips of a 50-years-old woman showing Crowe type I dysplasia on the right and type II dysplasia on the left hip. **(b)** Postoperative 4th year follow-up radiogram demostrating well united acetabular bulk femoral head autograft on the left side.

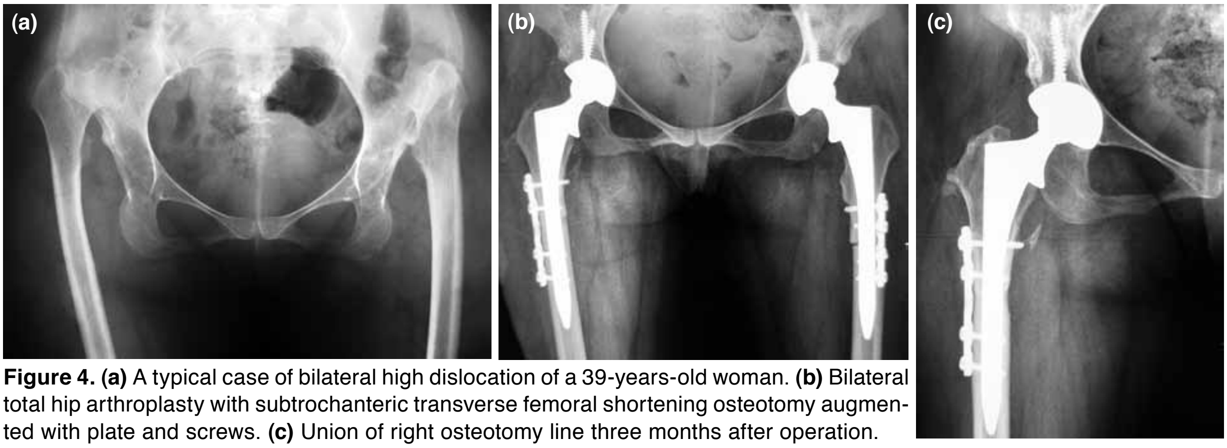

Figure 4. (a) A typical case of bilateral high dislocation of a 39-years-old woman. **(b)** Bilateral total hip arthroplasty with subtrochanteric transverse femoral shortening osteotomy augmented with plate and screws. **(c)** Union of right osteotomy line three months after operation.

80 hips. Slight and moderate limping persisted in only 14 hips at the latest follow-up.

We observed a total of 41 (39.8%) complications in 26 out of 69 patients (Table 3). Nine of them were seen intraoperatively. We saw femoral fissuring (non-displaced fractures) in eight hips (7.7%) during the operation. All were fixed with circulage wiring and postoperative weight-bearing was delayed according to the stability of the component. They all healed well. An acetabulum medial wall fracture was seen in one hip and the cup was implanted after grafting the medial wall, and healed without a problem. We observed three neurological complications; one sciatic and two peroneal lesions. The patient with sciatic lesion in whom the extremity was lengthened 4 cm was treated with supracondylar femoral shortening the day after the first operation and the lesion resolved in three months. In the other two hips in which lengthening had been under 3 cm, the sciatic nerve was explored and found to be intact, but the peroneal nerve palsies did not resolve. There was no postoperative neurological injury observed in shortened hips. We observed four early dislocations, which were reduced closely, followed with bracing for six weeks. Two of them were in shortened hips. We did not observe redislocation.

Deep venous thrombosis in two patients and pulmonary embolism in three patients were also seen. All the pulmonary embolism patients were operated on bilaterally. All these patients were treated with anticoagulant therapy and eventually recovered. One patient with bilateral THA died one month after the second operation from intracranial embolism. Five hips with superficial infections were treated with antibiotics. Neither a symptomatic septic nor aseptic loosening at the latest follow-up was observed. In total, we observed nine heterotrophic ossifications; six were grade I, three were grade II and one was grade III according to the Brooker classification.

DISCUSSION

Total hip arthroplasty in our patients improved mean Harris hip scores from 39.3 to 89.5. This was similar with to results in the literature (Table 4).[2,5,14] Our technique with the same type of standard sized prosthesis demonstrated at least the same results as other reports. We observed 41 complications in 26 out of 69 patients. Most were minor complications. When compared with primary osteoarthritis, one may consider these results unacceptable. But our complication rates were similar to other series in the literature.[2,4,15] If we look at the functional and clinical scores, we will see that 78.5% of the patients' results were excellent and good. Interestingly, despite the higher complication rates, 86.9% of the patients denoted satisfaction and felt that they were better after the operation. We believe that patient status before the operation (severe pain that did not decrease with any other treatment method and decreased capacity of daily activities) changed after surgery so that they fared well despite minor complications.

TABLE III

The summary of the complications

	No of hips (n=103)
Femoral split fracture	8
Acetabulum medial wall fracture	1
Heterotrophic ossification	9
Superficial infection	5
Deep infection	–
Derin ven trombozu	2
Pulmoner embolism	3
Nonunion of osteotomy line	5
Neurological deficit	3
Intracranial embolism	1
Acetabular displacement	1
Dislocation	4

TABLE IV

Study results of THA in dysplastic and dislocated hips

Study	Number of hips	Age of patients (years)	Follow-up (years)	Mean Haris hip score	Number of complications
Hartofilakidis and Karachalios[6]	84	23-70	7-15	Not given	25
Masonis et al.[26]	21	21-69	2-11	73	9
Nagoya et al.[8]	20	44-69	4-11	Not given	3
Reikeras et al.[5]	65	16-79	8-18	87	18
Krych et al.[2]	28	30-72	2-13	89	16
Current study	103	20-72	2-10	89	41

Patients with developmental dysplasia and dislocation of the hips who undergo THA are generally younger than primary osteoarthritic patients. We know that using cemented components in acetabular dysplasia or on structural grafted acetabulum causes bad long-term results with high revision rates.[16,17] Press-fit, porous coated acetabular components demonstrated a low prevalence of aseptic loosening.[18] Hartofilakidis and Karachalios[6] reported the survival rate of their cemented components as 89.1% at 10 years and 82.5% at 15 years. In contrast, Eskelinen et al.[18] presented a survival rate of 94% with revision for any reason as the end point and 98% with revision because of aseptic loosening as the end point using cementless femoral components at 10 years. A study of the Norwegian Arthroplasty Register reported that the results of THAs after developmental dysplasia of hip (DDH) were the same as those of THAs after idiopathic coxarthrosis after adjustments for younger age and for the use of more uncemented prostheses in patients with DDH.[4] Recently, new techniques with new surface bearings (metal-on-metal, alumina-on-alumina) were reported for these young patients to prevent polyethylene wearing implicated for loosening.[19,20]

Most of the series in the literature represent specially designed or modular prosthesis that were indicated for deformed femurs.[21-23] In also some femurs, extra small prosthesis should have been used, which might result in stem breakage. Small diameter canals with small diameter prosthesis with extra thin cement mantle result in cement failure and early loosening.[24] We believe that optimal canal fit with primary stabilization can be achieved with meticulous technique also in high dislocated hips with very narrow canals. Femoral fracture during insertion of the femoral component has been reported in up to 22%.[2,25] Fissuring in the proximal femur did not cause any problem in our series. Furthermore, Eskelinen et al.[18] recommended controlled splitting of the femurs both anteriorly and posteriorly for 8-10 cm and then implanting the cementless prosthesis in very narrow canals. In high-dislocated ones, the narrowest part of the canal was resected while shortening and the remaining bones were suitable for cementless components after meticulous reaming and rasping.

In Crowe type III and IV hips, soft tissue releases are generally not enough to reduce the femur into the anatomic hip center. Over-lengthening of the extremity may cause neurovascular problems. To avoid this, shortening of the femur is necessary. There are different techniques defined in the literature: proximal femoral shortening with or without trochanteric osteotomy, step-cut, chevron-like and transverse subtrochanteric osteotomies.[3,9,26] We preferred transverse subtrochanteric femoral shortening in our 45 hips necessitated shortening. According to us, neither necessity of shortening nor length of shortening can always be determined on preoperative X-rays or preoperative planning. The mobility of the hip after soft tissue releases and the critical limit of lengthening of the extremity is a dilemma preoperatively. Adjusting the shortening osteotomy, both seeing and palpating the nerve and determining the stability intraoperatively using the technique we explained before is safe, easy and reproducible. Other advantages of the technique are resecting the narrowest part of the canal and correcting excessive anteversion by derotating the femur easily. Not always achieving the rotational stability with optimum canal fit and fill with the distal side of the femoral component is the disadvantage of the technique as we observed in five nonunions, but stabilizing the osteotomy line with plates and screws when stability was in doubt resolved this problem. Nonunion of different shortening techniques has been reported at between 8% and 29%.[6,10,27] Our results showed that femoral shortening influences a statistically significant decrease in postoperative Harris hip scores. In addition, the scores of type III and IV hips were also worse than type I and II hips. As we think that femoral shortening usually performed on type III and IV hips, one may comment that shortening the femur on type III and IV hips deteriorates the results. These are more complicated procedures and need expertise.

It is recommended to limit the lengthening distance to 3-4 cm in order to avoid neurological complications.[18] In our study, two hips where nerve palsies were seen were lengthened shorter than 3 cm. Lengthening shorter than 3 cm also resulted in neurological palsies in another series.[17] Eggli et al.[28] did not find any statistical correlation between the amount of lengthening and the incidence of nerve damage and commented that nerve injury was most commonly caused by direct or indirect mechanical trauma and not by limb lengthening on its own.

We did not revise any components except one acetabulum with technical fault. We aimed to restore the anatomical hip center at the true acetabulum. We improved abductor mechanism in 80 hips in which the Trendelenburg sign became negative. High hip center increases joint reaction forces and promotes wearing and loosening, perpetuates abductor insufficiency, leg length discrepancy and limping. Restoration of the anatomical hip center results in better outcomes.[6,29] The true acetabulum is generally shallow and hypoplastic, which makes reconstruction difficult. There are different techniques defined in the literature to reconstruct the acetabulum like the 'protrusio socket' technique by Hess and Umber[30] and 'cotyloplasty' by Hartofilakidis et al.[31] We generally reamed the acetabulum posteromedially in order to cover the cup; where this could not be done, we used the femoral head as a structural graft to deepen the acetabulum. Although high failure rates up to 46% at twenty years were reported,[16,32] we believe that augmentation of the superolateral defect with structural femoral head graft and implanting cementless cup with screws is advantageous and effective while a bulk femoral head autograft is still available during the operation if we think about revision procedures in the future. In our series, we used acetabular grafts in 22.3% of the hips. Most of them (13 of 23) were in Crowe type II hips. Statistically, acetabular grafting did not deteriorate our final results.

There are some limitations to our study. First we did not report long-term results. Long-term follow-up is necessary for loosening of the components especially for the internally-fixed shortened femurs and for autogenous grafted acetabula. Second, we did not perform interobserver and intraobserver variability of the radiographic evaluations.

In conclusion, cementless standard sized components can be used in both dysplastic and dislocated hips if adjusted with meticulous technique.

Declaration of conflicting interests

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