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Short-term results of hip prosthesis with shortening osteotomy in patients with crowe type iv dysplastic coxarthrosis

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Abstract

Developmental hip dysplasia describes developmental abnormalities affecting the acetabulum, proximal femur, and capsule. Various surgical options, including pelvic and femoral osteotomies, are available yet degeneration and osteoarthritis may persist despite these interventions. Total hip arthroplasty with shortening osteotomy has yielded highly satisfactory results patients experiencing pain and reduced quality of life due to osteoarthritis. Crowe type 4 patients who were operated on by the same surgeon between 2010 and 2014 were included in the study. The study evaluated 14 hips from 9 female patients, aged between 42 and 52 years (mean age: 46.57±3.15 years). Each operated hip was followed up for at least 12 months. Preoperative, six-month, and one-year postoperative assessments included Harris Hip Scores, Oswestry Scale, VAS Hip and Lumbar, and SF-36 Quality of Life Indexes. Preoperative Harris hip scores (41.86±8.63) increased to 85.46±2.51 at six-months and 89.97±1.52 at one year. The mean preoperative VAS hip measurement was 8.50±0.76, while the mean postoperative six-month VAS hip measurement was 2.64±0.50 and the mean postoperative one-year VAS hip measurement was 2.14±0.36. The increase in the SF-36 quality of life index is statistically significant. The mean preoperative Oswestry measurement was 32.86±2.93, which decreased to 6.78±1.62 postoperatively and further decreased to 2.21±0.97 at one-year. The outcomes of shortening osteotomy combined with cementless total hip arthroplasty (THA) for treating pain and loss of function in patients with developmental dysplasia of the hip who do not respond to conservative treatments are highly favorable.

Keywords: Cardiovascular disease, risk factor, waist hip ratio, machine learning

Introduction

In the 1980s, the terminology of "congenital hip dislocation" was replaced by "developmental dysplasia" to better encompass hip conditions that may not be evident at birth but develop afterward [1]. "Developmental hip dysplasia" refers to a range of disorders from mild instability to complete displacement of the femoral head [2]. This term describes developmental abnormalities affecting the acetabulum, proximal femur, and capsule.

The incidence of diagnosed neonatal hip dislocation is 1-2 per 1000, whereas neonatal hip instability occurs at a rate of 15-20 per 1000. This suggests that a significant portion of cases with neonatal instability resolve without treatment within the first few weeks [3].

The etiology of developmental dysplasia of the hip (DDH) lacks a single identified factor but involves several predisposing factors such as ligament laxity, prenatal and postnatal posture. Racial differences exist with DDH being less common in black and yellow races but more prevalent in white races. Additionally, DDH is particularly endemic in regions like the Mediterranean, including Türkiye.

The increased use of hip ultrasonography has facilitated early diagnosis and treatment, leading to favorable outcomes [4]. Improved diagnostic and treatment resources, along with socioeconomic advancements, have resulted in a decline in cases presenting as hip osteoarthritis in young adulthood. Nonetheless, even with early intervention, hip joint degeneration may still

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occur in the future. Various surgical options, including pelvic and femoral osteotomies, are available yet degeneration and osteoarthritis may persist despite these interventions.

Total hip arthroplasty shortening osteotomy has yielded highly satisfactory results globally and in our country for patients experiencing pain and reduced quality of life due to osteoarthritis.

In this study, patients diagnosed with osteoarthritis due to Crowe type IV hip dysplasia between 2010 and 2014 were evaluated. The functional results of total hip arthroplasty with shortened transverse osteotomy performed in our clinic were evaluated.

Material and Methods

The study received ethics committee approval from Maltepe University Clinical Research Ethics Committee. A total of 58 hip patients who underwent surgery with the diagnosis of coxarthrosis due to developmental hip dysplasia were reached. Of these patients; 16 (27.5%) were Crowe type 1, 19 (32.75%) were Crowe type 2, 9 (15.5%) were Crowe type 3 and 14 (24.25%) were Crowe type 4. 14 Crowe type 4 hips that underwent abbreviation were included in our study. These hips underwent total hip arthroplasty by the same surgeon at the Department of Orthopedics and Traumatology, Maltepe University Faculty of Medicine, between 2010 and 2014. The exclusion criteria comprised active hip joint or systemic infections, conditions causing rapid bone destruction, neurotrophic arthritis, and abductor muscle inadequacy or absence, contraindications for Total Hip Arthroplasty (THA). The study evaluated 14 hips from 9 female patients, aged between 42 and 52 years (mean age: 46.57±3.15 years). Each operated hip was followed up for at least 12 months. Five patients underwent bilateral surgery. Three hips had prior periacetabular and femoral osteotomy. Preoperative, six-month, and one-year postoperative assessments included Harris Hip Scores, Oswestry Scale, VAS Hip and Lumbar, and SF-36 Quality of Life Indexes.

The Crowe classification system assessed dysplasia severity based on femoral head migration exceeding 100% proximally to the tear line [5]. For Crowe type IV patients, three-dimensional CT aided in determining femoral head height, shortening amount, and actual acetabulum location. Preoperative assessments included Harris Hip Score, Oswestry Scale, VAS Hip, VAS Low Back Pain Scales, and SF-36 Quality of Life Indices for all patients. The surgical team and anesthesiologists visited patients a day before the operation, providing procedure information and obtaining consent. Preoperatively, patients wore anti-embolic stockings for deep vein thrombosis prophylaxis, and postoperatively received a prophylactic dose of low molecular weight heparin. Patients underwent surgery via two separate incisions: posterior and lateral. Twelve out of 14 hips (85.7%) were operated on using a lateral incision, while two hips (14.3%) utilized a posterolateral incision.

During surgery, a transverse osteotomy was performed 2 cm distal to the lesser trochanter in the subtrochanteric region for all patients, without reaming the acetabulum. This approach ensured access to the true acetabulum. Following placement of the acetabular component with appropriate anteversion, all patients received an angled polyethylene liner. After achieving appropriate shortening, the proximal and distal parts of the femur were reamerized together with appropriate anteversion. The prosthesis was then placed in the correct size. The osteotomized bone was divided into two or three pieces as much as possible without devitalization. A grip plate was wrapped around the osteotomy line using a cable, applied to all patients to facilitate early motion onset and ensure strong fixation (Figure 1). All patients commenced mobilization with antiembolic measures. Enoxaparin sodium 40 mg was administered subcutaneously once daily for 20 days as prophylaxis. Acetylsalicylic acid 100 mg once daily was continued until unsupported mobilization was feasible. Partial weight-bearing was initiated on the first post-operative day. Follow-up appointments were scheduled for the second week, sixth week, third month, sixth month, and first year.

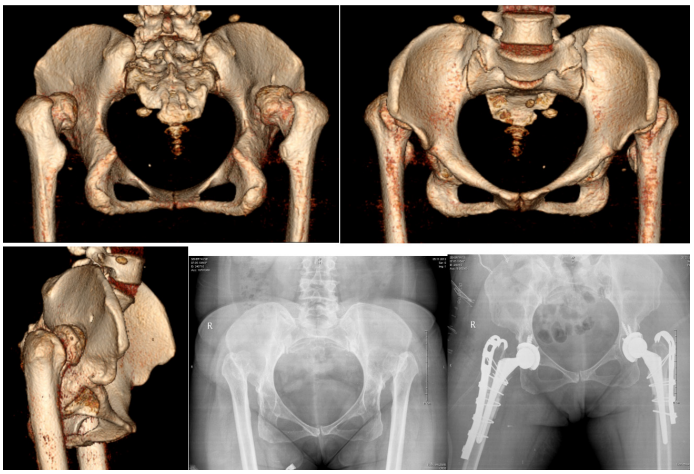

Figure 1. Bilateral Crowe type IV patient 3-d CT images, preopertive and postoperative final images

Results

After one year of follow-up on 14 hips from nine patients, significant improvements were observed in Harris hip scores (Table 1). Statistical analysis revealed a significant difference between the VAS hip and VAS lumbar measurements at follow-up (Tables 2, 3). Significant increases were noted in the postoperative quality of life scale scores compared to preoperative levels (Table 4).

Preoperatively, 14.3% (n=2) of patients had Oswestry levels at 40%-60%, indicating severe limitation of daily life due to pain, while 85.7% (n=12) had Oswestry levels at 60%-80%, indicating complete limitation of daily life due to pain. After analyzing the post-operative and first-year control Oswestry levels of the patients, it was found that all 14 patients were at the level of 0%-20%, indicating that pain no longer posed a significant problem in their daily lives (Table 5).

Among the nine patients (14 hips), femoral revision was required in two patients due to nonunion at the osteotomy line, fracture, and

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femoral collapse (Figure 2). One patient with bilateral nonunion experienced pain and gait issues, necessitating separate revision sessions. No complications such as deep vein thrombosis, infection, dislocation, loosening of components, neurovascular injury, embolism, or heterotopic ossification were observed in any patient during the follow-up period. However, the patient with bilateral nonunion had a history of smoking.

Table 1. Harris score evaluation

	Harris		[a]p	Dual comparison; [b]p
	Min-Max (Median)	Mean±SD		
Preop	28.3-56.0 (42.5)	41.86±8.63	**0.001****	Preop-Postop: **0.001****
Postop	81.0-88.3 (86.5)	85.46±2.51		Preop-Postop 1.year: **0.001****
Postop 1.year	87.2-92.0 (89.9)	89.97±1.52		Postop-Postop 1 year: **0.001****

Table 2. VAS Hip assessment

	VAS (Hip)		[a]p	Dual comparison; [b]p
	Min-Max (Median)	Mean±SD		
Preop	7-9 (9)	8.50±0.76	**0.001****	Preop-Postop: **0.001****
Postop	2-3 (3)	2.64±0.50		Preop-Postop 1.year: **0.001****
Postop 1.year	2-3 (2)	2.14±0.36		Postop-Postop 1.year: **0.008****

Table 3. VAS Lumbar assessment

	VAS (Lumbar)		[a]p	Dual comparison; [b]p
	Min-Max (Median)	Mean±SD		
Preop	5-8 (6.5)	6.36±0.93	**0.001****	Preop-Postop: **0.001****
Postop	2-3 (3)	2.71±0.47		Preop-Postop 1.year: **0.001****
Postop 1.year	2-3 (3)	2.64±0.50		Postop-Postop 1.year: **0.317**

Table 4. SF-36 scale score evaluation

		SF-36		[b]p
		Min-Max (Median)	Mean±SD	
Physical function	**Preop**	0-0 (0)	0.00±0.00	**0.001****
	Postop	50-80 (70)	68.57±8.86	
Role difficulty	**Preop**	0-0 (0)	0.00±0.00	**0.001****
	Postop	75-100 (100)	94.64±10.65	
Pain	**Preop**	0-12 (0)	4.14±5.79	**0.001****
	Postop	84-100 (84)	86.29±5.81	
General health	**Preop**	20-35 (25)	25.71±4.32	**0.001****
	Postop	82-92 (87)	88.43±3.63	
Vitality	**Preop**	70-85 (75)	76.07±5.94	**0.013***
	Postop	80-90 (80)	81.79±3.17	
Social function	**Preop**	0-12.5 (0)	4.46±6.22	**0.001****
	Postop	100-112.5 (112.5)	110.71±4.54	
Emotional role difficulty	**Preop**	0-0 (0)	0.00±0.00	**0.001****
	Postop	100-100 (100)	100.00±0.00	
Mental health	**Preop**	52-88 (68)	68.57±11.51	**0.001****
	Postop	80-100 (94)	91.71±6.92	
Total physical health	**Preop**	5.0-11.2 (7.5)	7.46±1.80	**0.001****
	Postop	77.7-90.5 (85.9)	84.48±4.18	
Total mental health	**Preop**	33.6-40.2 (37.4)	37.28±2.39	**0.001****
	Postop	91.2-98.6 (97.1)	96.05±2.42	

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Table 5. Oswestry measurement evaluation

	Oswerstry		[a]p	Dual comparison; [b]p
	Min-Max (Median)	Mean±SD		
Preop	27-38 (33)	32.86±2.93	**0.001****	Preop-Postop: **0.001****
Postop	5-9 (7)	6.78±1.62		Preop-Postop 1.year: **0.001****
Postop 1.year	1-3 (3)	2.21±0.97		Postop-Postop 1.year: **0.001****

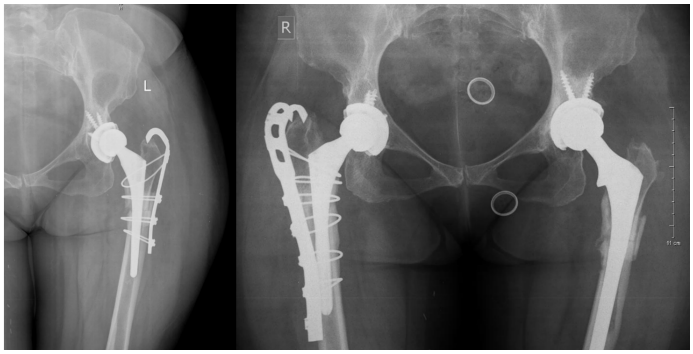

Figure 2. Non-union and revision image of the osteotomy line

Discussion

Despite preventive measures for developmental hip dysplasia, many cases remain undetected in our country. This may later lead to the development of degenerative arthritis in the hip joint and lead to pain and functional problems. Total hip replacement is an effective treatment method for patients suffering from severe pain and decreased quality of life.

Deformities in bone and soft tissues, along with issues from previous surgeries, have historically discouraged prosthetic use in Crowe Type 4 hips. Charnley initially discouraged total hip arthroplasty in patients with untreated congenital dislocated hips due to insufficient bone stock [6]. However, advancements in technology and increased experience over the last 40 years have expanded the indications for arthroplasty. Consequently, total hip arthroplasty has become applicable in developmental dysplasia of the hip. Total hip arthroplasty for osteoarthritis secondary to developmental dysplasia of the hip differs significantly from primary osteoarthritis. Anatomical and biomechanical changes, including proximal femoral migration, make the procedure technically challenging and increase the risk of complications [7].

Many issues lack clear consensus in the literature regarding total hip arthroplasty for developmental dysplasia of the hip, including the choice of incision, acetabular reconstruction, femoral shortening, and prosthetic selection [8-10]. Surgical approaches for total hip arthroplasty in developmental dysplasia of the hip include antero-lateral, direct lateral, and posterior approaches. In our cases, we utilized the direct lateral approach for 12 patients and the posterolateral approach for two patients. Posterolateral incision was preferred due to previous surgery and to avoid making a new incision. We believe that a lateral incision allows easier access to the true acetabulum and carries less risk of dislocation. A recent experimental study investigating gait biomechanics and performance following these approaches found no long-term superiority among them [11]. A study reviewing the Cochrane database found no significant difference between the posterior and direct lateral approaches in terms of post-operative Trendelenburg gait, nerve damage, risk of dislocation, and functional outcomes [12].

Cementless total hip arthroplasty has been demonstrated to alleviate pain and enhance joint function in adult patients with coxarthrosis associated with developmental hip dysplasia [13]. We used cementless joint prostheses for all patients, including those with primary coxarthrosis and hip dislocations. Specifically, a porous-coated acetabular cup was press-fit into the true acetabulum in all hips in our study. Studies have indicated that porous-coated components placed via the press-fit method result in less aseptic loosening and better fixation [13]. In our study, we observed no revisions due to acetabular component loosening. Cemented acetabular cups have been associated with early failure in the literatüre [14]. It is recommended to place the cup at the anatomical level to ensure stable fixation, maintain abduction strength, and equalize leg lengths [15,16]. Placing the cup above the acetabulum can decrease the force arm of the abductor mechanism and increase component load [17]. Thin iliac bone in a high hip center may not provide adequate coverage. Optimal bone stock for reconstruction is found in the true acetabulum [6,18]. Placing the acetabular component in the true acetabulum in all hips was considered crucial for achieving successful outcomes and preventing component laxity. In Crowe type 4 dysplastic hips, acetabular bone stock is typically low due to underdeveloped or rudimentary acetabula. In our study, we employed acetabular components with small diameters (ranging from 40 mm to 44 mm) based on the principle of presfit placement.

In hip osteoarthritis secondary to high hip dislocation (Crowe Type 4), pathological bony changes in the proximal femur are often accompanied by surrounding soft tissue changes [5,6,8]. Placing the acetabular component in the true acetabulum and lowering the femur distally may lead to complications if secondary soft tissue changes are not appropriately addressed. In cases of hip osteoarthritis secondary to high hip dislocation, the abductor muscles, iliopsoas, rectus femoris, gluteus maximus, adductor muscles, fascia lata, and other thigh muscles exhibit shortened length and increased tension. The piriformis is shortened, while other external rotators are lengthened. Primary soft tissue release often involves tenotomy of the adductor and

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iliopsoas muscles. Here's a concise summary. If reduction cannot be achieved through primary soft tissue release, additional measures may include cutting the gluteus maximus tendon at its femoral attachment and bluntly stripping the adductor muscles from the linea aspera [19]. In our study, iliopsoas tenotomy was performed in all patients, while abductor tenotomy was performed in four patients (28.5%).

Subtrochanteric osteotomy can be performed using oblique, straight, or step resection methods. Plate and screw fixation is recommended for rotational stability in a straight osteotomy line, but it is not necessary for stepped and oblique osteotomy [7,20]. In our study, all patients underwent a straight osteotomy 2 cm distal to the trochanter minor. This provided better acetabular exposure, shortened the femur, and shifted the proximal portion distally. A mean shortening of 3.89±2.01 was performed in 14 hips. In these patients, the average distal lowering of the greater trochanter was 4.85±1.05cm, and the average lowering of the hip rotation center was 4.90±0.47cm. We provided rotational stability with a femoral stem placed in appropriate anteversion as presfit. The shortened femoral fragment was divided into three and secured around the fracture line using a grip plate and cable. In this way, we allowed patients to walk with weight bearing in the early postoperative period. Nonunion occurred in two hips (14.3%) in one patient in our study. Femoral revision was performed in this patient presenting with pain, limited motion, and a history of smoking.

In our study, the Harris hip score improved from 41.86±8.63 to 89.97±1.52 following total hip arthroplasty across all Crowe types. This outcome aligns with findings in the literature. Functional and clinical outcomes were rated as good or excellent in 85.7% of patients.

Patients with developmental hip dysplasia and dislocation typically undergo total hip arthroplasty at a younger age compared to those with idiopathic osteoarthritis [9]. The mean age of patients in our study was 46.7 years, all of whom were female. The mean age and gender distribution in our study align with the literatüre [3]. Consistent with the literature, female gender is more common. However, males are also seen with a frequency of 8-10%.

In our study, complications occurred in three out of 14 hips (21.4%) among nine patients, consistent with findings in the literatüre [21]. All complications necessitated revision surgery. Despite the elevated risk of dislocation, there was no disparity in implant survival between acetabular dysplasia and primary osteoarthritis [22]. Studies have indicated a higher risk of revision for the acetabular component in cases of congenital dislocation [14]. However, in our study, no cases of dislocation occurred during the follow-up period. We think that we have succeeded in this regard with direct lateral incision and early rehabilitation.

Increased risk of neurological injury during hip surgery has been attributed to factors such as female gender, surgical technique, trochanter fixation with cerclage wire, intraoperative hip dislocation, direct compression from retractors, cement damage, polymerization heat and hematoma. Among these, extension of the extremity is reported as the most significant factor [23]. Studies recommend limiting lengthening to 3-4 cm to prevent neurological complications [13]. In our study, we performed shortening osteotomy for dislocations measured 3-4 cm above our measurements, and no post-operative neurological deficits were observed in any patient.

There are three important limitations in our study. First, the follow-up period is short. The results may be more significant in the long term. Second, although the number of hip dislocations decreased with the measures taken, the number of cases followed up was small. Third, the study was designed retrospectively.

Conclusion

Pain serves as the primary factor influencing the decision to undergo total hip arthroplasty in these patients. For appropriate indication and treatment, the patient's history should be taken in detail, and the images should be appropriate and detailed. The patient should be informed about the procedure to be performed. Complications that may occur during and after the procedure should be explained and managed well. The outcomes of abbreviation combined with cementless total hip arthroplasty (THA) for treating pain and loss of function in Crowe type 4 hip are quite good. The majority of patients experience a significant post-operative improvement in pain, gait, activity, deformity, and range of motion, which are key criteria in the Harris evaluation scale.

Conflict of Interests
The authors declare that there is no conflict of interest in the study.

Financial Disclosure
The authors declare that they have received no financial support for the study.

Ethical Approval
Approval numbered 2015/900/15 is available as a result of the Maltepe University Clinical Research Ethics Committee meeting dated 29 january 2015.

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