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Long-term follow-up results of femoral varus osteotomy in the treatment of Perthes disease, and comparison of open-wedge and closed-wedge osteotomy techniques

A retrospective observational study

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Abstract

In this retrospective observational study, I aimed to report long-term follow-up results of femoral varus osteotomy in the treatment of Perthes disease patients who were between 6 and 8 years old at the onset of the disease with Herring B and C hip involvement. I also aimed to compare 2 different osteotomy techniques: open-wedge and closed-wedge femoral varus osteotomies.

Patients with Perthes disease treated with femoral varus osteotomies were invited for final examination. Twenty two hips of 19 patients were evaluated. Mean follow-up period was 15.2 years. Patients were divided into 2 homogenous groups according to femoral osteotomy technique. In Group A (12 hips) open-wedge osteotomy, and in Group B (10 hips) closed-wedge osteotomy was performed.

There were 15 male (78.9%) and 4 female (21.1%) patients. The median age at the onset of the disease was 7 years in Group A and B. The mean follow-up period was 16.2 years in Group A, and 11.4 years in Group B. According to Stulberg classification 5 hips (22.7%) were healed as Class I, 4 hips (18.2%) were healed as Class II, 12 hips (55.5%) were healed as Class III, and 1 hip (4.6%) was healed as Class IV. Also in Group A 4 hips (33.3%) were healed as Class I or II, 7 hips (58.3%) were healed as Class III, and 1 hip (8.3%) was healed as Class IV; in Group B 5 hips (50.0%) were healed as Class I or II, and 5 hips were healed as Class III (50.0%). There was no significant difference between the groups. According to Iowa scale, mean values were 92.6 in Group A and 92.4 in Group B. There was no significant difference between the groups. At the final follow-up mean center-edge angles of Group A and B were 16 and 22, the difference was significant.

Long-term follow-up results showed that femoral varus osteotomy was an effective treatment method in Perthes disease patients who were between 6 and 8 years old with Herring B and C hip involvement at the onset of the disease. Hip joint congruency was obtained with femoral varus osteotomies, and closed-wedge osteotomy served more favorable center-edge angle results.

Abbreviations: CDA = femoral neck-shaft angle, CE = center-edge angle.

Keywords: femoral varus osteotomy, Herring classification, Perthes disease, Stulberg classification

1. Introduction

Perthes disease is an uncommon painful disorder of the hip in childhood characterized by avascular necrosis of the femoral head. The incidence of Perthes disease is 2.84 per 100,000 children in a most recent study.[1] The treatment of Perthes disease is controversial according to age and stage at diagnosis. Various treatment methods have been reported such as symptomatic treatment, brace treatment, and surgical treatment.[2,3] Concentric reduction of the femoral head into the acetabulum is the aim of the treatment.[2] Surgical containment can be obtained by femoral osteotomy and innominate osteotomy.[3–5] Femoral varus osteotomy can be performed with open-wedge or closed-wedge technique.[6,7]

Herring et al[2,3] divided femoral head into 3 parts; lateral, central, and medial pillars. Lateral pillar involvement was evaluated in Herring classification. There was no involvement of lateral pillar in Group A, >50% of lateral pillar height was maintained in Group B, <50% of lateral pillar height was remained in Group C.[2,3] Herring et al[3] reported better outcome with surgical treatment in children who are older than 8 years with Herring Group B hips, and poor outcomes in children of all ages with Herring Group C hips.[3] Also, favorable outcomes were reported unrelated to treatment in patients who are <8 years with Herring Group B hips,[3] but better femoral head sphericity was obtained with femoral osteotomy in patients who are over the age of 6 years at the time of diagnosis with Catterall

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Group III and IV hips.[8] There is no consensus in the treatment of children older than 6 years and younger than 8 years at the time of diagnosis, because their prognosis aren't as good as children younger than 6 years.[3,8–10]

There are various treatment methods in Perthes disease patients who were between 6 and 8 years old at the time of diagnosis, but none of them is better than the other. Femoral varus osteotomy could be performed for the treatment of Perthes disease.[6] Hip joint containment which is an important goal of the treatment could be obtained by femoral varus osteotomy, and open-wedge and closed-wedge techniques were defined for femoral varus osteotomies.[6,7] I aimed to report long-term follow-up results of femoral varus osteotomy in the treatment of Perthes disease patients who were between 6 and 8 years old at the onset of disease with Herring B and C hip involvement. I also aimed to compare 2 different osteotomy techniques: open-wedge and closed-wedge femoral varus osteotomies.

2. Patients and methods

This was a retrospective observational study that was conducted at the Department of Orthopedic Surgery of Karadeniz Technical University Medical School, and approved by the institutional review board. All patients provided written informed consent. The study protocol conforms to the ethical guidelines of Helsinki declaration. Patients with Perthes disease treated with femoral varus osteotomies between 1990 and 2010 were invited for final examination. Among those patients who accepted to attend our study, and reached skeletal maturity were evaluated. The results of 22 hips of 19 patients who were between 6 and 8 years old at diagnosis of Perthes disease with Herring B and C involvement, treated with proximal femoral varus osteotomy were evaluated.

Patients were divided into 2 homogenous groups according to femoral osteotomy technique. In Group A (12 hips of 11 patients) open-wedge osteotomy was performed and fixated with stainless steel plate as described by Catterall,[7] and in Group B (10 hips of 8 patients) medial closed-wedge osteotomy was performed and fixated with blade plate as described by Axer.[6]

After confirming the diagnosis range of motion exercises were started, skin traction was applied to patients to regain hip motion. Proximal femoral derotation osteotomy was performed to all patients to obtain containment. For surgical containment the amount of varization and derotation was calculated preoperatively.

All patients were placed in a hip spica cast for 6 weeks, then they allowed bearing weight, and the plates were removed 12 to 18 months after the operation.

On the final examination physical assessment of the hip was performed. Pain with daily activities or sports activities was examined. Range of motions of the affected hips and Trendelenburg-signs were evaluated. Hip functions were assessed according to Iowa scale.[11] Iowa scale is a hip scoring scale developed by Larson and used for the assessment of clinical outcomes and hip function.[11] Leg lengths were measured from the anterosuperior iliac spine to the medial malleolus in unilateral cases. Anteroposterior and lateral views were obtained in the preoperative and postoperative period, and at the final check-up for radiographic evaluation. Femoral neck-shaft angle (CDA), center-edge angle (CE), and trochanteric height were measured for detailed assessment. Trochanteric height was measured as defined by Stulberg et al.[12] Stulberg et al[12] classified the outcomes into 5 classes. Class I and II hips had spherical congruency, Class III and IV hips had aspherical congruency, and Class V hips had aspherical incongruency.[12] On final radiographs Stulberg class of the hips were determined according to Stulberg criteria.[12,13]

Statistical analysis was performed using the SPSS 24 (SPSS Inc., Chicago, IL). Chi-square test and Mann–Whitney *U* test were applied to assess the outcome variables between the 2 groups. *P* value $<.05$ was considered significant.

3. Results

There were 15 male (78.9%) and 4 female (21.1%) patients. There were 12 left (54.5%) and 10 right (45.5%) hips. Mean follow-up period was 15.2 years (range, 8.8–18.4). The median age at onset of the disease was 7 years (range, 6–8) in Group A, and 7 years (range, 6–8) in Group B. The mean follow-up period was 16.2 years (range, 13.1–18.4) in Group A, and 11.4 years (range, 8.8–13.4) in Group B.

All patients were satisfied with the status of the hip joint. Two patients (1 from each group) have pain during sporting activities.

Table 1

Radiological details of Group A patients.

	Pre CDA	Pop CDA	Final CDA	Pre CE	Pop CE	Final CE	Trochanteric height	Stulberg classification
1	133	128	140	28	20	19	2.5	1
2	140	115	129	28	24	25	4	3
3	134	112	117	16	20	16	4	2
4	135	119	104	15	20	15	4.5	3
5	132	105	115	10	16	14	5	4
6	132	118	111	13	20	16	5	3
7	122	103	128	21	18	23	2	1
8	145	110	100	20	30	16	5	3
9	132	104	116	10	7	15	4	2
10	131	109	124	12	16	12	5	3
11	142	111	104	20	24	15	4	3
12	135	113	128	11	16	7	4	3
Mean	134	112	118	17	19	16	4	

Final CDA = final femoral neck-shaft angle, Final CE = final center-edge angle, Pop CDA = postoperative femoral neck-shaft angle, Pop CE = postoperative center-edge angle, Pre CDA = preoperative femoral neck-shaft angle, Pre CE = preoperative center-edge angle.

Table 2

Radiological details of Group B patients.

	Pre CDA	Pop CDA	Final CDA	Pre CE	Pop CE	Final CE	Trochanteric height	Stulberg classification
1	140	115	128	10	25	22	3	3
2	145	122	124	8	18	21	2.5	1
3	140	118	120	20	19	17	4.5	2
4	134	120	135	14	15	23	3.5	1
5	134	116	127	15	21	22	3.5	2
6	135	118	138	18	20	28	2	1
7	132	106	129	16	18	19	3.5	3
8	124	111	118	20	25	17	5	3
9	134	110	135	17	19	25	5	3
10	122	118	130	15	21	28	3	2
Mean	134	115	128	16	20	22	3.5	

Final CDA = final femoral neck-shaft angle, Final CE = final center-edge angle, Pop CDA = postoperative femoral neck-shaft angle, Pop CE = postoperative center-edge angle, Pre CDA = preoperative femoral neck-shaft angle, Pre CE = preoperative center-edge angle.

All patients were pain free at daily activities. Range of motion of the affected hips was almost unrestricted, except limited internal rotation of 2 hips (15–20° of limited internal rotation when compared with contralateral hip). The Trendelenburg-sign was positive in 3 patients (2 in Group A, 1 in Group B). In patients with unilateral disease the mean shortening was 1.0 cm in Group A, and 1.2 cm in Group B. According to Iowa scale, mean values were 92.6 (range, 88–97) in Group A and 92.4 (range, 89–96) in Group B. There was no significant difference between groups ($P = .83$).

The mean preoperative, postoperative, and final CDA were 134, 114, and 123, respectively. At the final radiographs mean CE was 19, and mean trochanteric height was 3.8. The results of both groups were compared (Tables 1 and 2). Mean preoperative and postoperative CDA and CE were similar for both groups. At the final examination mean CDA of Group A was 118, and mean CDA of Group B was 128, and the difference was significant ($P = .043$). Also, mean CE angles of Group A and B were 16 and 22, and the difference was significant ($P = .006$). The mean trochanteric height was higher in Group A, but no significant difference was determined ($P = .26$).

According to Stulberg classification, 5 hips (22.7%) were healed as Class I, 4 hips (18.2%) were healed as Class II, 12 hips (55.5%) were healed as Class III, and 1 hip (4.6%) was healed as Class IV. 40.9% of patients (Class I or II) healed as spheric, 55.5% of patients (Class III) healed as ovoid, and 4.6% of patients (Class IV) healed as flat. Also in Group A 4 hips (33.3%) were healed as Class I or II, 7 hips (58.3%) were healed as Class III, and 1 hip (8.3%) was healed as Class IV; in Group B 5 hips (50.0%) were healed as Class I or II, and 5 hips were healed as Class III (50.0%). There was no significant difference between the groups ($P = .32$) (Figs. 1A–D and 2A–D).

4. Discussion

In spite of the numerous studies published on the prognosis, the treatment of Perthes disease is still controversial. Young age and less involvement of the femoral head epiphysis are well known good prognostic criteria. Majority of the patients before the age of 6 who were receiving symptomatic treatments had spherical femoral head, but patients who were older than 8 years of age at the onset of the disease have poorer prognosis.[14] The patients were between 6 and 8 years old at the onset of the disease, and surgical containment results of patients were evaluated at skeletal maturity.

Larson et al[15] concluded that pain and arthritis are common in nonoperatively treated Perthes patients in their study with a mean of 20.4 years follow-up. Saran et al[5] recommended femoral varus osteotomy or Salter innominate osteotomy for improved femoral head sphericity in children older than 8 years, but children aged 6 to 8 years remain in gray zone in their recent meta-analysis study. Schmid et al[16] and Beer et al[17] reported good long-term results with femoral osteotomy in their heterogeneous group of patients at skeletal maturity. In this study, surgical treatment of Perthes disease revealed spherical and aspherical congruency with no pain in homogeneous group of patients.

Aksoy et al[9] showed that femoral varus osteotomy healed with flat femoral heads in 14% of hips in patients younger than 9 years old with Herring C involvement. Friedlander and Weiner[18] found 43% of the hips healed with Stulberg class I or II after femoral varus osteotomy in patients operated before 9 years old. Gower and Johnston[19] concluded that round femoral heads had better hip ratings than flattened heads in their study with an average 36 years follow-up. Herring et al[3] reported the outcomes were unrelated to treatment in patients who are <8 years with Herring Group B and C hips; favorable outcomes were obtained in Group B and poor outcomes were obtained in Group C. Wiig et al[8] reported the results of prospective study of 368 unilateral Perthes disease patients with 5-years follow-up. One hundred fifty two patients were older than 6 years at onset, and 71 of them were treated with femoral osteotomy, femoral osteotomy results were better than conservative treatment in that age group with >50% femoral head involvement.[8] Terjesen et al[20] showed that patients with total involvement of femoral heads had better femoral head sphericity with femoral osteotomy. Also, Terjesen et al[20] reported that 42% of femoral head healed as spheric, 44% healed as ovoid, and 14% healed as flat with femoral osteotomy in children between 6 and 8 years old at onset. We observed that 40.9% of our patients healed as spheric, 55.5% healed as ovoid, and 4.6% healed as flat in our homogeneous group similar to Terjesen et al.[20] Most of the patients had hip joint congruency, but 1 patient had incongruent hip.

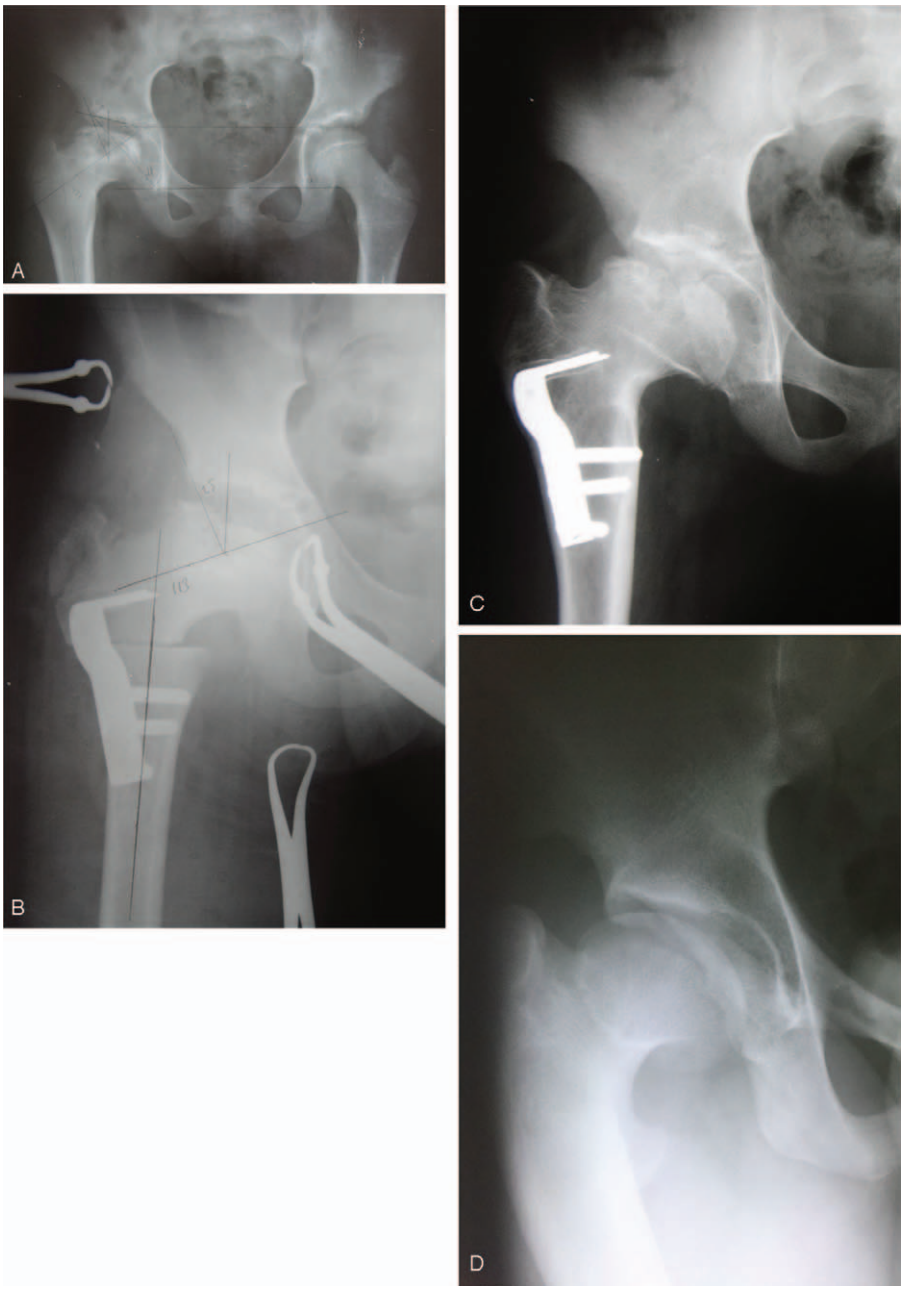

Figure 1. Radiographs of 7-year-old patient treated with closed-wedge osteotomy. (A) Preoperative. (B) Intraoperative. (C) Postoperative. (D) Follow-up after 13 years.

Follow-up towards skeletal maturity is very important for the evaluation of results of Perthes disease. Mean follow-up period was 15.2 years in our study and all patients were followed to skeletal maturity in contrary to Terjesen et al.[20]

Williams et al[21] concluded that open-wedge procedure is more preferable than closed-wedge because it reduces femoral shortening. We found no difference between groups according to leg-length difference, Iowa scale, and Stulberg classification. Greater trochanter overgrowth leads to a gait disturbance because of abductor insufficiency.[22] There was no significant difference of trochanteric heights between 2 different osteotomy techniques in this study, but final CDA and CE angle differences were significant. Mean CDA of closed-wedge osteotomy group was 10° more than open-wedge osteotomy group. Mean CDA of closed-wedge osteotomy group was in normal limits and more favorable than open-wedge osteotomy group. CE angle was used as a measure of acetabular development and degree of femoral head displacement. Mean CE angle of closed-wedge osteotomy group was 6° more than open-wedge osteotomy group. Femoral head coverage and acetabular development of closed-wedge osteotomy group was better than the open-wedge osteotomy group. Mean CE of closed wedge osteotomy group showed that closed-wedge osteotomy group approached normal acetabular development and femoral head coverage.

The limitations of the study are lack of conservatively treated control group and limited number of patients.

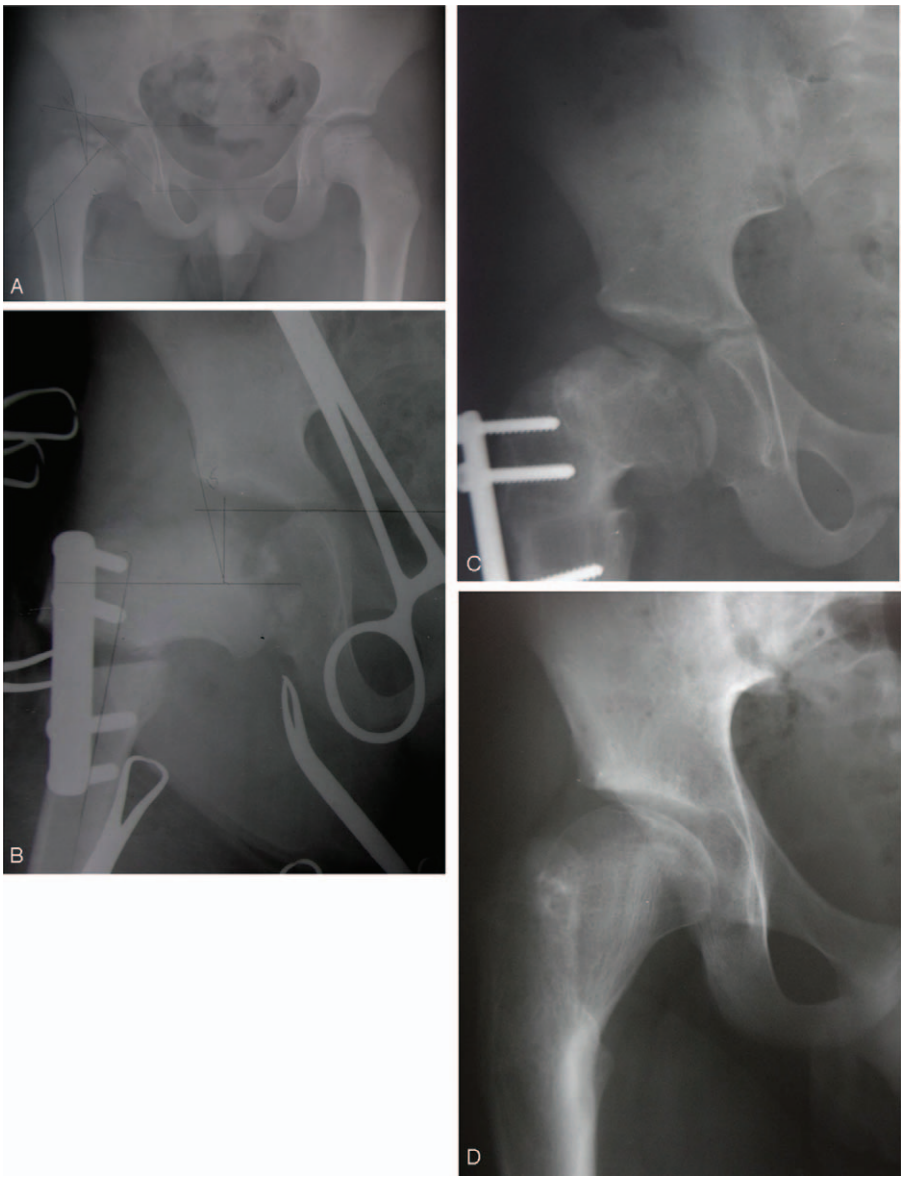

Figure 2. Radiographs of 7-year-old patient treated with open-wedge osteotomy. (A) Preoperative. (B) Intraoperative. (C) Postoperative. (D) Follow-up after 12 years.

Long-term follow-up results showed that femoral varus osteotomy was an effective treatment method in Perthes disease patients who were between 6 and 8 years old with Herring B and C hip involvement at the onset of the disease. Hip joint congruency was obtained with femoral varus osteotomies, and closed-wedge osteotomy served more favorable CE angle results.

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Author contributions

Conceptualization, data curation, formal analysis, investigation, methodology, writing-original draft, writing-review and editing were completed by Atilla CITLAK.

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