In this study, clinical and radiological results were evaluated in patients with Legg-Calve-Perthes disease treated with Salter pelvic osteotomy. Between 2004 and 2008, 16 patients underwent a Salter osteotomy as treatment for Legg-Calve-Perthes disease (15 male, 1 female; 10 right hip, 6 left hip). The mean age at the time of surgery was 8.1 ± 1.4 (range: 6 to 10) years. Surgical indications were: age between 6-10 years at the onset of the disease; Herring classification type B, B/C, or C; and at least one risk sign. 6-8 year old patients were classified as group I and 9-10 year olds were classified as group II. We investigated the effects of age and Herring classification on radiological outcomes.

The final radiographic evaluation according to the Stulberg classification showed nine hips (56.25%) classified as good (Stulberg I/II), five (31.25%) as fair (Stulberg III) and two (12.5%) as poor (Stulberg IV). In group I, 7 patients (70%) had good results, while only 2 (33.3%) in group II. The results in group I were statistically better than group II (p < 0.05). Based on the Herring lateral pillar type, of the 12 patients classified as B or B/C, at final follow-up, 8 (66.6%) had a good outcome (Stulberg I/II), whereas in the four patients classified as type C, only one (25%) had a good outcome.

The Salter pelvic osteotomy is an effective method of surgical treatment for Legg-Calve-Perthes disease in patients between 6-8 years of age.

**Key words:** Legg-Calve-Perthes disease, Salter osteotomy, treatment outcome.

**INTRODUCTION**

Legg-Calve-Perthes (LCP), or idiopathic, avascular necrosis of the femoral head in children, is a disease associated with ischemia, necrosis, and repair of the proximal femoral epiphysis due to a localized or systemic reason, which usually results in sequelae. Although its etiology has not been clarified, the common belief is that it is a multifactorial disease in which genetic and environmental factors play a role. Lateral column involvement, the extent of involvement of the epiphysis, femoral head lateralization (subluxation), age of onset, dis-
ease stage, and treatment modality have been reported as the most important factors affecting the prognosis (5,8,13,19).

The aim of treatment is to obtain a spherical hip joint and to prevent or minimize the risk of degenerative joint disease that may develop at a young age. In his 1966 study, Salter reported the concept of biological plasticity (22). According to this theory, if the femoral head is held in the acetabulum during the process of repair, it is predicted that a normal or near-normal femoral head will form. In light of this information, containment therapy has become important in the treatment of Perthes. Containment therapies have been discussed in two parts: surgical containment treatments (pelvic, femoral and combined osteotomies) and non-surgical containment treatments (abduction traction, orthoses). In recent years, arthrodiastasis, which aims to reduce the load to the femoral head, and biological treatment methods, which stimulate new bone formation and reduce bone resorption, have been proposed (2,16,17,21,24).

In this study, we evaluated the clinical and radiological results in patients with Legg-Calve-Perthes (LCP), who received containment therapy with a Salter pelvic osteotomy.

**PATIENTS AND METHODS**

The sixteen patients (15 male, 1 female) who have been treated with Salter pelvic osteotomy in our clinic for the diagnosis of LCP between 2004 and 2008 were retrospectively analyzed. All patients had unilateral disease (10 patients (62.5%) had involvement of the right hip, and six had involvement of the left hip). The mean age at time of surgery was 8.1 ± 1.4 years (range 6-10 years). Indications for surgery were: 6-10 years of age at the onset of the disease; Herring lateral column classification of B, B/C, or C, and at least one radiographic or clinical risk factor (11). Clinical risk factors included adduction contracture and decreased range of motion. Radiographic risk factors included subluxation of the femoral head, horizontal position of the epiphyseal line, calcification lateral to the epiphysis, diffuse metaphyseal changes, and Gage sign. Patients had not received any previous regular treatment. Preoperatively, the range of motion was evaluated, and radiographs in both anterior-posterior and frog position were taken. In order to increase the range of motion, the patients were referred to physical therapy and rehabilitation before surgery. Approval of the local ethics committee within our hospital was obtained prior to the start of the study.

**Operative technique**

A classic Salter osteotomy was performed in the supine position using a bikini incision. The autograft harvested from the iliac bone was placed in the osteotomy line and was fixed with two or three thick Kischner wires. In all cases, the iliopsoas muscle was lengthened at the musculotendinous junction. A pelvipedal spica cast was applied for four weeks after surgery. Rehabilitation was started after the end of the fourth week, and full load was applied at the end of the tenth week.

Pelvic radiographs in both the anterior-posterior and frog position were taken early in the postoperative period, at three, six and twelve months postoperatively, and once a year thereafter. Preoperative and postoperative clinical evaluation was done according to the Harris Hip Score (HHS) (10).

In the preoperative radiographic evaluation, Herring's (11) lateral column classification and Waldenström's staging were used. In addition, the central edge (CE) angle was measured before and after surgery. The most recent follow-up radiographies were evaluated according to the Stulberg classification (23). The impact of the extent of the lateral column involvement on the results was evaluated according to the Stulberg classification. To assess the impact of the age of onset of the disease on the results, patients were divided into two groups. Group I consisted of patients with an age of onset between 6-8 years, and Group II consisted of those who were 9-10 years old at the onset of the disease.

For the statistical analyses, the t-test and Wilcoxon test were used for dependent samples, and the Mann-Whitney U-test and the chi-square tests were used for independent samples. Significance level was set at p < 0.05.

**RESULTS**

The mean follow-up period was 50.9 ± 15.3 months (range 35-84 months). Prior to surgery, containment was complete in two hips, whereas subluxation was present in 14 hips. During the final examination, containment was complete in 11 hips, and subluxation was present in the other 5 hips. Preoperatively, 6 patients had a normal walking
pattern while 10 patients had a limp; during the final examination, 12 patients had a normal walking pattern and 4 patients had a limp. Preoperatively, 10 patients had an average length discrepancy of 1.2 cm, whereas during the final examination, 6 patients had an average length discrepancy of 0.7 cm. According to Herring’s lateral column classification, preoperatively there were 4 (25%) type B, 8 (50%) type B/C, and 4 (25%) type C hips. According to Waldenström’s staging, 3 hips (18.7%) had avascular necrosis, 11 hips were (68.8%) in the fragmentation stage, and 2 hips (12.5%) were in the reossification stage.

The mean preoperative CE angle was 14.9 ± 4.9°, the early postoperative angle was 32.9 ± 4.9°, and at the last control it was found to be 30.3 ± 3.8°. The difference between the preoperative and the final examination was statistically significant (p < 0.01). There was a statistically significant difference between the preoperative mean HHS (71.06 ± 6.99) and the final examination mean HHS (92.56 ± 5.12) (p < 0.01).

Regarding the impact of the Herring’s lateral column involvement on the radiological results, the four hips which were type B preoperatively became respectively Stulberg classification type I (n = 2), type II (n = 1), and type III (n = 1) at final control (Fig. 1A, B). The eight hips that were Herring B/C preoperatively became respectively Stulberg classification type I (n = 1), type II (n = 4), type III (n = 2), and type IV (n = 1) at final examination (Fig. 3A, C). The four hips that were Herring C preoperatively became respectively Stulberg classification type II (n = 1), type III (n = 2), and type IV (n = 1) at final examination (Fig. 2A-C) (Table I).

Between Group I and Group II, which were formed to evaluate the effect of age of onset on the results, there was no statistically significant differ-

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**Table I.** — The effects of lateral column involvement on radiological results.

<table>
<thead>
<tr>
<th>Herring</th>
<th>Number of hips</th>
<th>Stulberg-I</th>
<th>Stulberg-II</th>
<th>Stulberg-III</th>
<th>Stulberg-IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>B/C</td>
<td>8</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>C</td>
<td>4</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>16</td>
<td>3 (18.75%)</td>
<td>6 (37.5%)</td>
<td>5 (31.25%)</td>
<td>2 (12.5%)</td>
</tr>
</tbody>
</table>

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ence in terms of lateral column involvement. There were ten patients in Group I with a mean age of 7.2 years. Group II was comprised of six patients with a mean age of 9.6 years. According to the Stulberg classification, in Group I, good results were achieved in seven (70%) patients, whereas only two (33.3%) patients in Group II had good results. The results in Group I were significantly better (p < 0.01) than Group II (Table II).

No complications such as nonunion, loss of graft reduction, infection, and nerve palsies were encountered.

**DISCUSSION**

The basic principle of the treatment of LCP is to reduce the load on the femoral head by providing coverage of the femoral head during the biological plastic phase. For this purpose, many conservative and surgical treatment modalities have been attempted (3,4,6,15,18). However, it has been report-
ed that surgical containment should be preferred to conservative treatment methods because of the roundness of the femoral head; the deterioration of the roundness of the femoral head increases the risk of the development of early degenerative osteoarthritis (12,20,23,28). For these reasons, the surgical containment of the femoral head has recently been used more frequently in the treatment of LCP patients between the ages of 6-10 years (1,9,25).

Surgical options include pelvic osteotomies, proximal femoral osteotomies, combined osteotomies, which are a combination of both techniques, and arthrodiastasis. Among these options, the most frequently used method is the Salter pelvic osteotomy. The Salter osteotomy has the advantages of providing a better containment of the femoral head anteriorly and laterally, causing a prolongation of the limb by about 1 cm, and correcting the Trendelenburg gait, as well easy implant removal and no risk of pathologic fracture (25). In addition, this method has been reported to accelerate the revascularization of the epiphysis, which in turn triggers a biological effect and shortens the active phase of the disease (7). However, in patients with advanced age and severe deformity, a Salter osteotomy alone may not be sufficient for the rotation of the acetabulum and the containment of the femoral head; therefore, additional procedures and different methods may be required (27). Furthermore, the extra pressure applied on the femoral head by the Salter osteotomy is a disadvantage of this technique (29).

In their study comparing three different methods of treatment of LCP (physiotherapy, orthotics and femoral osteotomy), Wiig et al achieved the least
successful results below and above 6 years of age in the group with the Scottish Rite orthosis (28). For patients less than six years of age, there was no difference between the results of physiotherapy and femoral osteotomy, while above six years of age, femoral osteotomy was found to be superior to physiotherapy. In a study on the Atlanta Scottish Rite orthosis, Martinez et al recommended that weight-bearing braces should not be used in the treatment of LCP (18).

In their prospective study of the hips of 345 6-12 year old patients with five different treatment methods, Herring et al. found no differences among the three groups: without treatment, treatment with brace, and treated with range of motion (ROM) exercises (12). Furthermore, the authors reported that they obtained better results after surgery in patients with an age of onset above 8 years and with lateral column B and B/C, whereas the results were often poor in cases with type C. The best results were achieved with Salter osteotomy in the group with an age of onset of 6-8 years (69% Stulberg type I and II).

Ishida et al. treated 37 cases with Salter osteotomy (14). After an average follow-up of 115 months, the hips were evaluated according to the Stulberg classification. 11 hips were evaluated as Type I, 5 hips as Type II, 13 hips as Type III, and 6 hips as Type IV. They reported the radiological results (according to Stulberg) of those treated at less than 7 years of age to be better, but that age did not have any effect on the clinical outcomes.

In the final follow-up of 40 patients treated by triple pelvic osteotomy, Wenger et al. obtained 42% good results (Stulberg I and II), 47% intermediate results (Stulberg III), and 11% poor results (Stulberg IV, V) (24). The results were better in Herring B hips compared to Herring C hips; patients treated younger than 8 years fared better than the older patients.

In our study of 16 cases, we found that the radiological results (according to Stulberg) of Group I were significantly better compared to that of Group II (p < 0.05). As far as clinical outcomes, the mean HHS in Group I was 95 while 85 in Group II; this difference was not statistically significant. The rate of good radiological results (Stulberg Type I and II) in Group I was 70%; this rate was 33.3% in Group II.

Of the 12 hips, which were Herring Type B and B/C according to the lateral column involvement preoperatively, 8 (66.6%) were evaluated as good according to the final Stulberg classification. This rate was only 25% (1 hips) in Herring Type C. We believe that either the addition of a proximal femoral osteotomy or a triple osteotomy would be a more appropriate treatment option in cases of severe deformity and in patients over 8 years old, as a Salter osteotomy alone does not provide sufficient rotation and containment.

Further studies are needed with a greater number of subjects, longer follow-up, and standard groups. However, as stated by Ishiada et al, this is rather difficult due to the difficulty of pre-operative standardization, the age at the time of the treatment, the radiographic findings with regard to the femoral head at the end of the disease process, the numerous factors that affect the results, and the creation of control groups (14).

These studies and the present data suggest that, in the treatment of patients with Perthes, which has a risk of poor prognosis especially in patients in the 6-8 year old age range, Salter pelvic osteotomy is a convenient and effective method of treatment given current knowledge. However, the understanding of the etiology of LCP and the development of treatment options directed toward this etiology will bring more successful options for treatment.

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REFERENCES


