Original Article

Clinical study on salter innominate osteotomy for developmental dysplasia of hip in children

Xiaofeng Ming*, Fanguo Kong*, Wuyin Li, Dengshan Chen, Chuanwei Zhang, Lei Wang

Department of Pediatric Orthopedics, Henan Luoyang Orthopedic Hospital (Henan Provincial Orthopedic Hospital), Zhengzhou 450000, Henan Province, China. *Equal contributors.

Received August 22, 2016; Accepted September 30, 2016; Epub December 1, 2016; Published December 15, 2016

Abstract: Objectives: This is to analyze the clinical effect of Salter Innominate Osteotomy on developmental dysplasia of hip (DDH) in children and the correlation between clinical variables before and after operation and adverse reactions. Methods: Retrospective analysis was adopted to analyze the efficacy of Salter Innominate Osteotomy on developmental dysplasia of hip in eighty children admitted to Henan Luoyang Orthopedic Hospital (Henan Provincial Orthopedic Hospital). According to the percentage of femoral head not covered by acetabulum within 6 months after surgery, these patients were divided into five groups. The differences of acetabular index, wiberg central-edge angle and the occurrence of adverse reactions were contrasted among the five groups. Results: Fine rate of Salter Innominate Osteotomy on DDH in children was more than 90%. And three patients had adverse reactions. Femoral head coverage of acetabulum was closely related to acetabular index before surgery. Conclusions: The incidence of adverse reactions after Salter Innominate Osteotomy was low. Preoperative and postoperative acetabular index, wiberg central-edge angle, femoral head coverage ratio and other indexes had a certain correlation with postoperative adverse reactions.

Keywords: Developmental dysplasia of the hip in children, salter innominate osteotomy, clinical study

Introduction

Developmental dysplasia of hip (DDH) is a common disease in pediatric orthopedics. If children with DDH are not treated with correct therapy in time, they will suffer from dysfunction of the hip joint and early degenerative osteoarthritis, even soft tissue dysplasia in acetabulum, femoral head, femoral neck bone structure, joint capsule, ligamentum teres and muscles around joints. In 1961, Slater adopted innominate osteotomy at first to treat acetabular dysplasia of DDH and subluxated dislocation. At present, Salter Innominate Osteotomy has been widely applied to the treatment of DDH in children [1]. However, some patients are accompanied by different degrees of adverse reactions in postoperative recovery [2, 3]. Therefore, recovery evaluation and adverse reaction after Salter Innominate Osteotomy are always the focus of clinical research.

The important parameters to evaluate the effect of Salter Innominate Osteotomy include acetabular index (AI), wiberg central-edge angle (CE angle), femoral head coverage, etc. At the same time these indexes are the hint to remind whether patients have adverse reactions after surgery. In order to analyze the effect of acetabular index and wiberg central-edge angle on the femoral head coverage after operation and the relationship between these indexes and postoperative adverse reactions, retrospective analysis was adopted to this study. According to the grade of postoperative femoral head coverage, patients were grouped. This research analyzed the clinical data of 80 patients with DDH treated with Salter Innominate Osteotomy.

Material and methods

Subjects

The patients with DDH admitted in Henan Luoyang Orthopedic Hospital (Henan Provincial Orthopedic Hospital) from 2009 to 2015 were treated with Salter Innominate Osteotomy. Patients with hip dysplasia, paralysis,
infection as well as patients lost in the follow-up were excluded. A total of 95 hips of 80 patients who met the requirement of grouping were randomly collected. Among these patients, male were 31 accounting for 38.7%, 49 female accounting for 61.3%, mean age with 5.6±2.5 years old (ranging 2-9 years old); 45 diseased left hips accounting for 47.3%, 50 diseased right hips accounting for 52.7%; average duration of follow-up was 15.5 months.

**Grouping**

According to the percentage of femoral head uncovered by acetabulum in six months after operation, patients’ stunted conditions after operation were divided into five levels [4]. 0 level: no dislocation; I level: 30% subluxation; II level: 30-60% subluxation; III level: 60-90% subluxation; IV level: complete dislocation. According to these levels, the eighty patients were divided into five groups. 15 hips were in 0 level, 23 in I level, 21 in II level, 20 in III level, and 16 in IV level.

**Imaging materials**

Before operation and six months after operation, patients’ x-ray films of pelvis ap were taken, and acetabular index (AI) and CE angle were made by imaging measurement. In six months after operation, x-ray radiographs and CT scanning were taken; percentage of femoral head uncovered by acetabulum of patients with DDH was calculated; patients were graded according to the above standards. In the final follow-up, postoperative effect was evaluated by Severin imaging rating standards and Mckay functional rating standards.

**Statistical analysis**

SPSS 18.0, the statistical software, was adopted to statistical analysis. Measurement data were showed as mean ± standard deviation (x±s). ANOVA was applied to comparison among groups. LSD method was applied to taking pairwise comparison. Paired t-test was applied to taking preoperative and postoperative comparison of acetabular index and CE angle. The differences had statistical significance with P ≤ 0.05.
Results

Clinical effect assessment after salter innominate osteotomy

In the final follow-up, most patients’ flexional degree of the hip joint in affected side reached or approached the degree in unaffected side. In affected side, the extending, adduction, and abduction of hip and activity of extorsion in hip flexion returned normal. According to Mckay criteria, the results of clinical follow-up after operation showed in Table 1. The results of follow-up showed that the postoperative qualified ratio of patients was 94.6%. According to Severin criteria, the results of X-ray checking follow-up results showed in Table 2. The results of follow-up showed that there was no patient with subluxation and dislocation of hip after operation, and the qualified ratio was 92.6%.

Acetabular index and CE angle comparison of patients in all groups before and after operation

The details of comparison showed in Table 3. Eighty cases were taken Salter innominate osteotomy six months ago. At present, according to the percentage of femoral head uncovered by acetabulum, there are 15 hips in patients with no dislocation (0 level), 23 hips in 30% patients with subluxation (I level), 21 hips in 30-60% patients with subluxation (II level), 20 hips in 60-90% patients with subluxation (III level), and 16 hips in patients with complete dislocation (IV level). Paired T test was applied to comparison acetabular index and CE angle of patients in all groups before and after operation, and the differences had statistical significance (P < 0.05). The acetabular index reduced from 33.6±5.1 before operation to 22.3±4.3 after operation; the CE angle recovered to 16.6±4.0 after operation from 0.58±3.2 before operation.

The analysis of variance was also applied to comparison patients’ acetabular indexes and CE angles among groups. The results showed that it had obvious differences. By pairwise comparison, the differences of preoperative acetabular index between patients with no dislocation group (0 level) and patients with complete dislocation group (IV level) had statistical significance (P < 0.05). Preoperative acetabular index of patients in no dislocation group was 33.2±3.6. Preoperative acetabular index of patients in complete dislocation group was 35.6±3.4, which was the biggest among groups. And also, postoperative acetabular index of patients in complete dislocation group had the biggest mean among groups. In postoperative follow-up, there were 2 cases in complete dislocation group suffering from redislocation during postoperative recovery. 1 case in III level group (60%-90% subluxation group) suffering from redislocation, and there was no adverse reaction, such as femoral head necrosis, and arthritis in early phase. The detail information of patients with redislocation showed in Table 4.

Discussion

From Tables 1 and 2, Salter innominate osteotomy had high curative effects for child with DDH. The overall excellent and good rates were above 90%. Salter innominate osteotomy is mainly suited to patients between 2 and 6 years old, which could correct abnormally acetabular direction, minish acetabular index, enlarge CE angle, improve adaptation among femoral heads, and increase the stability after restoration [5]. Acetabular index (AI) is the most classic indicator to measure operation results. Postoperative descending degree of AI is closely related to prognosis. Mean AI of normal newborn infant is 27.5°. After 1 year old, AI is less than 25°. In 2 years old, it drops to 20°. The change of AI after operation could reflect the change of acetabular shape. After operation AI of 80 cases averagely decreased 11°. The normal range of CE angle is 20°-40° inward. The smaller the CE angle is, the more instable the

Table 4. Basic information of patients with redislocation

<table>
<thead>
<tr>
<th>Patients ID</th>
<th>Level</th>
<th>Age</th>
<th>Acetabular index</th>
<th>CE angle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Preoperation</td>
<td>Postoperation</td>
<td>Preoperation</td>
</tr>
<tr>
<td>1</td>
<td>III level</td>
<td>7 years old 6 months</td>
<td>35.5</td>
<td>24.9</td>
</tr>
<tr>
<td>2</td>
<td>IV level</td>
<td>9 years old 1 month</td>
<td>37.6</td>
<td>25.3</td>
</tr>
<tr>
<td>3</td>
<td>IV level</td>
<td>9 years old 9 months</td>
<td>38.7</td>
<td>24.6</td>
</tr>
</tbody>
</table>
Salter innominate osteotomy on DDH

hip joint will be. CE angles of 80 cases notably improved after operation, which grew to around 16° from approaching to the minus value.

Femoral head coverage rate of acetabulum could visually display the shape and development of acetabulum. In fetus and newborn period, they have lower acetabulum and lower coverage rate with averagely 65%. In 4-5 years old, their coverage rate is about 70%, which approaches to the rate of normal adults. Femoral head coverage rate in acetabulum of patients with DDH was somewhat increased after Salter innominate osteotomy. Significant change of femoral head coverage rate in acetabulum of patients had happened in the first year after operation, which is the critical period to develop acetabulum. Within four years, it would gradually recover [5-8]. In our research, among 80 cases there were 3 cases happened redislocation after Salter innominate osteotomy, 1 case in III level group, 2 cases in IV level group, and other groups without adverse reactions. It showed that the lower the femoral head coverage rate in acetabulum after operation was, the greater the risk of redislocation would be. At the same time, both the preoperative and postoperative AIs of the 3 cases were higher than the mean of each group. CE angles after operation were lower than the mean in each group, which showed that the 3 cases’ hip joints were unstable and easy to dislocate compared with other patients. Another interesting phenomenon was that when patients’ acetabulum had higher femoral head coverage rate after operation, AI had the trend of decreasing, and CE angle had the trend of increasing. By measuring 97 cases with acetabular dislocation, Taketa, et al. [9] also had approved a correlation between femoral head coverage rate and CE angle. By imaging analysis, Yuguang Wang [10] also found a negative correlation between cartilage AI and femoral head coverage rate of patients’ DDH. The more close the AI was, the better the femoral head coverage rate of acetabulum would be. In addition, age also could be one reason to make patients suffering from dislocation [11].

In conclusion, adverse reactions still existed in Salter innominate osteotomy. How to prevent adverse reaction according to some indexes, such as preoperative and postoperative AI, CE angle, and femoral head coverage rate of acetabulum, and the underlying correlation among indexes is still a valuable research topic.

Disclosure of conflict of interest

None.

Address correspondence to: Wuyin Li, Department of Pediatric Orthopedics, Henan Luoyang Orthopedic Hospital (Henan Provincial Orthopedic Hospital), 100 Yongping Road, Zhengzhou 450000, Henan Province, China. Tel: +86-0371-55966339; Fax: +86-0371-67077303; E-mail: wuyinli1@sohu.com

References

Salter innominate osteotomy on DDH

