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KEYWORDS: congenitally dislocated hip, femoral neck anteversion

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ANTEVERSION OF THE FEMORAL NECK IN CONGENITAL DISLOCATION OF THE HIP

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find if derotation osteotomy affected the growth of the hip joint. The anteversion
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Key words: congenitally dislocated hip, femoral neck anteversion.

Laterality of the femoral head, deformation of the ossification center and
dysplasia of the acetabulum, which often follow treatment of congenital dislocation
of the hip, are thought to be at least partly due to increased anteversion of the
femoral neck. Derotation osteotomy of the femur, therefore, has been practiced
singly or in combination with other surgical operations. The idea that a decrease
in the anteversion angle results in an increase in the concentration of the femoral
head with respect to the acetabulum and that the growth of both the femoral
head and the acetabulum are accelerated thereby is, however, not fully accepted.

In this paper, the effect of a change in the anteversion angle before and about
ten years after treatment on hip growth was studied.

SUBJECTS

Included in the study were patients who visited the Department of Orthopaedic Surgery
of Okayama University Medical School or who were transferred to our department after
receiving conservative treatment at other hospitals or by practitioners because of unfavorable
progress. Treatment was given only after the confirmation of the anatomical condition inside
the hip by arthrography, except in the case of the Pavlik harness (1).

Patients treated by the Pavlik harness. Ninety-eight joints diagnosed as congenitally dislocated
hips by clinical and radiographic findings of 86 patients born between 1963 and 1969
were treated by the Pavlik harness within 6 months of birth. The measurement of the antever-
sion angles at the age of 9 - 10 was feasible with 55 joints of 47 cases (54.7 percent).

Patients treated by the frog plaster. This group consisted of 92 patients born between 1963

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and 1972, and included 100 joints diagnosed as congenitally dislocated hips by clinical and radiographic findings. This group also included those cases where, because early treatment by the Pavlik harness had failed, the frog plaster (2) was applied for a short period after manual reduction under general anesthesia, followed by the Pavlik harness again (1). However, there were 36 patients (37 joints) treated by the frog plaster alone within 1 - 3 years of birth, which is considered the most applicable period for the method. The anteversion angles before and after the treatment were measured in 15 joints of 14 cases (38.9 percent).

Patients treated by the Colonna operation. In this group were 30 patients (30 joints) who were born between 1963 and 1971 and were diagnosed as having congenital dislocation of the hip. This operation (3) was applied to cases where conservative treatment had failed or the dislocation was confirmed after starting to walk and open reduction was not considered feasible due to the advanced dislocation. The measurement of the anteversion angles was carried out in 22 joints of 22 cases (73.3 percent).

Patients treated by derotation osteotomy. Included in this group were 40 joints of 37 patients born between 1954 and 1969 in which derotation osteotomy alone was applied. Conservative treatment of these patients was considered unsatisfactory and radiographs showed that the concentration of their femoral heads improved after internal rotation. In this derotation osteotomy group, 34 joints of 32 cases were followed up. The anteversion angles before and after the operation were examined in 15 joints of 14 cases (43.8 percent).

METHODS

The pre-treatment anteversion angles (with the exception of those of the Pavlik harness) were measured on bi-directional radiographs, namely the antero-posterior views of the hip joint in the extension position and in the flexion-abduction position, which were taken for arthrographic examination of the hip joint. The Reynolds method (4) was used. No arthrographic examination of the hip joint was carried out before treatment by the Pavlik harness, so the pre-treatment measurement of the anteversion angle was infeasible.

Children treated were requested to return to our clinic to receive an examination for the purpose of observing their progress after the treatment when they reached 1, 3, 6, 9-10 and 17-18 years of age. As the children's early physical growth must somehow be established around 9 years after birth, the anteversion angles after the treatment were measured when they were around this age. The age at which the anteversion angles were measured in patients treated with the derotation osteotomy was about 13 years on the average because the age at operation was higher than those treated by the other methods. The follow-up measurement was made by the Rippstein method (5).

The reason why the different measurement methods were used before and after the treatment is that at our clinic the Reynolds method (4) was adopted for the measurement of anteversion angles in children in 1963, while the Rippstein method (5) was adopted in 1972. The author examined the correlation between the two methods in 3 joints of male patients and 17 joints of female patients in whom congenital dislocation of the hip was treated conservatively, and the measurement of the anteversion angle was feasible by both the Reynolds and Rippstein methods. Using the correlation expression thus obtained, the anteversion angles in terms of the Rippstein method were estimated from the values measured by the Reynolds method.

The four groups were evaluated by Severin's classification (6) using radiographs taken at the final follow-up examination.
RESULTS

The correlation coefficient between the Reynolds and Rippstein methods (4, 5) was 0.717 (p<0.01), and the estimated Rippstein values before the treatment were determined by the linear regression formula:

\[ Y(\text{Rippstein}) = 1.28 \times Y(\text{Reynolds}) - 10.2. \]

The estimated value of the anteversion angle before treatment was compared with the Rippstein real value after treatment. The derotation rate, i.e., the proportion of the difference in the anteversion angle before and after treatment to the original anteversion angle before treatment, was also determined.

As shown in Table 1, the average anteversion angle in the frog plaster group was 55.5 degrees before treatment and 35.3 degrees after, resulting in a derotation rate of 36.4 percent. In the Colonna operation group, the average anteversion angles before and after the treatment were 64.9 degrees and 37.7 degrees, and the derotation rate was 41.9 percent. The derotation rate of the derotation osteotomy group, 69.3 percent, was the highest among the groups.

Since it is generally recognized that the anteversion angle in healthy children decreases according to their age, the measurement of the so-called normal side was used for comparison of the values before and after treatment (Table 2). The estimated Rippstein values were used for the anteversion angles before the treatment. Average anteversion angles of the normal hip before treatment were 36.9

<table>
<thead>
<tr>
<th>Method of treatment</th>
<th>Number of hips treated</th>
<th>Before treatment</th>
<th>After treatment</th>
<th>Derotation rate (R)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Age (months)</td>
<td>Anteversion angles</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reynolds</td>
<td>Estimated Rippstein value (A)*</td>
<td></td>
</tr>
<tr>
<td>Pavlik harness</td>
<td>55</td>
<td>-</td>
<td>-</td>
<td>10 39.8±8.8</td>
</tr>
<tr>
<td>Frog plaster</td>
<td>15</td>
<td>19</td>
<td>51.3±18.1 55.5±23.2</td>
<td>10 35.3±13.4**</td>
</tr>
<tr>
<td>Colonna operation</td>
<td>22</td>
<td>23</td>
<td>58.7±18.9 64.9±24.2</td>
<td>10 37.7±11.4**</td>
</tr>
<tr>
<td>Derotation osteotomy</td>
<td>15</td>
<td>29</td>
<td>60.4±16.6 67.1±21.2</td>
<td>13 20.6±18.3**</td>
</tr>
</tbody>
</table>

Values and the mean ± S.D. (standard deviation)
- * Gained by a regression line from the Reynolds method values.
- ** Statistically significant at the 1 percent level by Student's t-test.
TABLE 2. ANTEVERSION ANGLES ON THE SO-CALLED NORMAL SIDE BEFORE AND AFTER TREATMENT

<table>
<thead>
<tr>
<th>Method of treatment</th>
<th>Number of hips treated</th>
<th>Before treatment Age (months)</th>
<th>Anteversion Reynolds Estimated Rippstein value (A)*</th>
<th>After treatment Age (years)</th>
<th>Anteversion Rippstein (B)</th>
<th>Derotation rate (R) = ( \frac{A - B}{A} \times 100 ) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pavlik harness</td>
<td>30</td>
<td>10</td>
<td>39.3±8.6</td>
<td>10</td>
<td>37.3±11.7</td>
<td>-1.1</td>
</tr>
<tr>
<td>Frog plaster</td>
<td>10</td>
<td>18</td>
<td>36.8±10.2 36.9±13.0</td>
<td>10</td>
<td>37.3±11.7</td>
<td>**</td>
</tr>
<tr>
<td>Colonna operation</td>
<td>15</td>
<td>22</td>
<td>42.3±15.8 44.0±20.3</td>
<td>10</td>
<td>35.7±9.4</td>
<td>18.9</td>
</tr>
<tr>
<td>Derotation osteotomy</td>
<td>7</td>
<td>19</td>
<td>50.6±18.1 54.5±23.1</td>
<td>11</td>
<td>33.1±4.5</td>
<td>39.3</td>
</tr>
</tbody>
</table>

(−) Not statistically significant at the 1 percent level by Student's t-test. Values are the Mean ± S.D.
* Gained by a regression line from the Reynolds method values.
** Statistically significant at the 1 percent level by Student's t-test.

TABLE 3. COMPARISON OF THE ANTEVERSION ANGLES ON THE SO-CALLED NORMAL AND AFFECTED SIDES

<table>
<thead>
<tr>
<th>Method of treatment</th>
<th>So-called normal side Number of hips treated</th>
<th>M. S.D.</th>
<th>Affected side Number of hips treated</th>
<th>M. S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pavlik harness</td>
<td>30</td>
<td>39.3±8.6</td>
<td>55</td>
<td>39.8±8.8</td>
</tr>
<tr>
<td>Frog plaster</td>
<td>10</td>
<td>37.3±11.7</td>
<td>15</td>
<td>35.3±13.4</td>
</tr>
<tr>
<td>Colonna operation</td>
<td>15</td>
<td>35.7±9.4</td>
<td>22</td>
<td>37.7±11.4</td>
</tr>
<tr>
<td>Derotation osteotomy</td>
<td>7</td>
<td>33.1±4.5</td>
<td>15</td>
<td>20.6±18.3</td>
</tr>
</tbody>
</table>

** Statistically significant at the 1 percent level by Student's t-test.
(−) Not statistically significant at the 1 percent level by Student's t-test. M: Mean, S.D.: Standard deviation.

degrees in the frog plaster group, 44.0 degrees in the Colonna operation group and 54.5 degrees in the derotation osteotomy group. A statistically significant difference was found between the derotation osteotomy and the frog plaster groups, and between the derotation osteotomy and the Colonna operation groups (p<0.01). The anteversion angles after treatment were 39.3 degrees in the Pavlik harness group, 37.3 degrees in the frog plaster group (derotation rate of -1.1 percent), 35.7 degrees in the Colonna operation group (derotation rate of 18.9 percent) and 33.1 degrees in the derotation osteotomy group (derotation rate of 39.3 percent). A significant difference was found between the derotation...
osteoartomy and Pavlik harness groups (p<0.01).

The comparison of the anteversion angles after the treatment on the so-called normal side and those on the affected side is shown in Table 3. In the Pavlik harness group, the average anteversion angles were 39.3 degrees on the normal side and 39.8 degrees on the affected side. The angles of the normal and affected sides were 37.3 and 35.3 degrees in the frog plaster group, and 35.7 and 37.7 degrees in the Colonna operation group. No significant difference was shown between the normal and affected sides in the Pavlik harness, frog plaster and Colonna operation groups. However, the derotation osteotomy group showed a significant difference between the normal side (33.1 degrees) and the affected side (20.6 degrees).

The results obtained through the follow-up survey were assessed with Severin’s classification (Table 4). Because the bottom of the acetabulum is reamed out in

<table>
<thead>
<tr>
<th>Method of treatment</th>
<th>Severin’s classification</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I (percent)</td>
</tr>
<tr>
<td>Pavlik harness</td>
<td>46 (83.6)</td>
</tr>
<tr>
<td>Frog plaster</td>
<td>10 (66.7)</td>
</tr>
<tr>
<td>Colonna operation</td>
<td>0</td>
</tr>
<tr>
<td>Derotation osteotomy</td>
<td>3 (20.0)</td>
</tr>
</tbody>
</table>

the Colonna operation group, the joint is no longer normal anatomically. Hence, the patients of the Colonna operation group are not included in the Severin I group. Patients classified as Severin I and II included 50 in the Pavlik harness group (90.9 percent), 14 in the frog plaster group (93.4 percent), 19 in the Colonna operation group (86.4 percent), and 5 in the derotation osteotomy group (33.3 percent).

The correlation between the CE angles according to Severin's classification and the anteversion angles after treatment was examined (Figs. 1-4). The correlation coefficient was 0.1170 in the Pavlik harness group, -0.3223 in the frog plaster group, 0.2435 in the Colonna operation group and 0.0995 in the derotation osteotomy group. There was no correlation between the CE angles and the anteversion angles among the four groups.

DISCUSSION

The first attempt to determine anteversion angles from a skeleton was made
Fig. 1. Pavlik harness group. The correlation between anteverision (AV) and CE angles is 0.1170.

Fig. 2. Frog plaster group. The correlation between anteverision (AV) and CE angles is -0.3223.

Fig. 3. Colonna operation group. The correlation between anteverision (AV) and CE angles is 0.2435.
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Anteversion of the Femoral Neck in CDH

![Chart showing relationship between anteversion angle and CE angle.](chart)

Fig. 4. Derotation osteotomy group. The correlation between anteversion (AV) and CE angles is 0.0995.

by Mikulicz (7). Later, the first attempt to measure the angles clinically was made by Soutter et al. (8) by means of mono-directional plane radiography. In Japan, the first report on the angle measurement was made by Takagi (9), who examined the angles by radiographic fluoroscopy. Recently, Peterson et al. (10) and Reikerās et al. (11) have studied the relation between the acetabulum and femoral neck by means of computerized tomography and found it very useful for measuring anteversion.

It has already been pointed out by Suzuki (12) and Akahoshi et al. (13) that the anteversion angles vary according to the measuring method and examiner. In the present survey, the Reynolds method was used for measurement before the treatment since that method was in use at the time, whereas the Rippstein method was used after the treatment since our department adopted that method in 1972. Accordingly, the values of the anteversion angles measured by the Reynolds method were converted to Rippstein values.

Comparison of the anteversion angle before and after treatment by the frog plaster, Colonna operation and derotation osteotomy (Table 1) shows that the anteversion angles after treatment are markedly smaller than before treatment. Statistical analysis (Student’s t-test) of the estimated Rippstein values before the treatment and the Rippstein values after the treatment invariably showed a significant difference ($p<0.01$). The derotation rate was largest in the derotation osteotomy group, followed by the Colonna operation and frog plaster groups. The derotation rate in the derotation osteotomy group was very large, while the rates in the latter two groups were quite small. The derotation osteotomy carried out to decrease the anteversion angle was effective in this respect as the measurement 10 years later showed.

Comparison of the anteversion angles on the so-called normal side before and
after treatment (Table 2) showed that before the treatment the angles were largest in the patients treated by the derotation osteotomy, and that there was a statistically significant difference between the frog plaster and derotation osteotomy groups ($p<0.01$). It was thus confirmed that in the patients who underwent derotation osteotomy because of a large anteversion angle, the anteverision angle on the so-called normal side was also large, as was pointed out by Fabry et al. (14).

Comparison of the anteverision angles after the treatment and the Rippstein estimated values before the treatment showed that there was little difference in the frog plaster group and that the derotation rate in the Colonna operation group was only 18.9 percent, while the rate was 39.3 percent in the derotation osteotomy group (Table 2). Comparison by Student's $t$-test of the anteverision angles after treatment showed a statistically significant difference between the Pavlik harness and the derotation osteotomy groups ($p<0.01$). There was, however, no significant difference between the derotation osteotomy group and the other two groups.

It has been reported by Le Damany (15) and Dunlap et al. (16) that the anteverision angle decreases with increasing age. According to the results of the present study, the anteverision angles in the derotation osteotomy group, which were the largest before the treatment, became the smallest after the treatment. Judging from the fact that the anteverision angles were also significantly smaller in the derotation osteotomy group than in the Pavlik harness group after the treatment, the surgery carried out on the affected side may have had an influence on the normal side.

Also, the fact that the derotation rate of patients who underwent the Colonna operation was larger than in the frog plaster group indicates that surgical treatment had some influence on the natural decrease in the angles on the normal side.

With regard to the Pavlik harness, frog plaster and Colonna operation groups, no statistically significant anteverisional difference between the normal and affected sides was noted at the final follow-up survey. In the derotation osteotomy group, however, the average anteverision angle on the affected side was 20.6 degrees as against 33.1 degrees on the normal side. This difference was statistically significant ($p<0.01$) (Table 3). The derotation effect of the derotation osteotomy was greater than the natural decrease in the anteverision angle as well as the derotation effect of the other treatment methods, even after 10 years.

In a $\chi^2$ test of the results (Table 4), differences among individuals were found to be significant ($p<0.01$).

Included in the Severin I and II groups, where the progress is favorable with regard to the concentration of the femoral head, were 93.4 percent of the frog plaster hips, 90.9 percent of the Pavlik harness hips, 86.4 percent of the Colonna operation hips, but only 33.3 percent of the derotation osteotomy hips. Thus, the therapeutic effect of the derotation osteotomy was significantly lower than that of the other three methods and was not as favorable as expected. In spite of normal growth of the hip joint through surgical derotation in the derotation osteotomy group, the
present follow-up survey showed that the clinical results in the derotation osteotomy group were not so favorable, indicating that there is no correlation between the derotation and the therapeautical effect.

As shown in Figs. 1 to 4, the correlation coefficients between the CE angles, which are the basic scale of Severin's classification, and the anteverision angles after each individual treatment were so small that no correlations were recognized. Since the larger the CE angles become, the greater the appreciable therapeautical effect is, there ought to be a high negative correlation coefficient if the derotation had a favorable influence on the therapeautical effect. A negative correlation was, however, noticeable only in the frog plaster group, but the coefficient was extremely small. No such correlation was noticeable in the Colonna operation group which showed a much better therapeautical effect than the derotation osteotomy group.

The assessment of the therapeautical effect of various treatment methods according to the CE angles showed that neither the anteverision angle nor derotation are important consideration in the treatment of congenital dislocation of the hip.

No significant relation between the CE angles and the anteverision angles or the degree of derotation after treatment was found, which enables us to conclude that the hip joint growth is not influenced so much by the extent of anteverision.

Acknowledgment. I am greatly indebted to Prof. G. Tanabe for his advice and instructions. I also wish to thank Associate Prof. T. Ohta of the Dept. of Hygiene and Drs. H. Kunisada, Y. Miyake, H. Inoue and K. Oda of the Dept. of Orthopaedic Surgery for their assistance and cooperation.

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REFERENCES

1. Pavlik, A.: Die funktionelle Behandlungsmethode mittels Riemenbügel als Prinzip der konserva-
vativen Therapie bei angeborenen Hüftgelenksverrenkungen der Säuglinge. Z. Orthop. 89, 341-
352, 1957.
2. Lorenz, A.: Bemerkungen zur Technik der Reposition und Retention der kongenitalen Hüftgel-
3. Colonna, P.C.: An arthroplastic operation for congenital dislocation of the hip, a two stage pro-
6. Severin, E.: Contribution to the knowledge of congenital dislocation of hip joint: late result of
closed reduction and arthrographic studies of recent cases. Acta Chir. Scand. (Suppl. 63) 84, 1-142,
1941.
Med. J. 78, 1071-1077, 1903.


