ABSTRACT

Objective: Radiographic evaluation of the evolution of hips that underwent soft-tissue release. Methods: This was a retrospective evaluation on 101 spastic cerebral palsy patients who underwent soft-tissue release between 1991 and 2006. Forty-four patients met the inclusion criteria: 23 boys and 21 girls; 34 diparetic and 10 quadriparetic. Functionally, 29 were non-walkers, five were able to walk at home and 10 were able to walk within the community. Reimers’ index (RI) and the acetabular index (AI) were measured on pre and postoperative radiographs, with a minimum follow-up of three years. The mean age at the time of surgery was 6.4 years. Results: The results were considered good if the RI had reduced, or had increased by less than 10%. This was found in 52% of this study. We observed a clear improvement in IR, along with worse results in patients with more than five years of postoperative follow-up. Conclusion: Soft-tissue release should be performed as early as possible, regardless of age, walking condition, clinical type, RI, AI or sex, and as soon as the patient clinically presents less than 30° abduction, because of the benefits relating to walking, prevention and treatment of subluxation, hygiene and pain relief.

Keywords – Cerebral palsy; Hip dislocation

INTRODUCTION

Children with cerebral palsy may present subluxation or dislocation due to spasticity(1,2). It is believed that this may result from the muscle imbalance that causes anomalous hip positions in adduction, flexion and internal rotation(3). The severity of the hip dislocations is related to the degree of spasticity and functionality. The prevalence of this condition was found to be 80% in one study (35 out of 44 children) and it was more frequently seen in children who were non-walkers with quadriparetic conditions(4). The secondary effects of spastic subluxation and dislocation include problems of positioning, personal hygiene, walking and pain. In addition, the adducted position of the hip contributes towards the development of pelvic tilting and subsequent scoliosis(5,6).

Different surgical procedures, including both soft-tissue and bone operations, may be used to treat these conditions, depending on the child’s age, severity of the condition and abnormality of the hip. Soft-tissue surgery (muscle resection and tenotomy) acts to prevent subluxation and dislocation of spastic hips(7,8). However, there are doubts regarding the age, indications for the surgical procedures and the muscles involved, along with the postoperative management(9) and the durability of the result obtained.

The aim of this study was to radiographically evaluate the evolution of the hips of children with diparetic and quadriparetic cerebral palsy, after performing soft-tissue release (tenotomy on the adductor and gracilis muscles).
SAMPLE AND METHODS

The method consisted of a retrospective assessment on 101 patients with a diagnosis of diparetic and quadriparetic cerebral palsy who underwent soft-tissue release surgery (tenotomy on the adductor and gracilis muscles) between 1991 and 2006, performed by the Neuromuscular Diseases Group of the Department of Orthopedics and Traumatology, Santa Casa School of Medical Sciences, “Fernandinho Simonsen” Wing, Santa Casa de Misericórdia de São Paulo. Among these, 44 patients fulfilled all the inclusion criteria (complete clinical and radiographic follow-up), of whom 23 were male and 21 were female, and there were 34 diparetic individuals and 10 quadriparetic individuals. Their walking condition was assessed before the operation and it was found that there were 29 who were unable to walk (non-walkers), five who were able to walk at home (home walkers) and ten who were able to walk within the community (community walkers).

The patients’ mean age at the time of the surgery was 6.4 years, with a range from one to 20 years.

Surgery was indicated for the patients with abduction of less than 30 degrees, which was investigated with the hips extended and using the stretch reflex.

The radiographic analysis was conducted using Reimers’ index (RI) and the acetabular index (AI) as the parameters. Reimers’ index consists of the percentage migration of the femoral head, obtained as the percentage of the femoral head that is lateral to Perkins line, in relation to the total diameter of the proximal femoral epiphysis. Reimers considered that up to three years of age, normal hips would present a femoral head completely covered by the acetabulum. Between the ages of four and 16 years, it was considered that normal hips could present up to 5% lateral to the Perkins line. In patients with cerebral palsy, hips with more than 33% migration were considered to present subluxation, and with 100% migration, dislocation. We divided the groups to stratify the preoperative radiographic condition as follows: normal RI < 20%; hip at risk, RI 20 – 32%; subluxation, RI 33 – 89%; and dislocation RI > 90%, as described by Terjesen et al.

The radiographic parameters were measured on preoperative radiographs and on the most recent radiograph obtained, in anteroposterior view of the pelvis. The minimum time that elapsed between the preoperative and postoperative radiographs was three years and the maximum was 15 years, with a mean of five years and 11.5 months (Figures 1, 2, 3 and 4).
Tenotomy was performed on the adductor muscles bilaterally (long adductor, short adductor and gracilis). The patients were kept in a bilateral plaster cast covering the legs and feet, with an abduction bar, for three weeks, followed by physiotherapy.

The criteria for evaluating the results were in accordance with Kalen and Bleck\(^1\), i.e. the results were considered good when the RI decreased or did not increase by more than 10%; if it increased by more than 10\%, the result was considered poor. We analyzed the hips separately and the patients as a whole. In the latter case, the side most affected was noted.

To evaluate the qualitative variables between each other, the chi-squared or Fisher’s exact test was used. To compare the variables from before to after the operation, in order to assess the evolution, the McNemar test was used. The software used was Epi-info 6.0 and SPSS for Windows (v. 13), and results were taken to be statistically significant when \(p < 0.05\).

### RESULTS

The mean length of follow-up was 5.9 years.

Among the group of 44 patients (88 hips), good results were obtained in 23 patients (52\%) and poor results in 21 (48\%). Regarding walking function, among the 10 community walkers, seven achieved good results (70\%); among the five home walkers, two obtained good results (40\%); and among the 29 non-walkers, 14 presented good results (48\%), \(p = 0.417\) (chi-square test) (Table 1).

Regarding the types of spastic cerebral palsy, 34 patients were diparetic, with good results in 18 (53\%). Among the quadriparetic patients, five (50\%) presented good results. The patients’ ages at the time of the surgery were also evaluated. For this, the patients were divided into two groups: four years of age or under; and over four years of age. Good results were obtained in seven (50\%) of the 14 children in the younger group, and in 16 (53\%) of the 30 children in the older group. Thus, there was no prognostic trend regarding the age at the time of the surgery (\(p = 0.837\) from chi-square), as represented in Figure 5.

The results from patients with follow-up less than versus greater than or equal to five years were compared. It was observed that in the group with less than five years of follow-up, 13 (65\%) of the patients obtained good results, while in the group with more than five years of follow-up, 10 (42\%) presented a good result, thus showing radiographic worsening over the long term. The statistical analyses on sex, type of cerebral palsy (diparetic or quadriparetic) (Figure 6), walking function (community walker, home walker or non-walker), age at the time of the surgery (less than or equal to four years versus more than four years of

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**Table 1 — Results according to motor function**

<table>
<thead>
<tr>
<th>Function</th>
<th>Good</th>
<th>Poor</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community walkers</td>
<td>7</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>Home walkers</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Non-walkers</td>
<td>14</td>
<td>15</td>
<td>29</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>23</strong></td>
<td><strong>21</strong></td>
<td><strong>44</strong></td>
</tr>
</tbody>
</table>

Source: SAME-ISCMSP

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**Figure 5 – Results from the surgery according to the patients’ ages at the time**

The results from patients with follow-up less than versus greater than or equal to five years were compared. It was observed that in the group with less than five years of follow-up, 13 (65\%) of the patients obtained good results, while in the group with more than five years of follow-up, 10 (42\%) presented a good result, thus showing radiographic worsening over the long term. The statistical analyses on sex, type of cerebral palsy (diparetic or quadriparetic) (Figure 6), walking function (community walker, home walker or non-walker), age at the time of the surgery (less than or equal to four years versus more than four years of...
RESULTS OF ADDUCTORS MUSCLE TENOTOMY IN SPASTIC CEREBRAL PALSY

age) and length of follow-up (less than five years versus greater than or equal to five years) (Figure 7), in relation to good or poor results, did not show statistical significance (p > 0.05).

The hips were evaluated separately and per patient, noting the worse side. In relation to the right side, 21 patients initially presented a normal hip, 10 were at risk and 13 were subluxated. Among the normal right hips, 10 (48%) obtained a good result; among those at risk, eight (80%) and among the right subluxated hips, 12 (92%); thus, presenting statistical significance: p = 0.016 (chi-square). No statistical significance was seen on the left side: p = 0.853 (chi-square), although good results were found for 11 (73%) of the normal left hips, 12 (80%) of those at risk and 10 (71%) of the subluxated left hips (Tables 2 and 3). By assessing the patients and considering the worse side to be the final result (Table 4), good results were found in five (42%) of the normal hips, eight (57%) of those at risk and nine (50%) of the subluxated hips, p = 0.687 (chi-square).

Comparison according to the presentation (normal, at risk or subluxated) before and after the operation produced p > 0.05 (McNemar) on both sides, i.e. without statistical significance (Tables 5, 6 and 7).

DISCUSSION

The 44 retrospectively selected patients were assessed to find evidence regarding when tenotomy of the adductor muscles should be performed and whether there were any prognostic indications, and in order to make comparisons with results in the literature. It ne-
eds to be borne in mind that tenotomy of the adductor muscles is not only for prevention but also for treatment of subluxated hips. There are other benefits such as improvement of walking and the ability to stand upright, increased abduction, improved hip symmetry, facilitation of hygiene and pain relief.

The results have been defined in certain ways. According to Kalen and Bleck, good results occur when there is a decrease in RI or an increase of not more than 10%. Silver et al. considered that the results were unsatisfactory if patients required new surgery to acquire hip stability (soft tissue or bone). Turkey and Lee added to the latter by suggesting that RI greater than 80% indicated an unsatisfactory result. Miller et al. classified the results as satisfactory when RI was less than or equal to 39% and unsatisfactory when it was greater than 40%. However, the three classifications cited above can be criticized. According to the classification of Miller et al., a hip with evident diminution of RI while still remaining greater than 40% is considered to be an unsatisfactory result. According to Silver et al., a patient who undergoes tenotomy of the adductor muscles with a hip that is already severely dysplastic and will probably undergo bone surgery shortly is considered to have an unsatisfactory result. According to Kalen and Bleck, a patient with a normal hip who presents an increase in RI greater than 10% but the hip remains normal is considered to have a poor result. Based on this analysis, the classification of Kalen and Bleck was used in the present study but the initial situation was also assessed in relation to the final situation (Tables 5, 6 and 7). In evaluating the right side, good results were seen in 92% of the subluxated hips, 80% of those at risk and only 48% of the normal hips. However, from comparison between the initial and final situations, we observed that out of the 21 normal hips, 14 remained normal, six went to the at risk group and only one subluxated (Table 5). This demonstrates the importance of evaluating the results using different methods. These good results were repeated in evaluating the left side (Table 6). Comparing these results with the literature, there was agreement with the conclusion of Presedo et al., who found that releasing the soft tissue provided effective treatment and prevention of hip subluxation in cases of cerebral palsy. Obviously, evaluations on patients whose hips are worse provide inferior results, as seen in other published papers (Tables 4 and 7). It is worth mentioning that it was impossible to establish a control group in this study, since there are other indications for this surgery in addition to prevention of subluxation.

The acetabular index was measured in the present study, and a preoperative mean of 23.82 degrees was found. No statistical difference was found through comparing the results from patients with $\text{AI} \leq 27.5$ with those with $\text{AI} > 27.5$, although there was a slight tendency towards better results in hips with a smaller AI, as demonstrated by Terjesen et al.

It needs to be borne in mind that both of these radiographic measurements are subject to variations when measured by different observers, or even by the same

### Table 5 – Results according to Reimers’ index on the right side before and after the operation

<table>
<thead>
<tr>
<th>Preoperative right-side RI</th>
<th>Normal</th>
<th>At risk</th>
<th>Subluxated</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>14</td>
<td>6</td>
<td>1</td>
<td>21</td>
</tr>
<tr>
<td>At risk</td>
<td>4</td>
<td>6</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Subluxated</td>
<td>3</td>
<td>4</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>Total</td>
<td>21</td>
<td>16</td>
<td>7</td>
<td>44</td>
</tr>
</tbody>
</table>

Source: SAME-ISCMSP
RI: Reimers’ index

### Table 6 – Results according to Reimers’ index on the left side before and after the operation

<table>
<thead>
<tr>
<th>Preoperative left-side RI</th>
<th>Normal</th>
<th>At risk</th>
<th>Subluxated</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>15</td>
<td>0</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>At risk</td>
<td>4</td>
<td>8</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>Subluxated</td>
<td>2</td>
<td>7</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td>Total</td>
<td>21</td>
<td>15</td>
<td>8</td>
<td>44</td>
</tr>
</tbody>
</table>

Source: SAME-ISCMSP
RI: Reimers’ index

### Table 7 – Results according to Reimers’ index for both sides before and after the operation

<table>
<thead>
<tr>
<th>Preoperative total RI</th>
<th>Normal</th>
<th>At risk</th>
<th>Subluxated</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>11</td>
<td>1</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>At risk</td>
<td>3</td>
<td>8</td>
<td>3</td>
<td>14</td>
</tr>
<tr>
<td>Subluxated</td>
<td>3</td>
<td>6</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>Total</td>
<td>17</td>
<td>15</td>
<td>12</td>
<td>44</td>
</tr>
</tbody>
</table>

Source: SAME-ISCMSP
RI: Reimers’ index
observer. Parrott et al. concluded that a standard deviation of around 8% should be accepted for RI and four degrees for AI.

In relations to the patients’ ages at the time of the surgery, Kalen and Bleck found better results in younger patients, and recommended that surgery should be performed before the age of five years. Sharrard et al. also found these result. On the other hand, no difference was found in the present study between patients operated before and after four years of age, in accordance with other studies: Silver et al., Cottalorda et al., Turker and Lee, Terjesen and Presedo et al.

There was no statistical significance in relation to the initial walking condition, as in the results from Silver et al. and Cottalorda et al. However, in the present study, good results were observed in 70% of the community walkers, versus 40% of the home walkers and 48% of the non-walkers, thus demonstrating a tendency towards better results for the community walkers.

The duration of the follow-up is an important variable for analyzing the results, and it was frequently discussed in previous published papers. Reimers et al. and Onimus et al. presented a mean follow-up of three years. Kalen and Bleck, Silver et al. and Miller et al. presented follow-ups of four to five years. Turker and Lee demonstrated that the good results deteriorated with longer follow-up. Terjesen et al. recommended a minimum follow-up of six years for evaluating the results. This worsening is expected because the evolution towards subluxation does not stabilize until skeletal maturity is attained. Based on these data, we divided our patients into two groups: the first with follow-up greater than or equal to five years and the second with follow-up less than five years. We clearly saw a tendency towards worse result among the patients with greater follow-up, but without statistical significance (Figure 7).

**CONCLUSION**

The radiographic results obtained from the present study make it possible to conclude that the soft-tissue surgery should be performed as early as possible, independent of age, walking condition, type of spasticity, AI, RI or sex, among patients with cerebral palsy who clinically present hip abduction less than 30 degrees, because of the benefits relating to walking, hygiene, pain relief and prevention and treatment of subluxation.

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**REFERENCES**