AVULSION OF THE DISTAL POLE OF THE PATELLA IN CEREBRAL PALSY

A CAUSE OF DETERIORATING GAIT

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Avulsion of the distal pole of the patella in spastic children with a flexed knee gait may upset the equilibrium of the knee and cause deterioration in walking. We emphasise the clinical features, discuss the mechanism and outline the principles of treatment.

Avulsion of the distal pole of the patella in cerebral spastic diplegia or hemiplegia associated with knee flexion during walking has been well described, with emphasis on the radiological signs (Kaye and Freiberger 1971; Rosenthal and Levine 1977).

Where avulsion was not diagnosed and consequently radiographs were not taken. It should be emphasised, however, that avulsion may occur painlessly, as in our illustrative case (though pain did develop three years later).

<table>
<thead>
<tr>
<th>Case</th>
<th>Age at presentation</th>
<th>Neurological type</th>
<th>Side affected</th>
<th>Presenting symptoms</th>
<th>Duration of symptoms (months)</th>
<th>Knee flexion (degrees)</th>
<th>Previous lengthening of tendo calcaneus</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>14</td>
<td>Spastic diplegia</td>
<td>Bilateral</td>
<td>Decreased walking distance Pain and swelling right knee only</td>
<td>24</td>
<td>R 0 10</td>
<td>R Yes</td>
</tr>
<tr>
<td>2</td>
<td>16</td>
<td>Spastic tetraplegia</td>
<td>Right</td>
<td>Decreased walking distance Pain right knee</td>
<td>24</td>
<td>10 25</td>
<td>Yes</td>
</tr>
<tr>
<td>3</td>
<td>11</td>
<td>Myelomeningocele and hypertonia</td>
<td>Bilateral</td>
<td>Decreased walking distance Pain right knee</td>
<td>12</td>
<td>R 0 20</td>
<td>R No</td>
</tr>
<tr>
<td>4</td>
<td>11</td>
<td>Spastic tetraplegia</td>
<td>Right</td>
<td>Decreased walking distance Severe pain right knee</td>
<td>19</td>
<td>20 30</td>
<td>Yes</td>
</tr>
<tr>
<td>5</td>
<td>11</td>
<td>Spastic diplegia</td>
<td>Bilateral</td>
<td>Decreased walking distance Pain and swelling in both knees</td>
<td>6</td>
<td>R 20 40</td>
<td>R Yes</td>
</tr>
<tr>
<td>6</td>
<td>10</td>
<td>Spastic diplegia</td>
<td>Right</td>
<td>Decreased walking distance Pain right knee</td>
<td>3</td>
<td>20 35</td>
<td>No</td>
</tr>
<tr>
<td>7</td>
<td>14</td>
<td>Spastic diplegia</td>
<td>Bilateral</td>
<td>Decreased walking distance Pain right knee</td>
<td>12</td>
<td>R 0 20</td>
<td>R No</td>
</tr>
<tr>
<td>8</td>
<td>15</td>
<td>Spastic diplegia</td>
<td>Right</td>
<td>Decreased walking distance No pain</td>
<td>12</td>
<td>30 50</td>
<td>No</td>
</tr>
</tbody>
</table>

In this paper we wish to describe certain clinical features, the consistency of which enables the diagnosis to be made readily. Since we became aware of this syndrome we have made the clinical diagnosis (confirmed by radiographs) in eight patients in a period of 12 months. In retrospect we can recall earlier examples.

Clinical and radiological features

Deterioration in the performance of a brain-injured child behoves us to seek an explanation. There may, for example, have been an increase in deformity or weight, withdrawal of effort in the face of handicap or even progression of the neurological deficit, affecting balance in particular. If, however, the deterioration is the result of avulsion of the distal pole of the patella, the symptoms and signs are characteristic.

The parents describe a deterioration in walking ability which is usually associated with pain in front of one or both knees. The child is seen to walk with more knee flexion than formerly and may support the knee.

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Figure 1—Boy aged 11 (Case 5). Lateral projection showing bilateral avulsion of distal pole. There is elevation of the tibial tubercle and marked patella alta. Figure 2—Three years later; although the knees are shown straight, he walked with them flexed. Figure 3—Anteroposterior view showing patella alta and some slight resemblance to bipartite patella. Figure 4—Photomicrograph of the excised lower pole of the patella. The pseudarthrosis lies at the top. Immediately below there is vascular granulation tissue filling the lacunae and new bone formation indicating a recent fracture; more distally the bone is normal (×10).

with a hand. On examination there is often acute local tenderness at the distal pole of the patella and an increase in, or the development of, fixed flexion deformity. A radiograph will confirm the diagnosis (Figs 1 and 2). In bilateral cases the appearances have, however, been mistakenly regarded as a type of bipartite patella (Fig. 3), in which the pattern is quite different.

CLINICAL MATERIAL
The salient features of eight patients with 12 affected knees are summarised in Table I. Seven patients had cerebral spastic diplegia (two tetraplegia, Cases 2 and 4), and one was in association with myelomeningocele (Case 3). Avulsion was bilateral in four. The presenting symptoms were a deterioration in the walking ability of all eight patients and pain in seven. Although pain was usually a presenting feature, it was absent in one patient with unilateral avulsion (Case 8) and felt in only one knee in three of the four patients who were bilaterally affected. Deterioration in walking was characterised by decreasing endurance and increasing knee flexion. Fixed flexion deformity and extension lag were very common.
features, being present in 7 and 12 knees respectively. Symptoms preceded diagnosis by between 3 and 24 months with an average of 14 months. Radiologically, separation of the distal pole from a patella (of otherwise normal contour) which was displaced proximally (patella alta) was invariable. Elongation and attenuation of the patella as described by Rosenthal and Levine (1977) was not seen.

ILLUSTRATIVE CASE REPORT
A boy aged 11 years (Case 5; Table I) with cerebral spastic diplegia when first seen walked freely without aids (48 m in 75 seconds) with his heels raised 5 cm, his left knee flexed 45° and his right knee flexed 20°. Both calcaneal tendons were elongated. He returned two years later complaining of pain in the front of the left knee and that his walking ability had deteriorated over the past six months. He was now confined to the house. On walking, both knees were flexed 40° and both had fixed flexion deformities of 20°. There was tenderness at the distal pole of both patellae, more marked on the left; a radiograph revealed avulsion of the distal poles. Bilateral hamstring release was performed and the flexion deformities corrected by serial plasters. The distal pole of the left patella was excised and on microscopy showed evidence of a recent fracture (Fig. 4).

Mechanism
Attempts to control knee flexion caused by hamstring overaction, especially if there is also some fixed flexion, clearly impose unusual demands upon the extensor mechanism. In particular, stress is concentrated on the patellar ligament, especially at its origin and its insertion. Indeed, it is calculated that when there is 30° of knee flexion the force transmitted through the quadriceps to stabilise this position amounts to more than twice the body weight in a normal subject. In the presence of spastic hamstrings the forces are magnified (Perry, Antonelli and Ford 1975). A fatigue fracture is therefore likely to occur which, because of continuing distraction, progresses to non-union (Fig. 2).

Management
If we assume that the cause of deterioration is overactivity of the hamstrings opposed by a weakened quadriceps mechanism, it would seem logical to correct any fixed flexion and also to reduce hamstring power by means of serial plasters and appropriate tenotomies or tendon lengthenings. The necessity to remove the detached fragment of patella is questionable, although we have done so twice when pain was a prominent feature. Rosenthal and Levine (1977) have shown that despite the unfavourable features, union can occur during the time that the knee is necessarily immobilised in extension.

DISCUSSION
It is suggested that avulsion of the fragment follows a fatigue fracture secondary to the increased load imposed upon the extensor mechanism. This is supported by the gradual onset or the intermittent nature of the early symptoms and by the lack of a history of injury.

The combination of patella alta and extension lag indicates elongation of the extensor mechanism. Avulsion of the distal patella, together with the high patella (and in one patient elevation of the tibial tubercle also) (Figs 1 and 2) suggests that the elongation occurs in the patellar ligament. The resulting stress is therefore more likely to be concentrated upon the distal rather than the proximal pole of the patella.

Lastly, we considered the influence of previous lengthening of the tendo calcaneus which if injudiciously performed may augment knee flexion during walking. Four patients had been so treated and four had not. Conclusion. If the walking ability of a spastic child deteriorates, the possibility of avulsion of the distal pole of the patella should be considered. The condition can be diagnosed clinically and confirmed radiographically. In management it is important to correct any fixed flexion of the knees.

REFERENCES

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