RADIONUCLIDE SCANNING IN THE EARLY DIAGNOSIS OF PERTHES’ DISEASE

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A prospective survey was carried out on all cases of irritable hip presenting at the Royal Liverpool Children’s Hospital over a period of one year. All children had a radioisotope scan of the hips and were then followed for one year by serial radiography. Five of the 50 children seen during the one year had areas of ischaemia in the capital femoral epiphysis demonstrated on the scan. All five developed radiological signs of Perthes’ disease within six months. The remaining 45 had radiographically normal hips at one year.

Perthes’ disease is the name given to a condition of the hip which shows characteristic radiological changes in childhood. It is suggested that the aetiology of these changes is a disturbance of the vascularity of the capital femoral epiphysis leading to necrosis and subsequent revascularisation (Trueta 1957; Sanchis, Zahir and Freeman 1973). When the radiological changes become apparent the acute stages of the capital femoral ischaemia have presumably ended and the initial ischaemia has resolved (Jensen and Lauritzen 1976; McKibbin and Ralíš 1974). Many authors have noted that a small percentage of patients presenting with radiological signs of Perthes’ disease had a previous history of an irritable hip (Jacobs 1960; de Valderrama 1963). Spock (1959) who reviewed the cases of Perthes’ disease recorded in the literature found the incidence of irritable hip to be 1.5 per cent. During follow-up 6.4 per cent of these children with irritable hip syndrome developed radiological signs of Perthes’ disease. Assuming that the interruption of the blood supply to the capital femoral epiphysis was important in the pathogenesis of Perthes’ disease, we decided to use technetium-99m (\(^{99m}\)Tc) radionuclide imaging to determine the state of vascularity of the femoral epiphysis in children with irritable hips and correlate any abnormality with subsequent radiological appearances over a follow-up period of one year.

Radionuclide imaging is capable of fine resolution and it is possible to make both a qualitative and quantitative scan of the capital femoral epiphysis and to differentiate it from the roof of the acetabulum and the femoral growth plate (Danigelis et al. 1975). The scanning agent used was \(^{99m}\)Tc-labelled methylene diphosphonate. The radionuclide has a short half-life of six hours, a low energy radiation (140 kiloelectron-volts) and no primary \(\beta\) emission, which makes it safe for paediatric practice (Subramanian et al. 1972).

The exact location of the radioactive tracer within the bone is unknown, but in new bone it seems to be linked to the hydroxyapatite crystals instead of calcium. The degree of uptake depends on several factors such as capillary permeability and the receptors available, but the degree of regional blood flow and the presence of active osteoblasts are the main determinants. Decreased uptake is a sign of decreased blood flow to the epiphysis (Fasting et al. 1978; Hughes 1980). The scan is performed three hours after injection of the radioactive label, by which time it is linked to the hydroxyapatite within the bone. Scanning at an earlier stage would pick up the radionuclide in the circulation and soft tissue so that an area of inflamed synovium would mask the degree of uptake in the capital femoral epiphysis.

CLINICAL MATERIAL AND METHODS

All patients attending the Royal Liverpool Children’s Hospital over a period of nine months with a diagnosis of irritable hip were included in the survey. There were 17 girls and 33 boys (ratio 1:2). The age at presentation ranged from 3 to 12 years with a mean of 6.05. There were 23 right hips and 27 left hips. The diagnosis was based on symptoms of pain in the hip, thigh or knee, the presence of a limited range of movement in the hip, and associated muscle spasm, with or without a limp. There was no abnormality on radiological examination and no clinical evidence of septic arthritis or osteomyelitis. The children and their parents were closely questioned regarding factors of
possible aetiological importance, such as preceding trauma or sepsis of the upper respiratory tract. Routine physical examination was performed. Special investigations included taking a blood count and blood film, estimation of erythrocyte sedimentation rate (Westergren method), determination of rheumatoid arthritis latex agglutination status, a Widal titre and an anti-staphylococcal titre. Throat swabs and mid-stream specimens of urine were cultured.

Plain radiographs of the hips were made in the anteroposterior and the frog lateral positions; radiographs of the hands and carpus were taken to establish the bone age. A radioisotope scan of the hip was performed within 36 hours of admission in all cases except three who were scanned at five days. A weight-related dose of $^{99m}$Tc-labelled methylene diphosphonate was administered intravenously. Three hours after injection parallel and pin-hole collimated images of both hips were obtained using a gamma camera linked to a computer. All patients were asked to void urine before the scanning in order to reduce any contribution from activity in the bladder. In certain cases oral administration of promethazine was necessary. The results were recorded photographically and the scans interpreted by two of the authors without seeing the patients.

The children received routine hospital treatment for irritable hip: consisting of bed rest and skin traction followed by slow mobilisation once the pain and muscle spasm associated with the hip had settled. After discharge the children were not restricted in any way. Routine clinical examination was performed and radiographs of the hips taken in both anteroposterior and frog lateral positions during follow-up at three, six and 12 months. Each radiograph was examined by a staff radiologist and by two of the authors without reference to the result of the radioisotope scan. The scans and radiographs were correlated at the end of the survey.

**RESULTS**

A total of 50 children (50 hips) satisfied the criteria of having an irritable hip in the absence of abnormal radiographs. The symptoms which had been present in these children for a mean of 4.5 days before presentation

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**Table 1.** Comparison of normal children and those with Perthes’ disease.

<table>
<thead>
<tr>
<th></th>
<th>Perthes*</th>
<th>Normal</th>
<th>Significance using t test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>5</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>5.17–10.08 (mean 7.6)</td>
<td>4.0–12.75 (mean 6.05)</td>
<td>NS</td>
</tr>
<tr>
<td>Sex (M:F)</td>
<td>4:1</td>
<td>1.8:1</td>
<td>NS</td>
</tr>
<tr>
<td>Duration of symptoms (days)</td>
<td>0.5–7.0 (mean 2.8)</td>
<td>0.5–150 (mean 13)</td>
<td>$P=0.5$</td>
</tr>
<tr>
<td>Trauma</td>
<td>2</td>
<td>11</td>
<td>NS</td>
</tr>
<tr>
<td>Respiratory tract sepsis</td>
<td>1</td>
<td>9</td>
<td>NS</td>
</tr>
<tr>
<td>Pyrexia</td>
<td>0</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>White cell count</td>
<td>5.0–11.2 (mean 8.1)</td>
<td>4.7–13.6 (mean 7.24)</td>
<td>$P=0.5^*$</td>
</tr>
<tr>
<td>ESR</td>
<td>4–15 (mean 8)</td>
<td>2–56 (mean 12)</td>
<td>$P=0.5$</td>
</tr>
</tbody>
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*compared to expected values for the normal population
NS = not significant

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Scans showing deficient uptake in the right hip and radiographs taken three months later for two six-year-old boys.
Scans showing deficient uptake in the left hip and radiographs taken six months later. Figures 5 and 6—An eight-year-old girl. Figures 7 and 8—A five-year-old boy. Figures 9 and 10—A ten-year-old boy.

included pain, which occurred mainly in the affected groin and sometimes radiated to the knee, and sometimes a limp. In all patients there was limitation of movement of the affected hip, especially of medial rotation.

There were five abnormal scans showing various degrees of failure of uptake of the isotope within the affected capital femoral epiphysis and adjacent metaphysis (Figs 1, 3, 5, 7, 9). These five children with abnormal scans showed radiological signs of Perthes' disease (two Grade 2 and three Grade 4 on the Catterall scale) within six months (Figs 2, 4, 6, 8, 10). The remaining 45 children with normal scans showed no sign of Perthes' disease on clinical and radiographic examination at follow-up after 12 months.

The clinical and biochemical findings were analysed to determine any other common factor amongst those children presenting with irritable hip and later developing Perthes' disease (Table I). When compared with the contralateral hip, flexion was limited by an average of 30 degrees in the Perthes' group and 43 degrees in the normal group. Similarly, there was no significant difference in the range of other movements of the affected hip in the two groups. There was no
evidence of an increased incidence of elevated antibody titres in either groups. The anti-streptolysin titre, Brucella antibodies and rheumatoid agglutination factor (sheep-cell agglutination) showed no significant changes.

DISCUSSION

It is now accepted by most authorities that Perthes' disease is an entity characterised by infarction and necrosis of the capital femoral epiphysis, and subsequent revascularisation of the growing epiphysis (McKibbin and Ráliš 1974; Inoue et al. 1976; Jensen and Lauritzen 1976). Investigation of the aetiological factors producing the infarction has previously been hindered by the fact that the diagnosis of Perthes' disease is based on characteristic radiological features resulting from necrosis and collapse of the capital femoral epiphysis, and the repair response when revascularisation has occurred. Treatment of Perthes' disease now aims at limiting the extent of collapse of the softened epiphysis and maintaining congruence of the reforming epiphysis by containment. These efforts have been hampered by relatively late diagnosis.

In our study of 50 hips we found that the only factor common to all the children developing Perthes' disease after presentation with an irritable hip was evidence of varying degrees of capital femoral infarction detected by the radionuclide scan. This was not evident in the children who failed to develop radiological signs of Perthes' disease within one year of presentation. The other clinical and biochemical factors investigated failed to show any significant difference in either group. In particular the incidence of antecedent trauma and sepsis of the upper respiratory tract showed no correlation.

As a result of our investigation using radionuclide imaging in establishing the presence of an ischaemic capital femoral epiphysis at an early stage, we suggest that measures to protect the softened epiphysis can be taken before collapse has occurred. However, as yet we are unable to comment on the influence this will have on the subsequent congruence of the revascularised and reforming epiphysis. With regard to the aetiology, early diagnosis of infarction of the epiphysis should allow more intensive investigation of the factors producing the interruption of the blood supply. The reliability of the $99m^\text{Tc}$ scanning in the early diagnosis of Perthes' disease is similar to that reported recently by Sutherland et al. (1980). We now consider that it is a valuable and necessary investigation in all cases of irritable hips.

We are grateful to the staff of the Department of Nuclear Medicine, Royal Liverpool Hospital, for their help and cooperation in undertaking the scanning of the children in this survey, and to Mr C. J. E. Monk, Consultant Orthopaedic Surgeon for allowing patients in his care to be included in this study.

REFERENCES