THE INFLUENCE OF JOINT POSTURE ON INTRA-ARTICULAR PRESSURE

A STUDY OF TRANSIENT SYNOVITIS AND PERTHES' DISEASE

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The pathogenesis of Perthes' disease has been related to increased intra-articular pressure secondary to a joint effusion. The pressure within the hip in different positions was measured in eight children with transient synovitis and four with the synovial stage of Perthes' disease. In the position of comfort for the hip this pressure was always less than the arteriolar blood pressure and in a supine position it did not exceed the systolic blood pressure. However, in extension with medial rotation the intra-articular pressure always became several times the systolic blood pressure. This high pressure was also recorded in the stable lateral position which occurs normally during sleep.

It is concluded that in the presence of a synovial effusion in the hip, a position of extension and medial rotation causes an increase in intra-articular pressure which may compromise the blood supply to the capital epiphysis of the femur.

The cause of the initial ischaemia in Perthes' disease is not clear. Several investigators have suggested that an increase in intra-articular pressure for a certain duration of time is important (Woodhouse 1964; Tachdjian and Grana 1968; Kemp 1973). In a juvenile patient the femoral capital epiphysis is exclusively supplied by intra-capsular, extra-osseous blood vessels (Trueta 1957). Synovitis, leading to excessive synovial fluid, causes an increase in intra-articular pressure (Jayson and Dixon 1970a) which may compress the intra-articular vessels and affect the blood supply of the epiphysis (Borgsmiller et al. 1980; Launder, Hungerford and Jones 1981; Lucht et al. 1983).

The joint capsule of the hip is under full tension when the joint is in extension and medial rotation; in all other positions some capsular relaxation occurs (Walmsley 1928; Lloyd-Roberts 1953). This has been confirmed in cadaver examinations; intra-articular pressure was minimal in flexion, slight abduction and lateral rotation (the position of comfort) and at its peak in extension, medial rotation and wide abduction (Eyring and Murray 1964). Soto-Hall, Johnson and Johnson (1964) monitored intra-articular pressures in the hips of patients with idiopathic synovial effusion but did not investigate the changes in pressure in different joint positions.

The present study records the relation between joint position and hydrostatic intra-articular pressure in cases of symptomatic effusion of the hip caused by either transient synovitis or the early stage of Perthes' disease.

MATERIALS AND METHOD

Hydrostatic pressure recordings were made in various hip postures in eight children with transient synovitis and four children with the synovial stage of Perthes' disease. The presence of free fluid in the hip was demonstrated in all cases by traction radiography (Vegter and van den Broek 1983).

Under general anaesthesia a 19-gauge spinal needle was introduced into the hip from an anterolateral direction using image intensifier control. A saline-filled epidural catheter with multiple openings at its tip was introduced through the needle, which was then withdrawn. The catheter was connected to a transducer, which was linked to a recording apparatus (Siemens Mingograph 62). The intra-articular location of the catheter and lack of blocking was confirmed by the immediate changes in pressure recordings which were seen when the joint position changed. With the child still under general anaesthesia, intra-articular pressure was recorded in the position of comfort, in the supine position with the hip extended in slight lateral rotation, and in extension combined with medial rotation, both before and after aspiration of excessive synovial fluid. In five of the children recordings were continued for five minutes with the hip in the position of maximum pressure in order to record any possible fall in pressure with time.

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Fig. 1

During sleep, in the naturally occurring lateral trunk posture, the underlying hip is in a position of extension and medial rotation.

Because of the early results, the last seven children also had pressure readings in a lateral trunk posture before excess fluid was aspirated. This is a stable position, seen during sleep, in which the hip is extended and medially rotated (Fig. 1).

RESULTS

The results are summarised in Tables I and II. The mean intra-articular pressures in transient synovitis are similar to those in the synovial stage of Perthes' disease, and typical recordings are shown in Figures 2 to 6. When there is an effusion, the intra-articular pressure varies in the position of comfort from 6 to 35 mmHg and is therefore lower than the arteriolar blood pressure. Change in the joint position to one of extension with slight lateral rotation results in a rise to a mean pressure of 60 mmHg. In only one case did the intra-articular pressure rise slightly above the systolic blood pressure (Table I).

Medial rotation of the extended hip, however, results in a dramatic rise in intra-articular pressure, becoming, in all cases, several times greater than the

Table I. Joint pressures in eight patients with transient synovitis recorded in various hip postures

Joint pressure (mmHg)							
Before aspiration					After aspiration		
Number	Position of comfort	Supine	Extension and medial rotation	Lateral trunk posture	Position of comfort	Supine	Extension and medial rotation
1	23	80	350	—	2	18	70
2	35	105	410	—	5	9	88
3	6	35	200	—	—	—	—
4	22	85	375	245	2	15	60
5	12	25	220	200	4	23	95
6	17	65	310	210	—	—	—
7	20	60	360	295	—	—	—
8	13	40	275	235	3	13	58
Mean	19	62	313	237	3	16	74

Table II. Joint pressures in four patients with Perthes' disease in various postures

Joint pressure (mmHg)							
Before aspiration					After aspiration		
Number	Position of comfort	Supine	Extension and medial rotation	Lateral trunk posture	Position of comfort	Supine	Extension and medial rotation
1	13	55	230	—	—	—	—
2	10	45	245	—	3	14	40
3	17	60	330	265	8	22	56
4	19	70	290	235	4	15	44
Mean	15	58	274	250	5	17	47

blood pressure (Fig. 3). In the five cases in which readings were continued for five minutes it was found that pressure remained high while the position of extension and medial rotation was continued. In the last seven

Fig. 2

Figures 2 to 5 – Intra-articular pressures recorded before joint aspiration. Arrows indicate a change in joint posture. Figure 2 – Changes from the position of comfort to one of extension with slight lateral rotation results in a pressure rise which returns to its initial value when the position of comfort is resumed.

Fig. 3

Change from extension with slight lateral rotation to extension with medial rotation causes a sharp rise in pressure to a value several times the systolic blood pressure. Return to the original joint position results in a drop to the initial pressure.

Fig. 4

The rise and fall in pressure with the changes in posture described for Figure 3 can be repeated to show the reproducibility of arterial tamponade.

Fig. 5

In the lateral trunk posture any change in the medial rotation of the extended hip by passive movement of the pelvis results in a pressure change, but the intra-articular pressure remains well above the systolic blood pressure.

patients (five with transient synovitis and two with Perthes' disease) pressures were recorded in the stable lateral position before aspiration of the joint. This is a position which occurs naturally during sleep (Fig. 1); it produced, in all cases, intra-articular pressures at least twice as high as the systolic blood pressure. Changes in the degree of medial rotation in this position, produced by moving the pelvis over the underlying leg, caused some changes in pressure, but this never fell below the systolic blood pressure (Fig. 5).

After aspiration of the joint fluid no further pressure readings could be obtained in three children with transient synovitis and in one with Perthes' disease. In all the other patients articular pressure in the supine position was similar to that in the position of comfort before aspiration, while the pressure with the joint in extension and medial rotation was similar to that recorded in the supine position before aspiration.

DISCUSSION

In patients with transient synovitis and in those in the synovial stage of Perthes' disease intra-articular pressure in the position of comfort averaged 19 and 15 mmHg respectively; these results were very similar to those reported by Caughey and Bywaters (1963) who recorded 6.5 to 36.7 mmHg in patients with chronic knee effusions. Soto-Hall et al. (1964) recorded pressures of 68 and 78 mmHg in two children with symptomatic hip effusion but did not investigate the effect of a change in position.

In our study extension with slight lateral rotation of the joint was shown to cause an increase in pressure which slightly exceeded the systolic blood pressure in only one case. Medial rotation of the extended hip, however, resulted in a consistent dramatic increase in intra-articular pressure. These findings accord with those of Strömqvist et al. (1985) on the dependency of intra-articular pressure to posture in traumatic hip joint tamponade.

After the aspiration of free fluid no further pressure readings could be obtained in four cases. The catheter tip may have either been blocked by synovial tissue or migrated out of the joint. In the other children, very low pressures were recorded in the position of comfort, as noted after aspiration of knee joint effusions by Eyring

Fig. 6

A recording after aspiration of the joint, made in extension with slight lateral rotation, shows that the intra-articular pressure is lower than the arteriolar pressure (note change in scale). The rise in pressure resulting from medial rotation does not exceed the systolic blood pressure.

and Murray (1964). The pressure rise in other leg positions was also very much reduced. This decrease of dependency on posture after aspiration is in accordance with the findings of Jayson and Dixon (1970b) for the knee: they related pressure to joint position and the amount of free fluid in rheumatoid and simulated effusions.

Ischaemic changes in the juvenile femoral head could well be produced by increased intra-articular pressure lasting for sufficient time. In the five children we studied for five minutes, we recorded no fall in the excess pressure produced by the position of extension and medial rotation. For ethical reasons we did not extend the period of this experiment.

During sleep the stable lateral position is assumed for prolonged periods (De Koninck, Gagnon and Lallier 1983). We have shown that intra-articular pressure in this posture, in all our cases, was enough to cause arterial tamponade. Morphological studies suggest that Perthes' disease is the consequence of more than one episode of infarction (McKibbin and Ráliš 1974; Catterall et al. 1982), and this could most easily be explained by repeated episodes of synovitis. Our investigation makes it clear that during a period of synovitis the repeated adoption of a posture of hip extension combined with medial rotation could result in episodes of raised intra-articular pressure which might compromise the blood supply of the juvenile capital epiphysis.

In the literature there is controversy whether venous or arterial tamponade is the cause of decreased perfusion of the femoral head epiphysis (Borgsmiller et al. 1980; Launder et al. 1981; Lucht et al. 1983) and therefore, of osteonecrosis (Woodhouse 1964; Tachdjian and Grana 1968; Kemp 1973). Our study shows not only the influence of joint position on the intra-articular pressure of an effusion in the hip, but also demonstrates the clinical reality of producing arterial tamponade in a naturally occurring joint posture.

This investigation has also provided experimental confirmation that hips with excess free fluid should be treated in traction until the effusion settles, with the joint maintained in flexion and abduction and the leg allowed to fall naturally into slight lateral rotation. In this way the position of comfort is adopted, and the traction prevents the child from rolling over during sleep into the potentially dangerous lateral trunk posture.

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