Avascular necrosis as a complication of septic arthritis of the hip in children

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Summary. *Seventy-one hip joints in 69 infants and children with pyogenic arthritis were studied. Twenty joints (28%) with the radiographic characteristics of avascular necrosis were identified and the changes classified into 3 groups: Group 1 (infants up to the age of 6 months) had ischaemic changes characterized by the absence or delayed appearance of the epiphyseal ossification centre; Group 2 (children aged between 7 months and 5 years) showed disappearance of this centre whether followed by revascularization or not, with the shape of the cartilaginous femoral head preserved in either case; and in Group 3 (children 6–16 years of age) the femoral epiphysis was either totally or partially involved with increased bone density; collapse of the head may or may not have occurred. At follow-up for between 2 and 15 years, a trend towards more severe deformities was seen in the 11 hip joints of Group 3 when compared to the 9 hip joints in Groups 1 and 2. The opposite was observed in relation to less severe deformities. Early diagnosis and treatment of infection is mandatory in patients with pyogenic arthritis and increased intra-articular hydrostatic pressure, or those with septic thrombosis of the epiphyseal vessels, which could cause avascular necrosis (AVN).*

Résumé. *L'étude porte sur 71 hanches de 69 malades porteurs d'arthrite pyogénique du nouveau né et de l'enfant. 20 hanches à caractéristiques*

radiographiques de nécrose vasculaire ont été sélectionnées. Les altérations mises en évidence ont été classées en 3 groupes: le Groupe I (jusqu'à 6 mois) se référant aux altérations caractérisées par un retard ou une absence du noyau épiphysaire; le Groupe II (entre 7 mois et 5 ans) se caractérisant par la disparition de ce noyau, suivit ou non de revascularisation; dans les 2 groupes le modèle cartilagineux de la tête du fémur est préservé. Le Groupe III (6 à 16 ans) met en évidence une augmentation de la densité de l'épiphyse fémorale, totale ou partielle et suivie – ou non de collapse. Après un follow-up minimum de 2 ans et maximum de 15 ans, on observe une tendance à des déformations plus sévères aux 11 hanches résultant de la somme des Groupes I et II. L'inverse se passe par rapport aux déformités moins importantes. Comme dans les cas d'arthrites pyogènes, l'augmentation de la pression hydrostatique intra-articulaire ou la thrombose séptique des vaisseaux épiphysaires peuvent produire des nécroses avasculaires, il est donc impératif que le diagnostic et le traitement soient précoces.

Introduction

In 1974 Kemp and Lloyd-Roberts [5] described 8 cases of avascular necrosis of the femoral head in children over 3 years of age following osteomyelitis of the proximal femur. We have studied the various forms of avascular necrosis of the femoral head and its deformities following pyogenic arthritis and related these to the clinical condition.

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Fig. 1. **a** 28-day-old male with clinical picture of infection and dislocation of the left hip. **b** 8 years later femoral head ossification is not seen, and femoral head cartilage deformed. Small deformed femoral head (Group 1, Type B)

Fig. 2. **a** 20-month-old female with 8-day history of pyogenic arthritis of left hip. X-ray 38 days after joint drainage. **b** Slight degree of flattening after 14 years on follow-up X-ray. (Group 2, Type A)

Fig. 3. **a** 13-year-old male with osteomyelitis and pyogenic arthritis of right hip. X-ray after articular drainage shows signs of decompression of the femoral neck with flattening of the head and change of density. **b** 2 years later X-ray shows re-ossification associated with flattening of the femoral head (Group 3, Type A)

Materials and methods

The clinical records of 80 patients with pyogenic arthritis of the hip joint were reviewed. Seventy-one joints in 69 children were selected for this study, and 11 hips which did not fit into the clinical research protocol were excluded. Our criteria for inclusion were a broadened version of that described by Wisberg et al. for osteoarticular infection [17], namely pain and restriction of active and passive motion, positive cultures from blood and articular fluid (synovial or exudate) and radiological signs suggestive of infection in the hip joint. Early diagnosis was established by articular aspiration or drainage by arthrotomy within 4 days from the onset of infection [2, 10]. The radiological signs used for early diagnosis were oedema of the pericapsular adipose tissue and widening of the joint space [7]. The Nade criteria [8] were used to determine whether the as-

pirated joint material was infected, i.e. a positive Gram stain and >5000 white cells/mm with >90% polymorphonuclear leucocytes. Once the diagnosis was established, antibiotic treatment with oxacillin was started. This antibiotic was changed if necessary following the results of sensitivity tests. The hip joint was surgically drained using an anterior approach followed by continuous irrigation for 10 days. Decompression of the proximal femoral metaphysis was performed in cases of associated osteomyelitis. The criteria for diagnosing avascular necrosis of the femoral head were established according to the radiological changes and were divided into 3 groups. In Group 1, the characteristic ischaemic changes were either absent or the appearance of the epiphyseal ossification centre of the femoral head was delayed (Fig. 1). In Group 2, epiphyseal ossification of the femoral head seen on X-ray had disappeared temporarily or permanently. In cases of temporary disappearance, re-ossification was "fragmentary" (Fig. 2). Arthrography was performed at follow-up if there was doubt about the preservation of the shape of the cartilaginous femoral head. In the great majority of our cases of AVN the diagnosis was made before MRI was available. In Group 3 the characteristic ischaemic signs were of increased bone density of the femoral epiphysis, which may have been partially or totally involved, and was sometimes followed by epiphyseal collapse (Fig. 3). The Hallel and Salvati radiological criteria were used to assess the type of deformity of the femoral head [3]. These were: Type A: flattening (loss of spherical shape) of the femoral head; Type B: a small deformed head with or without varus deformity of the femoral neck; Type C: absence of the femoral head; Type D: ankylosis. There were no examples of coxa magna in the 20 cases of AVN in our study.

Results

All our 71 hips showed limitation of internal rotation and loss of extension on physical examina-

tion prior to articular drainage. In the 34 late diagnosed hips these signs were more marked. There were deformities of flexion, abduction and lateral rotation in 46% which suggests that this is the best position to lower intra-articular pressure.

Twenty hips (28%) had radiological signs of avascular necrosis of the femoral head. The mean age of these children was 4 years (range: 25 days to 16 years), and the mean follow-up time was 5 years (range: 2–15 years). Eighteen were treated after the 4th day following the onset of infection with surgical drainage and continuous irrigation, and the remaining 2 received early treatment. Of the 20 cases of AVN, 10 were associated with osteomyelitis of the proximal femur, 9 with primary synovial pyogenic arthritis, and 1 with acetabular osteomyelitis (Table 1).

Avascular necrosis was more common in Group 3 and in Group 2 than in Group 1 – i.e. in older children (Table 2), with a trend toward more severe changes in the femoral head in those aged between 6 and 16 years (Table 3).

Discussion

In pyogenic infections, passive extension of the flexed hip prevents uptake of isotope by the femoral head during bone scanning, and this suggests that ischaemia occurs secondary to an increase in intra-articular hydrostatic pressure [14].

Table 1. Clinical features on follow-up of 20 patients with avascular necrosis

Case no.	Age on admission	Organism	Original x-ray	Days from onset to drainage	Treatment	Follow-up		Group	Deformity
						Years	Osteomyelitis upper end of femur		
1	28 days	Staph aureus	Pathological dislocation	15	SD	15	no	1	B
2	1 year	Strep viridans	Subluxation	8	SD	14	yes	2	A
3	16 years	Staph aureus	Joint space narrowing	21	SD	6	no	3	C
4	1 year	Staph albus	Subluxation	–	SDNP	2	no	2	B
5	6 years	Staph aureus	Swelling of thigh & hip	10	SD	2	yes	3	C
6	7 months	Staph aureus	Subluxation	7	SD	2	no	2	A
7	13 years	Staph aureus	Normal	21	SD	2	no	3	A
8	15 years	Staph aureus	Normal	6	SD	2	yes	3	C
9	4 years	Staph aureus	Sublux/lytic lesion acetab	4	SD	10	no	2	B
10	14 years	Staph aureus	Normal	30	SD	3	yes	3	C
11	12 years	Staph albus	Periosteal elevation upper end femur	19	SD	6	yes	3	C
12	11 months	Staph aureus	Path disloc & periost elev upper end femur	18	SD	2	yes	3	B
13	11 years	Staph epidermitis	Swelling of hip	11	SD	3	yes	3	B
14	2 years	Pneumococcus	Pathological dislocation	13	SD	6	yes	2	B
15	11 years	Staph albus	Swelling of thigh	11	SD	2	yes	3	D
16	2 years	Staph albus	Normal	–	SDNP	3	no	2	D
17	6 years	Staph aureus	Subluxation	16	SD	2	yes	3	B
18	6 years	Staph aureus	Normal	2	SD	2	no	3	A
19	1 month	Strep Hemolyticus	Normal	8	SD	3	yes	1	A
20	1 year	Staph aureus	Normal	8	SD	3	no	2	A

SD = Surgical drainage

SDNP = Surgical drainage not performed

Table 2. Outcome of clinical disease in the 3 patient groups

	Hips	Avascular necrosis
Group 1 (birth–6 months)	16	2 (12.5%)
Group 2 (7 months–5 years)	24	7 (29.1%)
Group 3 (6–16 years)	31	11 (35.4%)
Total	71	20

Table 3. Radiographic features of the femoral head in the 3 groups of avascular necrosis

Classification	Type of deformity
Group 1 (0–6 months)	A = 1 B = 1
Group 2 (7 months–5 years)	A = 3 B = 3 C = 0 D = 1
Group 3 (6–16 years)	A = 2 B = 3 C = 5 D = 1
TOTAL	20

Thus, longitudinal traction in extension, with or without internal rotation, should be avoided during the early treatment of pyogenic hip arthritis. We advise early aspiration followed by arthrotomy, and then allow the hip to adopt the position which results in a lower intra-articular pressure [11].

Avascular necrosis of the proximal femoral epiphysis in infants and children secondary to pyogenic arthritis has been attributed either to compression of nutrient vessels by the increased intra-articular hydrostatic pressure caused by purulent exudate [1, 2, 6, 12, 16], or to the septic vascular thrombosis caused by osteomyelitis of the proximal femur [5]. The relative rigidity of the capsule of the hip joint when compared to other synovial joints, and the change in the pattern of blood supply to the femoral head during growth, are also important factors in the development of AVN [5, 9]. Although the literature emphasises that in the first year of life the femoral head is largely cartilaginous and more susceptible to ischaemic changes [4, 9], our series shows that in 20 cases of AVN there were 11 in Group 3 children whose age ranged between 6 and 16 years (Table 2). Chondrolysis secondary to septic thrombosis [9, 12, 13] and the direct destructive action of purulent exudate occurring in infants [15] precluded the inclusion of these cases in our series. This must throw some doubt on our statistical analysis.

We conclude that avascular necrosis in infants and children is a severe complication of pyogenic arthritis of the hip and can lead to marked deformity of the femoral head, particularly in children aged 6–16 years (Group 3). It is fundamental to avoid any pathological increase of intra-articular hydrostatic pressure by making an early diagnosis and starting early treatment, preferably within 4 days of the onset of the joint infection. We advise immediate arthrotomy and continuous irrigation in these children combined with decompression of the proximal femoral metaphysis where there is a suspicion of osteomyelitis.

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