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INDICATION FOR WEIGHT RELIEF AND CONTAINMENT IN THE TREATMENT OF PERTHES' DISEASE

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Fifty-four cases of Perthes' disease each suffering from total involvement of the femoral head were investigated to establish the relative merits of total weight relief and containment in management. It was found that using Catterall's criteria, once the femoral head is "at risk", containment is the only treatment of value; but when the head is "not at risk" a combination of containment and total weight relief produces a near perfect result in every case.

Key words: Perthes' disease, indications for containment and weight relief

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Patients with severe Perthes' disease are offered treatment because the surgeon fears that when the disease has run its course a deformed femoral head will lead to osteoarthritis in later life. It follows that the aim of treatment is to produce a normal femoral head, and, over recent years, weight relief and containment have become established as the most hopeful avenues by which this aim might be achieved.

The mechanism by which containment is effective is uncertain, but it may influence the course of the condition either by preventing deformity of the femoral head during the evolution of the disease, or by influencing the process of remodelling during healing. Containment has gained in popularity over weight relief in the treatment of Perthes' disease, and indeed, Lloyd Roberts et al. (1976) offered the opinion that the latter is of no value in the treatment of this condition. However, Brotherton & McKibbin (1977) produced evidence that both methods of treatment improve the prognosis. This study was therefore designed to elucidate the effects of weight relief and to define its indications in management.

Independent of the method of management, two principal factors determine the prognosis: they are the age of the patient at the onset of the disease, and the degree of involvement of the femoral head (O'Garra 1959, Catterall 1971). In order to demonstrate the effectiveness of any treatment method, it is necessary to take account of these two factors.

Catterall (1971) described a system of four grades of increasing severity for the classification of the degree of involvement of the femoral head. Unfortunately there is little agreement between different observers in the classification of femoral heads by this system (Hardcastle 1980), the exception being Catterall Group 4, in which the involvement of the femoral head is total. It is to this group that this study is confined. In addition to being relatively easy to diagnose and classify, Group 4 disease carries a much worse prognosis than other groups, and therefore a satisfactory solution to the problem of management is the more pressing.

MATERIALS AND METHODS

The patients selected for study were those with total involvement of the femoral head corresponding to Group 4 of Catterall's classification. The hospital records were searched to identify patients with Perthes' disease and sufficiently good records were available to identify 316, of whom 54 were assessed as having Group 4 disease (Table 1). The classification was agreed by both authors and also by an experienced bone and joint radiologist. Cases with equivocal radiographs were rejected. The films taken at the time of diagnosis were used to classify the femoral heads into "at risk" or "not at risk" groups according to the criteria of Catterall (1972). All 54 patients with Group 4 disease were invited to attend for review. Respondents had antero-posterior and "frog" lateral radiographs taken of both hips; they interviewed by both authors, examined, and the method of treatment was recorded (Table 2).

Patients managed in containment plasters and their parents had been instructed that weight bearing in any form was forbidden. Since the purpose of this study was to assess the effects of weight relief, great care was taken to establish whether or not patients had borne weight on the affected limb during treatment. This fact was established by reference to the case notes, by the separate interviewing of the parents and child, and by the use of questions to allegedly non weight bearing children such as "What games could you play?", "How far could you walk?", or "were you good in goal?" It is unusual to find that a child has been kept totally off its feet for the whole treatment programme when that programme is carried out at home and although some patients were able to comply strictly with their instructions, others allowed themselves minimal weight bearing. This was defined as brief moments of standing or a maximum of one or two steps – such as might be required to reach a high object – less often than once a day. This minimal amount of weight bearing did not disqualify them from inclusion in the weight relief group.

Consequently the weight bearing group comprised those patients who bore weight deliberately, as a result of treatment by femoral osteotomy or a caliper, and those patients who bore weight in spite of instructions to the contrary.

Table 1. Hips selected for study

Total number with Perthe's disease	316
Patients with Group 4 disease	54 (17%)
Patients followed up with Group 4 disease	45
Hips followed up with Group 4 disease	49
Hips excluded from study	6*
Hips available for analysis	43

* Two cases were already burnt out before treatment given. Four cases excluded due to insufficient data.

The results of treatment were assessed by the methods of Mose (1964), Harrison (1976), Catterall (1971) and Ratliff (1956). Each off these methods has been used by previous authors in this field and it was thought appropriate to use them all. Mose and Harrison described very strict radiological criteria which are relatively straightforward to apply. Catterall's method of assessment must be criticised for giving considerable weight to uncovering of the femoral head as a criterion for downgrading results since inevitably the use of that criterion favourably prejudices the assessment of the results of containment osteotemy. Ratliff's assessment has the virtue that, being largely clinical, it can take account of symptoms such as pain, stiffness and limp which are said to mar the results of operative treatment.

All these methods assign a qualitative grade (out of a choice of good, fair, poor or very poor) to a result which lies in a continuous spectrum and there is often difficulty in assigning grades to borderline cases. Moreover, in any particular case the different methods of assessment do not necessarily assign the same grade: Catterall good may equate to Harrison fair; or a good result in Ratliff's mainly clinical analysis may score fair or even poor by the criteria of Mose. Finally, statistical analysis of this kind of qualitative date is unreliable without a very large number of cases.

To overcome these problems each of the four systems of analysis was scored out of a total of six points as illustrated in Table 3. Each hip was assessed by each of the four methods, and the four scores achieved were then added together to produce the "Summed Score" with a possible maximum of 24 points. This transfor-

Table 2. Methods of treatment of 43 Group 4 Perthes' hips

Treatment		Weight bearing (24)		Non-weight bearing (19)	
Contained	(33)	containment plaster	(13)	containment plaster	(16)
		Osteotomy	(4)		
Not contained	(10)	Caliper	(7)	Snyder sling	(1)
				Wheelchair	(2)

Table 3. Methods of scoring – combining the four systems allows a maximum of 24 points to be achieved

System	Good	Fair	Poor	Bad
Catterall	6	3	0	–
Mose	6	3	0	–
Harrison	6	4	2	0
Ratliff	6	4	2	0

mation of the data gave us a spectrum of quantitative results to which Student's 't' test might be applied.

RESULTS

The mean length of follow up from the onset of the disease was 10.9 years (range 7.9– 29). Table 4 illustrates the increased incidence of severe Perthes' disease in girls and Table 5 shows that the mean age at which Group 4 disease presents is a full year earlier than the age of presentation of lesser grades of the disease. This finding has not been reported before.

Age and "at risk"

Older children and those with at risk signs at the time of diagnosis are known to have a poor prognosis (Catterall 1971, Lloyd Roberts et al. 1976, Brotherton & McKibbin 1977). Figure 1 illustrates the relationship between these two factors. It can be seen quite clearly that the age of 5 marks a critical time, before which head at risk signs are very uncommon at the time of diagnosis, and beyond which they are to be expected. This correlation between age and at risk signs is very strong, so strong, indeed, that in the analysis of results either age or at risk may be chosen as a variable to the exclusion of the other.

Effect of total weight relief

The weight bearing group of hips achieved a lower mean score than the group managed with total weight relief but the difference was minimal (Figure 2A).

However, when hips at risk are separated from those not at risk, the effect of weight relief is seen to be very different in the two groups. Hips at risk do not benefit from weight relief (Figure 2B). In contrast hips not at risk managed with weight relief achieved significantly higher scores than those managed with weight bearing (Figure 2C).

Table 2 makes it plain that the majority of affected femoral heads were contained during treatment, either by conservative means in plaster, or by containment osteotomy. It is necessary

Table 4. Sex related to Catterall's groups

	Males : Females
Groups 1, 2, 3	4.1 : 1
Group 4	2.4 : 1

Table 5. Age at presentation related to Catterall's groups

	Mean age		
	Male	Female	All cases
Groups 1, 2, 3	6.2	5.2	6.1 years
Group 4	5.2	4.9	5.1 years

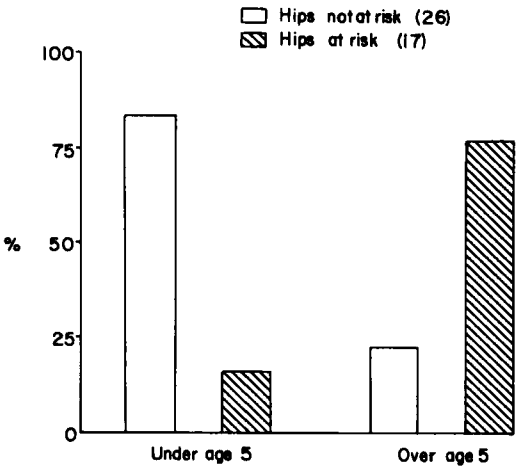

Figure 1. The relationship between age and "head at risk" signs. Over the age of 5 the signs are very commonly seen, whereas they are rare before that age.

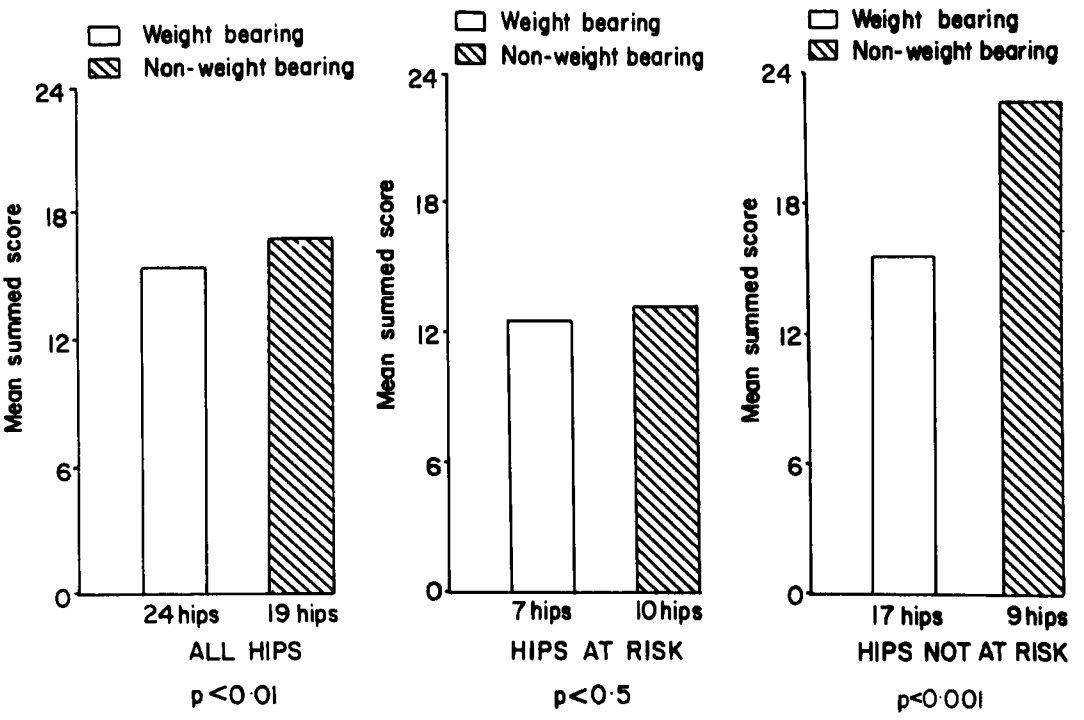

Figure 2. The effect of treatment by weight relief on the final outcome.

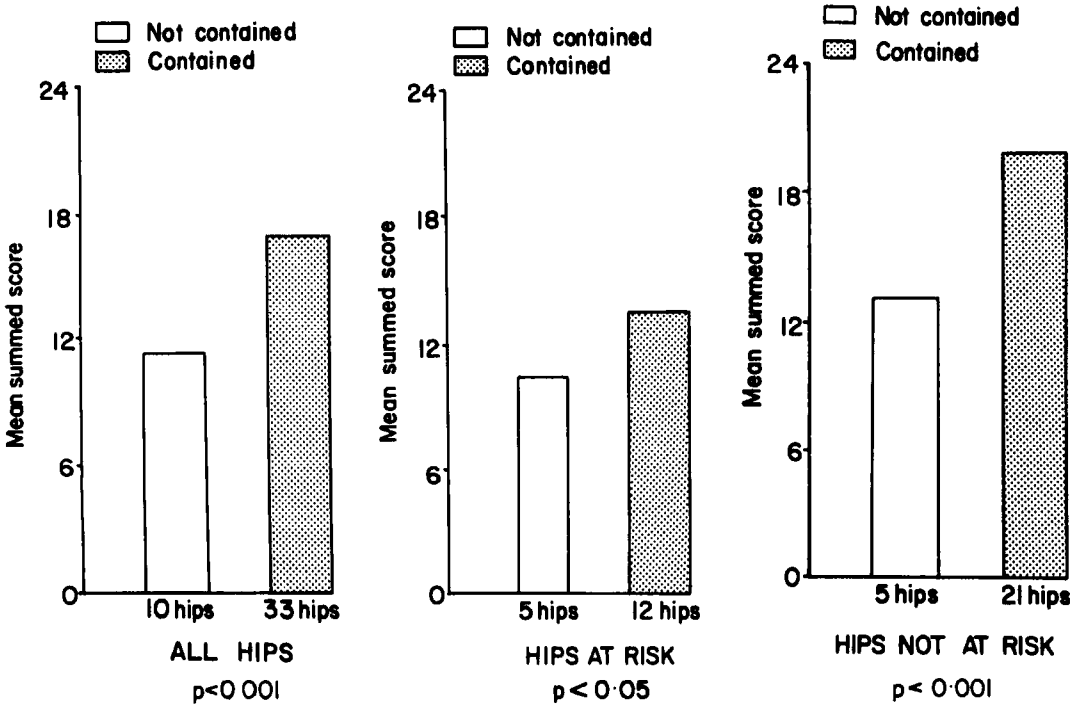

Figure 3. The effect of treatment by containment on the final outcome.

then to examine the effects of containment on the outcome, independent of the effects of weight relief.

Effects of containment

Figure 3A compares the mean score of contained hips with the mean score of uncontained hips. There is a clear advantage in favour of containment. When the effects of containment are related to the condition of the femoral head at the start of treatment, it is seen that when the head is at risk there is a rise in the mean score of contained hips (Figure 3B). However, when the femoral head is not at risk containment produces a rise in the mean score which is much more dramatic (Figure 3C).

Combined weight relief and containment

Figure 4 illustrates the results of treatment in that group of hips not at risk at the time of diagnosis. Although containment alone produces a gratifyingly high mean score, the combination of containment and weight relief gives a still higher score and the difference is highly significant ($P < 0.001$).

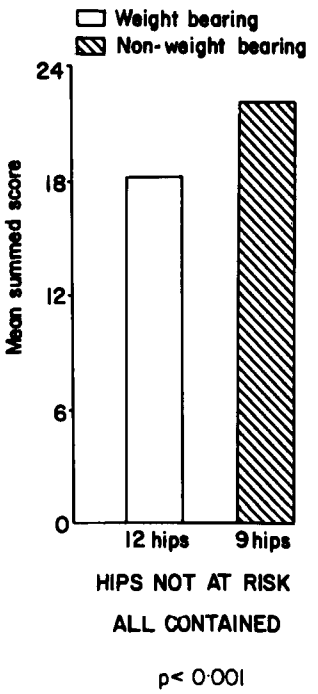

Figure 4. The combined effects of treatment by containment and weight relief on hips "not at risk".

DISCUSSION

The concept of the head at risk was introduced by Catterall (1971) as a means of identifying those femoral heads at risk of a bad result. However, the term "at risk" has been widely interpreted as meaning that the femoral head is *about* to collapse. Catterall himself states that collapse is *already* taking place when "calcification lateral to the epiphysis" is present. When at risk signs appear, the head is already deformed: it is the outcome which is at risk.

A clear appreciation of this is crucial to successful management, for if it is believed that at risk signs serve to warn of impending catastrophe then it could be reasoned that, in the absence of such signs, the femoral head was safe from harm and therefore not in need of treatment. That this is not the case is demonstrated clearly in Figures 2C, 3C, and 4 which show the inferior results in hips *not* at risk when denied the fullest treatment.

In a series of animal experiments Hall (1981) demonstrated that the susceptibility to collapse of the femoral head is directly proportional to the size of the ossific nucleus within it: the greater the proportion of the femoral head which is bone, then the greater is the risk of collapse if that bone becomes weakened. Since this proportion increases with age, older children with Perthes' disease should manifest an increased incidence of femoral head collapse (with head at risk signs). That this is so is shown in Figure 1, which illustrates a close relationship between age and at risk signs, these signs are uncommon below the age of 5 and almost the rule above that age. This explains the clinical observation that increasing age is associated with a worse prognosis. Conversely, the better prognosis in children under 5 is probably due to the femoral head having a small ossific nucleus and a consequent relative resistance to collapse. It is usual to ascribe the better outcome in the young to their better potential for remodelling, but, although this may be an im-

portant factor in the later phases of the disease, there can be little doubt that this influence is less important than absence of deformity following infarction of the ossific nucleus.

It would be a gross oversimplification to say that children under 5 never need treatment, but, the closer they approach this watershed, the more likely they are to suffer from being denied it. Although the undeformed femoral head does not show at risk signs, it may subsequently develop them as is clear from a comparison of this series with that of Lloyd Roberts (1976): in our series, where all cases were actively treated from diagnosis, only 42% of hips were at risk. In Lloyd Roberts' series, where the policy was to defer treatment until the appearance of head at risk signs, 82% became so afflicted. Thus the object of treatment in hips not at risk should be the prevention of deformity, and the only way in which this can be achieved is by influencing the deforming force. The direction of this force can be altered effectively by containment, and its magnitude can be reduced by total weight relief. That containment is effective is clear from Figure 3C: that weight relief improves the outcome is shown in Figure 2C: that these beneficial effects are additive is shown in Figure 4. Every single "not at risk hip" treated by containment and weight relief achieved a first class result (mean score 22, range 20–24).

As far as those hips with heads which are at risk are concerned, the results confirm that the signs are associated with a poor prognosis which nonetheless can be improved by treatment. We support the view of Lloyd Roberts et al. (1976) that when the hip shows at risk signs, containment improves the outcome but weight relief does not. However, it should be noted that although the prognosis in these cases was undoubtedly improved by treatment, the mean score (13.9) of this group was disappointingly low, and the extent of the improvement is far short of that desired. Certainly the improvement is not sufficiently impressive to allow Group 4 hips not at risk to be abandoned to a policy of supervised neglect in the vain hope of recovering the situation at operation when at risk signs appear.

CONCLUSION

The results of this study strongly underline the view that head at risk signs are associated with a poor prognosis. A method of management which prevents the onset of these signs is therefore desirable and a policy of delaying treatment until at risk signs appear is not justified. Once the head has become at risk containment is the only treatment which has been shown to be beneficial. When the head is not at risk a combination of containment and total weight relief prevents the onset of deformity and a perfect result is almost certain.

The indication for weight relief in the management of Group 4 Perthes' disease is the absence of at risk signs on the diagnostic radiographs.

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