MULTIPLE EPIPHYSIAL INJURIES IN BABIES
("BATTERED BABY" SYNDROME)

BY

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[WITH SPECIAL PLATE]

We hope in this paper to give publicity to a syndrome which we think commoner than is usually believed, and which would appear often to be misdiagnosed, with possibly tragic results. It concerns babies brought to hospital with unexplained swellings in the region of the ends of long bones who are in fact victims of unsuspected trauma which is often brutal and which has usually been inflicted by a parent.

The patients we report were all under 1 year old, but the literature contains accounts of the same thing in older children. An essential feature of the syndrome is that the history of trauma is not forthcoming, for it is suppressed by the culprit, while the victim is too young to give a history at all. This absence of history, or the substitution of a misleading and untrue history, is one reason for failure to make the correct diagnosis.

Many of our colleagues, both orthopaedic surgeons and paediatricians, with whom we have discussed this syndrome were themselves as ignorant of it as we were when we met our first cases. Our unfamiliarity with the condition was partly due to the fact that it has been reported almost solely in specialized journals and in America. The classical description is that of Caffey (1957) in a radiological journal. There are a few accounts in orthopaedic journals (Weston, 1957; Altman and Smith, 1960); but the only reference we have found in a non-specialized British journal is an account of a case in 1888 (West, 1888), in which the diagnosis was certainly missed.

Case 1

The patient, a male infant aged 10 months, was the son of a university student and of a mother who went out to work daily in a shop. It was the father's custom to wheel the child round in a pram every morning to the house of a neighbour, herself a mother of four, who cared for the baby until his mother would collect him after the day's work. He was brought to hospital one evening at 7.30 p.m. with the story that his custodian had that day brought the mother's attention to a swelling in his left thigh. We were told quite clearly that there had been no injury.

He was a healthy baby, weighing 17 lb. (7.7 kg.), who had not crawled or stood but who was otherwise normally advanced for his age. His left thigh showed a large, tender, soft swelling apparently connected with the lower end of the femur, but he permitted a range of movement of over 90 degrees in the knee, and there was no effusion in the joint. His rectal temperature was 100.2° F. (37.9° C.).

The first *x*-ray film, taken on the evening of admission, showed (Special Plate, Fig. 1) "cuffing" of the metaphysis of the lower end of the left femur, compatible with avulsion of bone at that site. There was also an "involucrum" of new bone surrounding the lower end of the left tibia, and a distinct suggestion of medial displacement of the lower left tibial and fibular epiphyses. The tibial lesion was clearly older than the femoral. There was also evidence of previous partial separation of the lower right tibial epiphysis with a small "cuff" of new bone there and, in further films, a uniting fracture of the middle of the shaft of the right clavicle (Special Plate, Fig. 2) and a peculiar thickening of the whole of the shaft of the left humerus, with irregularity of the upper metaphyses of both humeri. The thickening of the left humerus apparently represented a much later stage of the subperiosteal ossification seen around the lower third of the left tibia. The rest of the skeleton, including the mandible, was radiologically normal.

Later films showed the rapid formation of an involucrum around the lower end of the left femur (Special Plate, Fig. 3), which was well marked after only eight days. They also showed progressive healing of the fractured clavicle.

The child's blood was normal in all respects; there was not the slightest evidence of scurvy or of any general disease. During his stay in hospital the swelling in the thigh subsided rapidly and was barely detectable after four days. No further swellings appeared.

The police charged the father with inflicting grievous bodily harm. At his trial it was revealed that there had been many mornings on which the woman who cared for the baby during the day had pointed out bruises to the father, and, on one occasion two months before his admission to hospital, tenderness in the left axilla. She had been concerned enough about these injuries to seek the advice of two of her neighbours, one a State-registered nurse; but the father's repeated denials of any suggestion of injury had been accepted and no effective action was taken to protect the child until one of us reported the case to the police.

Case 2

This patient was the third child of a mother divorced for adultery by her first husband, the father of her first two children, who had been given their custody. At the age of 9 weeks this baby was admitted to another hospital because of unexplained swelling and bruising of both elbows, which had been "found" by the mother after he had had a "bad night." His temperature on admission was 100° F. (37.8° C.). Both elbows were swollen and deformed, the deformities suggesting dislocations to our colleague who saw them. Both the child's calves were swollen and his right ankle was bruised. Exhaustive investigations for blood disorders revealed no abnormality; there was never any suggestion of general disease. An unsuccessful attempt was made to reduce the supposed dislocations of the elbows, and the child was kept in hospital one month, during which the swellings subsided and no new ones appeared.

A month after leaving hospital he was readmitted because of an unexplained swelling in the region of his left hip. This, too, disappeared during a stay in hospital of three weeks. Thereafter there were incidents of unexplained swelling behind his ears, in his palms, and between his toes, sometimes associated with visible bruising.

He was referred to one of us five months after his first admission to hospital. He was then a plump, happy, and well-fed baby of 7 months, but with an obvious fracture of his left clavicle, attributed by his mother to an accidental fall when his father was carrying him. Both elbows showed deformities characteristic of malunited supracondylar humeral fractures. Flexion in each was limited, but extension was full.

We obtained all the *x*-ray films from the first hospital. The earliest, taken when he was 9 weeks old, showed deformities of both elbows (Special Plate, Fig. 4) which had excusably been mistaken for recent dislocations. There were also typical metaphysial irregularities at the lower end of the left radius and at the upper end of the right humerus, where a thin involucrum was already forming. The same process was taking place at the lower ends of the femora and at both ends of the

tibiae and fibulae (Special Plate, Fig. 5), where the metaphyses were "cuffed" with new bone. There was a healing fracture of the right clavicle. Films taken only 11 days later showed massive new bone around the left femur and around both humeri, the appearances at the elbows now being more clearly those of epiphysial separation and not dislocation. Involucra were also apparent around the shafts of both tibiae.

Our own films, taken five months after the first reported incident, showed considerable remodelling of the lower ends of the humeri (Special Plate, Fig. 6), but with persisting deformity. Similar remodelling was well advanced in the lower ends of the tibiae and particularly in the upper end of the left femur, where a film three months after the first incident had shown a very extensive involucrum (Special Plate, Fig. 7). There was also a recent fracture of the left clavicle, previously uninjured.

The appearances of the elbows in the earliest films (Fig. 4) were identical with those reported by Siffert (1963) in the elbows of newborn children who had survived difficult and traumatic births.

The mother denied any knowledge of how any of these injuries could have been inflicted, with the exception of the fracture of the left clavicle. The father failed to keep an appointment at the hospital for interview. The case was reported to the National Society for the Prevention of Cruelty to Children, to whom the mother had been well known during her first marriage and who had been known to have brutally beaten her older children on more than one occasion.

Case 3

A female non-identical twin was referred to one of us when she was 19 weeks old because of an unexplained swelling of her left elbow. She was a well-nourished baby, with a temperature of 101° F. (38.3° C.) and a painful, tender, swollen left elbow. A white-cell count of 19,000/c.mm. (50% polymorphs) helped to support the suggestion of osteomyelitis. There were abrasions on her scalp, and *x*-ray films showed typical metaphysial irregularity at the lower end of the right humerus, with evidence of older similar damage at the lower ends of the left humerus (Special Plate, Fig. 8), right ulna, right femur, right fibula, and the upper end of the right tibia. There were recent fractures of both first ribs and of the left eighth rib. Her haemoglobin was 60%, but her blood was otherwise normal except for the leucocytosis. She made a rapid recovery in hospital.

There was no evidence to indicate who was responsible for these injuries, which must have been inflicted on at least two occasions. The parents, who denied any guilt, were warned, and the child was allowed to go home.

At the age of 12 months she was brought back with a story that she had refused to take weight on her left leg for a month. *X*-ray examination (Special Plate, Fig. 9) showed incomplete detachment of the left upper femoral epiphysis with subperiosteal new bone formation along the femoral shaft. She made a good recovery from this injury as well.

Case 4

A male infant aged 3 months was brought to hospital with an unexplained swelling of his right elbow. There was a story that he bruised easily, but investigations for a bleeding diathesis were negative. He was seen by one of us three weeks later, when there was *x*-ray evidence of a typical epiphysial injury of the lower end of the right humerus, as well as multiple rib fractures, not all of the same age. The mother was a mentally disturbed person and was at first inclined to blame another child, but the truth was never established with certainty.

Unexplained Fractures

This problem of multiple *epiphysial* damage in very young children is related to the less obscure one presented by children brought to hospital with obvious fractures of the *shafts* of long bones but without any explanation for their occurrence. An isolated fracture of one long bone shaft may, of course, occur as one of the ordinary hazards of childhood, which include unobserved accidents for which no one may be to blame, but we have learned not to presume upon this.

A female infant aged 2 months was brought to hospital because she "had stopped using her right arm." There was an obvious fracture of the shaft of the right humerus, but injury was not admitted. Ten days later she was brought back because of vomiting and convulsions, which turned out to be due to a subdural haematoma. *X*-ray examination then revealed an involucrum along the shaft of the *left* humerus, healing fractures of seven ribs (Special Plate, Fig. 10), and the typical appearances of previous epiphysial damage in the lower ends of both tibiae. The subdural haematoma resolved after repeated daily tappings. Eventually the father admitted having "accidentally" dropped the child on two occasions during which she was "very troublesome" at night.

Multiple unexplained shaft fractures in babies are clearly outside ordinary domestic hazards.

A male infant aged 9 weeks was seen by one of us because of a swollen and tender left shin. There was no history of injury. An *x*-ray film showed a transverse fracture of the shaft of the tibia, for which a plaster cast was applied. Next day the child was brought back because his left arm had "gone limp." An *x*-ray film showed a transverse fracture of the shaft of the left humerus, which was splinted. Seven weeks later he was taken to another department because of convulsions. Bruised legs and a bruised right wrist were then noticed. This aroused suspicion of trauma, which was confirmed by the finding of a subdural haematoma, which was successfully evacuated by operation.

At a later date the above patient's younger brother, aged 5 months, was seen by one of us for a fracture of the shaft of the left humerus, for which there was a clear and admitted history of "accidental" injury; but bruises over his eyes, nose, and buttocks, and *x*-ray evidence of previous subperiosteal new bone around the injured humerus leave us in no doubt that this child, too, had been repeatedly assaulted.

"Battered Baby" Syndrome

The injuries inflicted upon babies may include anything from unexplained bruises to severe multiple fractures, from a black eye to a ruptured liver due to violent shaking by adult hands around the abdomen. The form with which this paper is particularly concerned—multiple epiphysial injury—presents as a combination of (1) unexplained swelling in a baby's limb, with (2) characteristic *x*-ray changes, usually with (3) elevation of temperature to about 101° F. (38.3° C.), and (4) leucocytosis of up to 19,000 or so white cells per c.mm.

There may or may not be visible bruising or a history of bruising, often allegedly "spontaneous." There are usually one or more fractures of the clavicle or of ribs, and in most cases *x*-ray films of the rest of the skeleton show changes in other bones, varying in age and at different stages of healing, usually including unsuspected and often soundly united fractures. We feel that we cannot overemphasize the importance of *x*-ray examination of the whole skeleton; for it is only by the use of such a "skeletal survey" in all children with unexplained lesions in limbs that the truth will usually be discovered.

It is characteristic that the child makes a good and rapid recovery while in hospital, during which time fruitless investigations are carried out for blood disorders. No new lesions occur while the baby is an in-patient.

X-ray Changes

The *x*-ray appearances of multiple epiphysial trauma should be unmistakable. As Caffey (1957) said, this is one of the few conditions in which the *x*-ray films can be read "with complete disregard for the clinical history," which is usually misleading. "The bones tell a story the child is too young to tell" (Kempe *et al.*, 1962). Apart from obvious fractures, the films show:

1. In the earliest stages, detachment of small flakes of bone from the affected metaphyses and, usually, soft-tissue swelling around the adjacent parts of the shafts.

2. Thereafter, progressive deposition of new bone in the region of the soft-tissue swelling—that is, under and in the periosteum around the shaft where the haematoma has spread after the partial detachment of the epiphysis. This new bone ultimately becomes incorporated in the shaft as part of the remodelling process of growth, but the shaft itself remains thickened for some months after the injury (Fig. 2). The new bone is clearly indicated eight days or so after the injury. It is thickest over the ends of the shafts, but it may extend along almost the whole length of the shaft as a massive involucrum (Fig. 7), and it may take the form of a "lip" (really a rim) overlapping the epiphysial plate.

3. Actual separation of an epiphysis *en masse* is rare, but does occur (Fig. 4). When it occurs the appearance may be confused with that of traumatic dislocation, an injury which probably never occurs in infancy.

Differential Diagnosis

The diagnosis, as has been said, is easy and is to be made with certainty from *x*-ray films. In theory, the condition can be mimicked by any disorder which causes spontaneous subperiosteal haemorrhage, and one's thoughts may be guided along those lines when the guilty parent suggests that the child bruises easily. Scurvy is to be excluded by general examination, by laboratory tests, and by the fact that the bones are normal apart from the effects of trauma. The *x*-ray changes in the "battered baby" are so like those often described in infantile scurvy (Barlow's disease) that, in our opinion, many of the illustrations in textbooks of radiology and of orthopaedics which purport to show typical changes of scurvy are in fact examples of this syndrome of epiphysial trauma. We are convinced that many children have been exposed to the hazards of repeated injury because of the erroneous diagnosis of scurvy in these cases.

The pyrexia and the leucocytosis suggest osteomyelitis, but the *x*-ray changes completely exclude this disease.

A rare but possible difficulty could arise in cases of congenital indifference to pain, when these epiphysial lesions could be inflicted unknowingly.

Because the "battered baby" syndrome has been associated with the name of Caffey, it must be made clear that it is not a form of "Caffey's disease"—infantile cortical hyperostosis (Caffey and Silverman, 1945)—which is not an epiphysial disorder and which typically affects, among other bones, the mandible.

Production of the Injuries

These epiphysial injuries are probably produced by shaking and twisting the child's limbs, though, in view of their resemblance to obstetrical injuries, pulling on the limbs, indeed swinging the child by its limbs, seems also a likely mechanism. Siffert (1963) has reproduced the sort of injury seen in the elbows of our Case 2 (Fig. 4) by a combined hyperextension and backward thrust upon the forearm of a newborn cadaver.

The fractures which accompany the epiphysial injuries, notably the fractures of the clavicle and of ribs, appear explicable only as a result of direct violence.

If violence is admitted at all, parents tend to imply that it has been the work of somebody else, either a jealous sibling or a child-minder. Otherwise they will protest that any force used by them was minimal, a mild shaking because the child was disturbing the household at night. It is all too easy to accept such excuses, and we have in fact done so; but our experience with the cases we report here now leads us to believe the worst. These babies are to be regarded as having been injured by brutal violence, and the culprit is almost always a parent.

This dismal syndrome is not uncommon. Dr. Norah Walker (personal communication, 1963) tells us that she has recently seen four cases, and others of our colleagues have told us of cases in Bradford, in Glasgow, and in Liverpool. After all, child assault and even child murder are not rare. One hospital in Pittsburgh reported six cases of "battered babies" in 16 months (Elmer, 1960), and in the Los Angeles Children's Hospital 25 were seen in two years (Gwinn *et al.*, 1961). Moreover, "for every child who is abused and enters a hospital, there must be another hundred treated by unsuspecting doctors" (Kempe *et al.*, 1962).

Prognosis

The fractures unite, the epiphysial injuries heal, the deformities correct themselves with the remodelling of the skeleton which occurs during rapid growth, and the limbs become normal. The psychological effects can only be surmised, but the death rate may be high. In the age-group under consideration this repeated trauma may be "found to be a more frequent cause of death than . . . leukaemia, cystic fibrosis and muscular dystrophy" (*J. Amer. med. Ass.*, 1962). In at least one reported case (Fisher, 1958) the child was later murdered by one or both parents. Kempe *et al.* (1962) collected the records from 71 American hospitals of 302 cases in 33 of which the child eventually died, mainly from head injury, and we were struck by the fact that major head injuries occurred in two of our cases some time after the original injuries. Subdural haematoma has in fact been reported in similar cases by Caffey (1946), by Lis and Frauenberger (1950), by Smith (1950), and by Marquezy *et al.* (1952).

LEGENDS TO SPECIAL PLATE

FIG. 1.—Case 1. Radiograph on admission to hospital. Note "cuffing" of metaphysis of lower end of left femur and involucrum of new bone around lower end of left tibia. There is also evidence of previous injury at lower metaphysis of right tibia.

FIG. 2.—Case 1. Fracture of shaft of right clavicle and older thickening of shaft of left humerus. Irregularity of upper metaphyses of both humeri.

FIG. 3.—Case 1. New bone formation around shaft of left femur. Films taken eight days after Fig. 1.

FIG. 4.—Case 2. Deformities of both elbows in a 9-weeks-old baby, with metaphysial irregularity at upper end of right humerus.

FIG. 5.—Case 2. Evidence of epiphysial trauma at lower ends of both femora and at both ends of both tibiae and fibulae.


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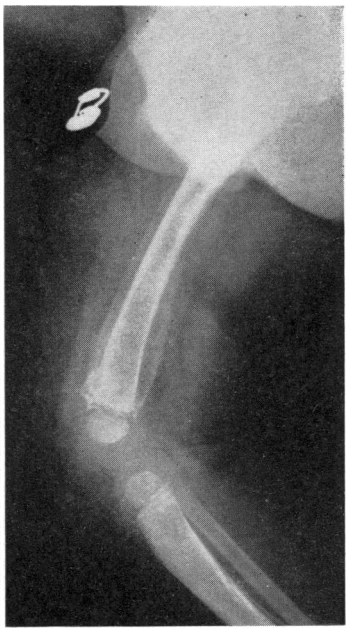

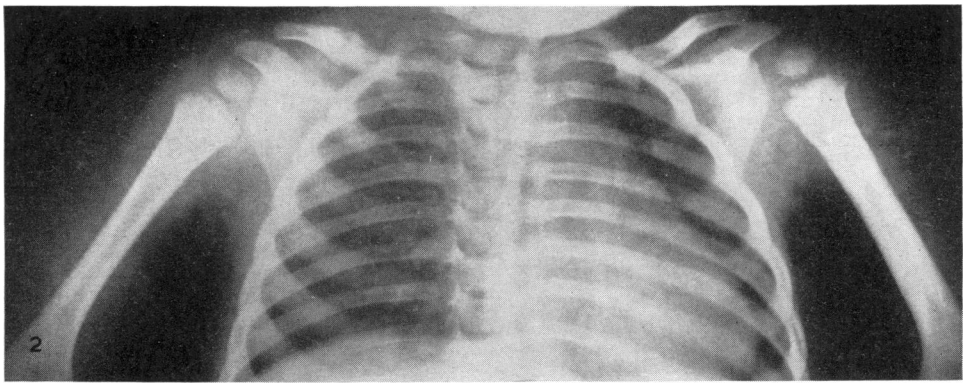
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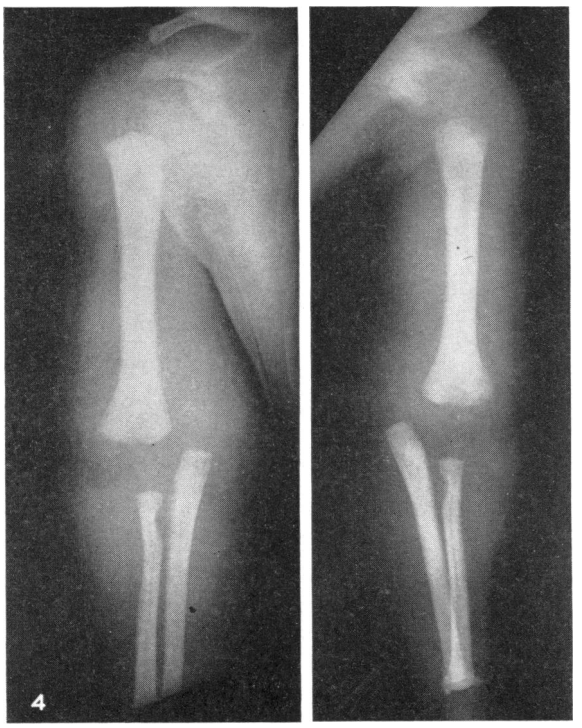
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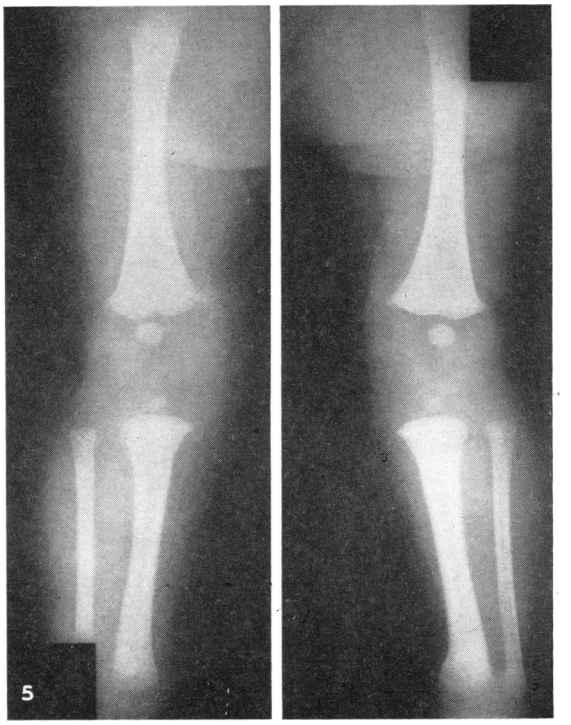
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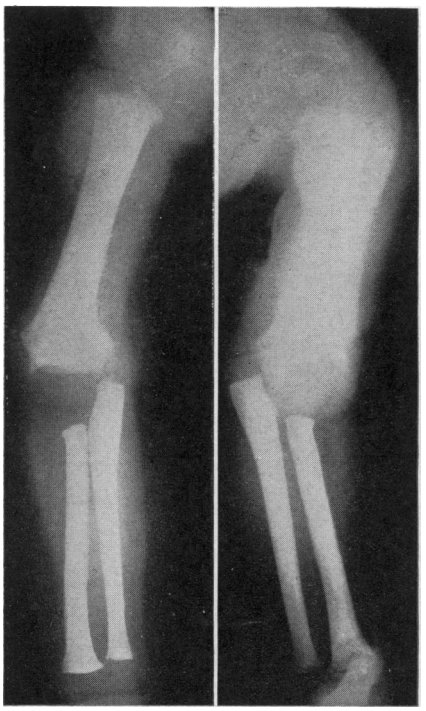

FIG. 6.—Case 2. Remodelling of lower ends of both humeri five months after Fig. 4.

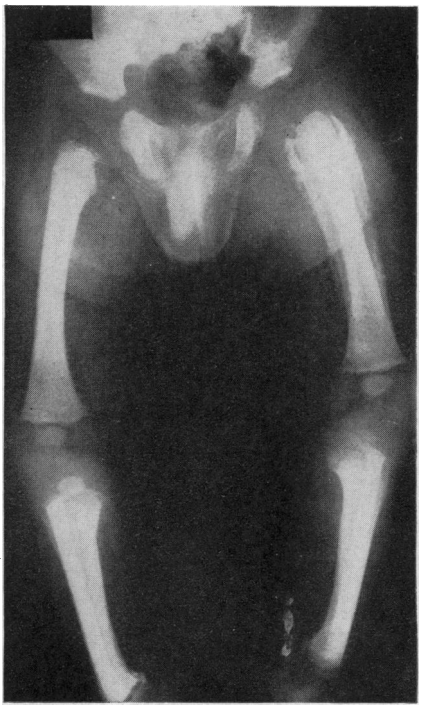

FIG. 7.—Case 2. New bone formation around shaft of left femur three months after the first reported incident.

FIG. 8.—Case 3. Partly healed epiphysial trauma at lower end of left humerus of a child of 19 weeks.

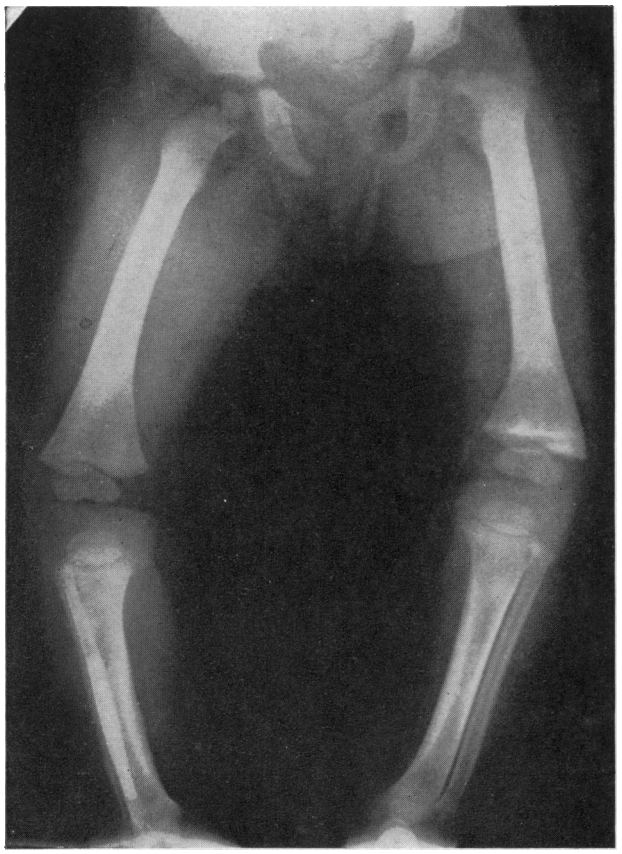

FIG. 9.—Case 3. Partial separation of left upper femoral epiphysis with new bone formation around upper end of shaft 33 weeks after Fig. 8.

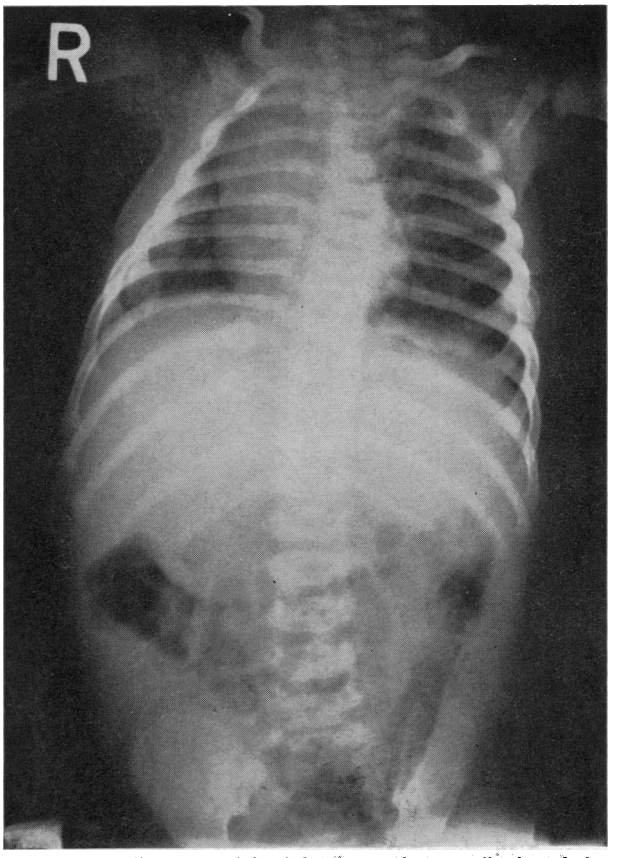

FIG. 10.—Healing, unexplained fractures of seven ribs in a baby of 2 months.

Doctor's Duty

This real risk of further and more serious injury means that not only must we recognize the syndrome for what it is, we must also report the cases to the police. We cannot return children to parents in whose care they may have a 10% chance of violent death. Doctors are reluctant to believe that such assaults on innocent babies are possible, and they are even more reluctant to become involved in the squalor of criminal proceedings, but in the interests of some of our most helpless patients we must realize that epiphysial trauma is due to violence and that not all parents, even if warned, are safe custodians.

Summary

Five cases of multiple epiphysial injuries in babies are described which illustrate the classical features of the condition—namely, (1) unexplained swelling in a baby's limb, (2) characteristic *x*-ray changes, (3) elevation of temperature, (4) leucocytosis.

Typical *x*-ray appearances are described, and it is emphasized that the diagnosis can be made from these rather than from the clinical history, from which a story of trauma is often conspicuously absent. The conditions must be differentiated from scurvy, osteomyelitis, and congenital indifference to pain, and should not be confused with the other form of "Caffey's disease"—namely, infantile cortical hyperostosis. The mode of production of these injuries is described and a plea is made for recognition of this syndrome and the desirability of reporting such cases to the police in order to minimize the risk of further injuries being inflicted upon these children.

Three of the patients whose cases we report were admitted under the care of Messrs. T. T. Stamm, J. S. Batchelor, and P. G. Epps, whom we thank for permission to make use of their records.

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SOME ASPECTS OF ACUTE HAEMATOGENOUS OSTEITIS IN CHILDREN

BY

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In the pre-antibiotic era acute haematogenous osteitis of childhood was a disease with a high risk to life and limb. When penicillin was introduced both mortality and morbidity rates dropped dramatically and it appeared that the *Staphylococcus aureus* had met its match. Dennison and Macpherson (1952) reported that osteitis of childhood had become "exceedingly rare" in Glasgow hospitals. This state of affairs no longer exists. Acute osteitis is now common in hospital practice and complications are frequent.

This paper is based upon a study of recent cases of the disease and is an attempt to form a rational approach to some of the problems.

Material

During the two-year period 1960–1 59 children in age-group 1–12 years were treated for acute osteitis in the Royal Hospital for Sick Children, Glasgow. The treatment of all patients included bed rest, splintage, and the exhibition of one or more antibiotics; 37 were subjected to operation, all within the first fortnight of the illness, and 13 were left with a chronic bone infection.

Patients can be placed into one of three groups (Table I). In assembling these groups the difficulty of confirming a purely clinical diagnosis of acute osteitis has been taken into account, and doubtful cases have been omitted. In most patients the diagnosis was supported by radiological evidence of osteitis: in all others the bone involved was accessible to clinical examination—for example, the tibia. It is appreciated that this is a review of immediate results, and it is possible that complications may later develop in an apparently healed bone.

TABLE I.—*Osteitis in Children* (1–12 *Years*). *Outcome in* 59 *Patients*

	Antibiotic and Cure	Antibiotics, Operation, and Cure	Antibiotics, Operation, and Chronic
Focus in a shorter bone ..	8	4	Nil
,, ,, ,,longer ,, ...	14	20	13
Total	22	24	13

This paper is concerned with haematogenous osteitis in children aged 1 to 12 years. In younger children osteitis has a different pathology and prognosis (Trueta, 1959). Osteitis in association with septic arthritis also presents a different clinical picture and requires other methods of treatment. During the period of the review 19 infants under 1 year of age were treated for acute osteitis, and 22 children under 12 years of age were treated as cases of septic arthritis. These 41 patients have been excluded from this review.

Analysis of Results

Most studies of osteitis tend to be statistical and each proponent of a routine of treatment vies to produce "better" figures than the last. Clinical experience shows how invidious such comparisons can be. The relative balance between the seed and the soil—the virulence of the organism and the resistance of the patient—difference in age of the child or timing of treatment, all summate to make each case unique. In any hospital series selection of patients is inevitable, for some are treated satisfactorily at home. In this area some family doctors refer the child on suspicion, while others wait until a complication develops.

Table I helps to concentrate interest upon the more serious cases. Osteitis of the vertebral body is well recog-

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