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OVERGROWTH FOLLOWING FRACTURE OF HUMERUS IN CHILDREN

By

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Fracture of the femur in children is followed by overgrowth of the bone provided the epiphyseal cartilage is intact (*Truesdell* 1921, *David* 1924, *Levander* 1929, *Blomkvist & Rudström* 1943, *Blount* 1952, 1954, *Trueta* 1957, *Greville et al.* 1957).

Such overgrowth has long been known in osteomyelitis not involving the epiphyseal cartilage (*Stanley* 1849, *Langenbeck* 1869, *Speed* 1923, *Trueta* 1955).

The phenomenon has received extensive attention and it is now widely accepted that the overgrowth is due to increased blood supply to the epiphyseal cartilage.

Attempts have been made to reproduce the phenomenon in laboratory animals. It has proved difficult to study the longitudinal bone growth in such small animals: they grow too quickly and the period of growth is too short. But the same tendency can be observed though the overgrowth is not so regular or so marked as in human beings (*Ollier* 1867, *Wu & Mu Miltner* 1937, *Brodin* 1955 and others). In larger animals (goats and dogs), however, the course resembles that in man (*Bisgaard & Bisgaard* 1935, *Greville & Jones* 1957 and others).

Though it is generally accepted that the overgrowth is due to increased circulation, our knowledge of the actual stimulus is still vague.

It is but natural that these observations gave rise to hopes of accelerating longitudinal bone growth of a shortened leg after poliomyelitis, for example. Implantation of various sorts of material has been tried with varying success. Thus *Pease et al.* (1952) inserted ivory pegs in the metaphysis of patients with a shortened leg after poliomyelitis and noted a certain acceleration of growth. *Trueta* (1953) and *Ståhl* (1957) plugged the marrow cavity of the tibia of the shortened leg: they loosened the periosteum and then cut a window in the corticalis through

TABLE 1

Overgrowth of Humerus Following Fractures at Different Levels of the Bone in Children. The Patients' Ages at the Time of Accident Ranged between 2 and 13 Years. 49 Patients Reviewed after an Interval of 1½ to 9 Years, the Remaning 21 Subjected to Repeated Examinations until 3 Years after the Accident.

			No.
1. *Supracondylar Fractures*			
0		overgrowth	2
2–5	mm.	overgrowth	8
6–9	mm.	overgrowth	18
10–17	mm.	overgrowth	16
			44
2. *Diaphyseal Fractures*			
0		overgrowth	3
7–10	mm.	overgrowth	8
			11
3. *Collum Chirurgicum Fractures*			
0		overgrowth	2
2–5	mm.	overgrowth	3
6–20	mm.	overgrowth	10
			15

Overgrowth was observed in 63 out of 70 cases.
Overgrowth was not found to vary with level of the fracture.

which they packed the marrow cavity with bone chips. They thus created an injury resembling a fracture as well as obstruction of the nutritional artery. This procedure also produced a certain degree of overgrowth.

Janes & Musgrove (1950) and *Hiertonn* (1961) established arteriovenous anastomoses in patients who had had poliomyelitis and the overgrowth they noted was astonishing. *Hiertonn*'s clinical observations may be regarded as the strongest evidence that hyperemia is the cause of the overgrowth. All previous clinical series have consisted of middiaphyseal fractures (*David* 1924, *Levander* 1929, *Blomkvist & Rudström* 1943, *Trueta* 1953). Since Trueta, for example, thought that it was obstruction of the nutritional artery that was responsible for the development of collaterals with consequent hyperemia of the epiphysis, we considered it of interest to study metaphyseal fractures. For this purpose we selected the humerus in which typical fractures may be

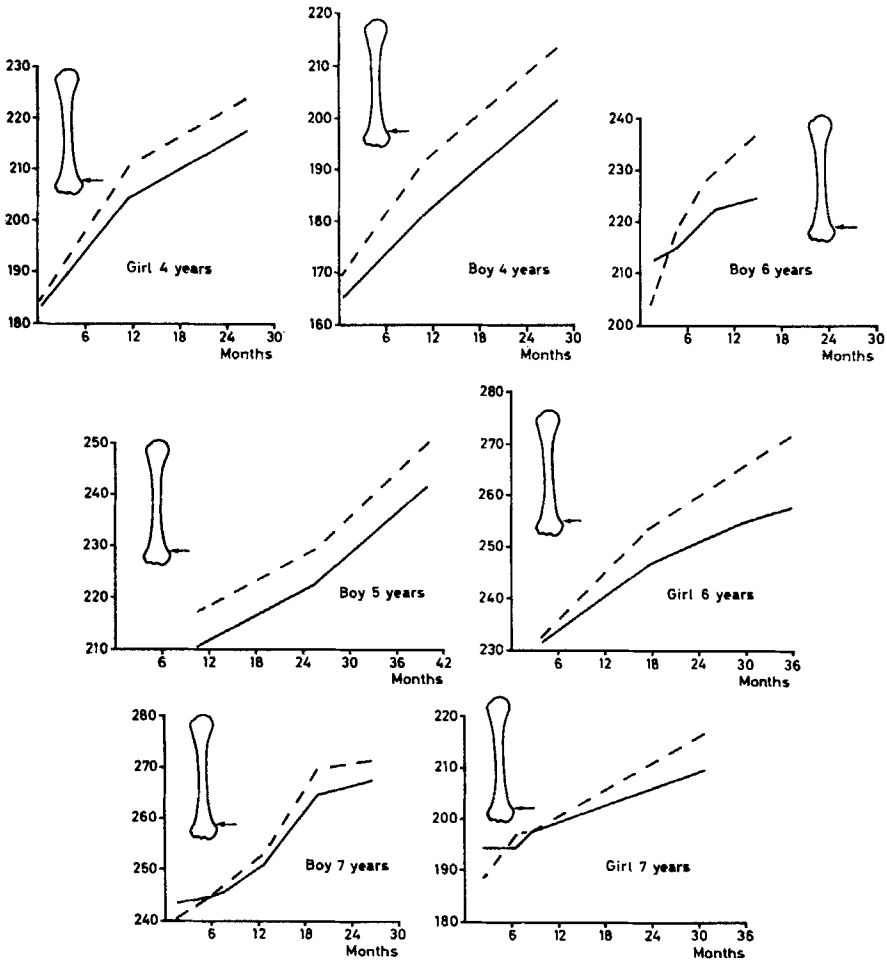

Fig. 1.
Supracondylar fractures.
– – – – – – – Injured side. ——————— Healthy side.

seen near the epiphysis, above the condyles as well as through the surgical neck. In supracondylar fractures of the humerus, for example, the blood supply via the nutritional artery to the proximal epiphysis is intact and this epiphysis accounts for about three fourths of the longitudinal growth of the bone.

Part of the present material was reported previously by *Emneus* (1957) and by *Emneus & Wiberg* (1957) in an earlier investigation in which the purposes was also to find answers to the following questions:

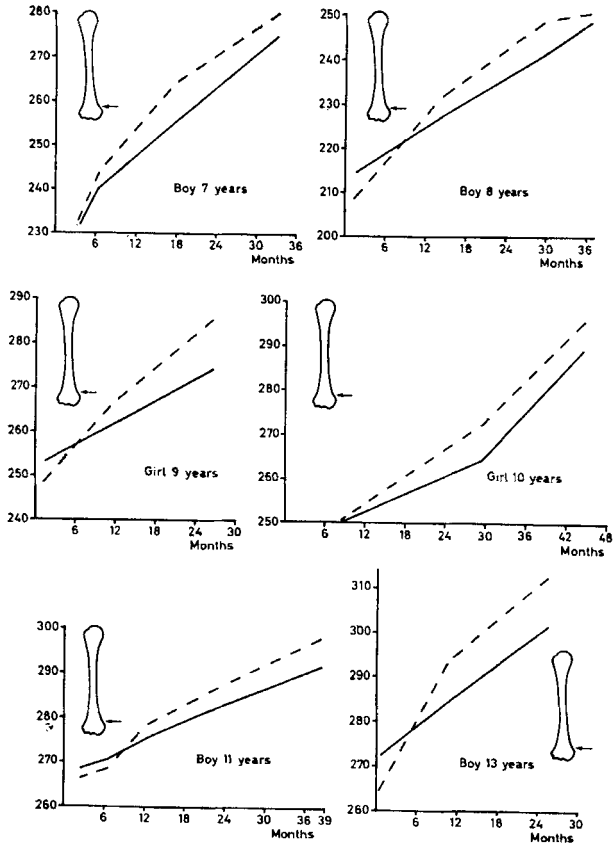

Fig. 2.
Supracondylar fractures.
– – – – – – – – Injured side. ———— Healthy side.

1. How often can overgrowth be demonstrated after fracture of the growing bone?
2. Does overgrowth vary with the level of the fracture?
3. When does overgrowth begin and how long does it continue?

The material now consists of 70 fractures, including 63 with overgrowth (Table 1).

Of the cases given in Table 1, 21 were followed up for 3 years after the accident, with repeated measurement of the roentgenographic length of the bone. The material is small but it should be mentioned that it is difficult to get children to present themselves for regular

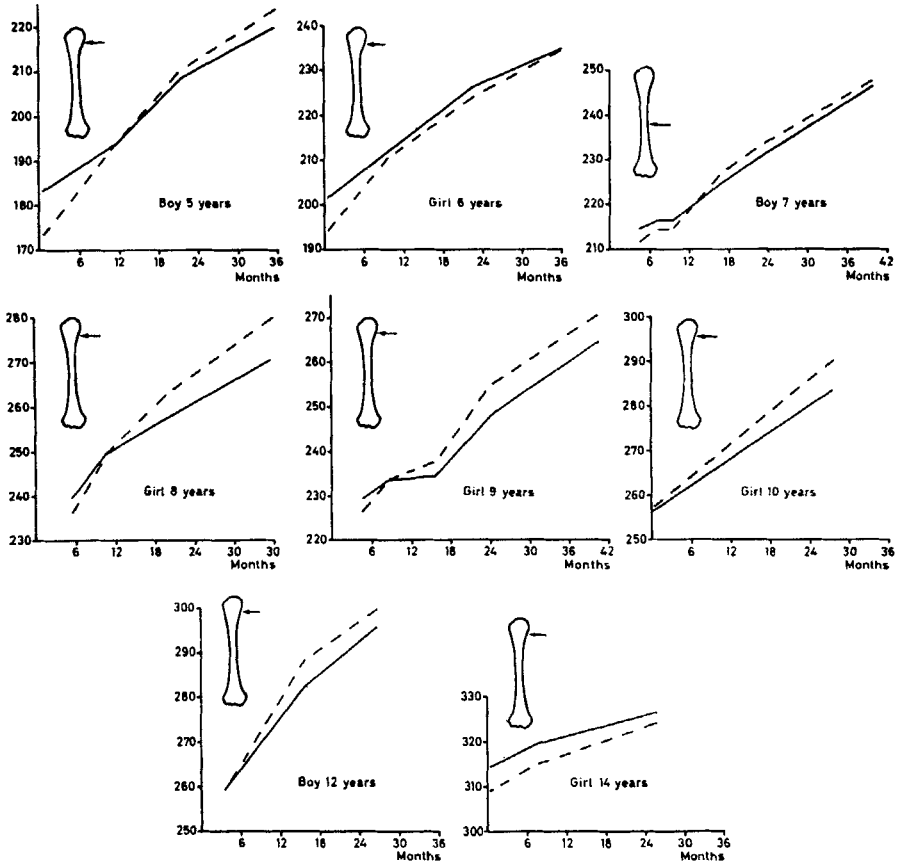

Fig. 3.
Mid-diaphyseal and surgical neck fractures.
– – – – – – – Injured side. ——————— Healthy side.

follow-up when they are symptomfree and healthy. This explains why the number of cases in which the growth in length could be measured repeatedly was relatively small.

The measurements were made in accordance with a roentgen-orthodiagraphic technique elaborated by *Norman* (1955). The mean error of the method is said to be about 1 mm.

Figs. 1–3 summarize the 21 cases (11 boys and 10 girls). Of the fractures, 14 were left-sided and 7 were right-sided. The rate of growth can be read from the diagram. The curves do not show when accelerated growth began, but such information should be obtainable from a series studied at shorter intervals. The curves do, however, show that stimula-

tion of growth continued for 12 months in 6 cases, for 18 months in 10, and still longer in 4. Only in one case was no difference found between the rate of growth of the fractured bone and the unfractured fellow bone. The boy was 5 years old (Fig. 1). Two explanations for this lack of difference may be considered. No growth had occurred, or it had occurred and discontinued within the 10 months before the first measurements had been taken. If the latter explanation be accepted, it would seem justified to postulate that overgrowth following fracture of the humerus in children is a regular occurrence.

The increased rate of growth of the humerus following proximal fractures was not found to differ significantly from that following distal fractures. Since the proximal epiphysis is responsible for three fourths of the growth in length of the bone, this lack of difference is astonishing and suggests either that the proximal epiphysis is stimulated by a distal fracture or that the rate of growth of the normally slowly growing distal epiphysis increases markedly. An investigation of this point is in progress.

SUMMARY

It has long been known that the rate of growth of a shaft bone after a fracture is temporarily increased. The phenomenon has been studied in human beings and in animals, and especially in the lower limbs. In the present investigation in which the material consisted of humerus fractures in 70 children, roentgenographic measurements were made on one later occasion in 49 and repeatedly in 21. The purpose was to assess the frequency of such overgrowth in length, its duration and its variation, if any, with the level of the fracture. Increased rate of growth was found in 63 cases. In 16 of 21 cases re-examined repeatedly the increased rate of growth ceased after 18 months and in 4 it continued still longer. The increased rate of growth was not found to vary with the level of the fracture.

RESUME

On sait de puis longtemps que le taux de croissance d'un corps osseux est temporairement accru après une fracture. Ce phénomène a été étudié chez l'être humain et les animaux, en particulier pour les extrémités inférieures. Dans la présente enquête, où le matériel d'observation représentait des fractures de l'humérus chez 70 enfants, des mensurations radiographiques ont été effectuées à une occasion ultérieure dans 49 cas et répétées dans 21 cas. Le but de l'examen était d'établir

la fréquence d'une telle supercroissance en longueur, sa durée et sa variation s'il y en avait, par rapport au niveau de la fracture. On a trouvé un taux accru de croissance dans 63 cas. Dans 16 des 21 cas réexaminés à plusieurs refrises, la croissance accrue s'est arrêtée au bout de 18 mois et dans 4 elle s'est poursuivie encore plus longtemps. Il n'a pas été constaté que le taux de croissance accrue varie suivant le niveau de la fracture.

ZUSAMMENFASSUNG

Die Tatsache, dass die Wachstumsgeschwindigkeit eines Röhrenknochens nach einem Bruch zeitweilig zunimmt ist seit langem bekannt. Diese Erscheinung ist beim Menschen und beim Tiere besonders an den unteren Gliedmassen untersucht worden. Bei der vorliegenden Untersuchung, in der das Material aus 70 kindlichen Humerusbrüchen bestand, wurden spätere röntgenologische Messungen einmal in 49 und mehrere Male in 21 Fällen vorgenommen. Man bezweckte damit die Häufigkeit des übermässigen Lengenwachstums, seine Dauer und eventuelle Verschiedenheit unter Berücksichtigung der Höhe des Bruches festzustellen. Eine Beschleunigung des Längenwachstums wurde in 63 Fällen gefunden. Bei 16 von 21 Fällen, die wiederholt untersucht wurden, hörte die Wachstumsbeschleunigung nach 18 Monaten auf und bei 4 setzte sie noch darüber hinaus fort. Es wurde gefunden, dass die Wachstumsbeschleunigung nicht von der Lokalisation des Bruches beinflusst wurde.

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