TIBIAL DYSPLASIA

A STUDY OF THE ANATOMY

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Three amputated legs with tibial dysplasia were studied by radiography, arteriography and anatomical dissection. The radiographic appearances were the same as the Type 1b tibial dysplasia described by Jones, Barnes and Lloyd-Roberts (1978) in that the tibiae were absent but the lower femoral epiphyses were normal. However, our anatomical findings differed from those of Jones *et al.* since no bony or cartilaginous anlage of the proximal tibia was found in any of the three legs. The pattern of vascular anomaly was identical in the three legs and similar to the findings of Hootnick *et al.* (1980) in congenital short fibula. Congenital fusion of the subtalar joint was a constant finding. These results support the hypothesis that the arterial and skeletal systems are vulnerable to a teratogenic insult in the fifth week of embryonic life. The bony and arterial anomalies should be borne in mind by the surgeon attempting reconstructive surgery for this condition.

In 1978 Jones, Barnes and Lloyd-Roberts suggested a scheme for the classification and management of congenital aplasia and dysplasia of the tibia with intact fibula (Fig. 1). Their classification is based on the early radiographic appearance of the leg. In Type 1a the lower femoral epiphysis is hypoplastic and the tibia completely absent (tibial aplasia). In Type 1b the lower femoral epiphysis is normal and, in their series, a cartilaginous anlage of the upper tibia was always present but its ossification was delayed (tibial dysplasia).

We have had the opportunity to study the morbid anatomy and vascular structure of three legs of the Type 1b variety. The aim of this investigation was to define the pathology more clearly in the hope of establishing a more rational basis for treatment.

MATERIAL AND METHOD

The amputated legs from three children, two aged 18 months and one aged seven years, were available for study. Plain radiographs taken shortly after birth were obtained for each patient. At the time of this study patients with radiographical Type 1b tibial dysplasia

were treated by disarticulation through the knee. The specimens thus available were submitted to arteriography immediately after amputation by cannulating the arteries present at the level of amputation. A detailed anatomical and histological examination was then carried out.

Type	Radiological Description	No. of limbs
1	<ul style="list-style-type: none"> • Tibia not seen • Hypoplastic lower femoral epiphysis 	6
	<ul style="list-style-type: none"> • Tibia not seen • Normal lower femoral epiphysis 	12
2	<ul style="list-style-type: none"> • Distal tibia not seen 	5
3	<ul style="list-style-type: none"> • Proximal tibia not seen 	2
4	<ul style="list-style-type: none"> • Diastasis 	4

Fig. 1

Congenital aplasia of the tibia. Radiological types according to Jones *et al.* (1978), reproduced with permission.

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Fig. 2
Radiograph taken shortly after birth of a patient with Type 1b tibial dysplasia.

Fig. 3

Fig. 4

Figure 3—A child aged five years showing separation of the talar and calcaneal centres of ossification suggesting the presence of a subtalar joint. Figure 4—Two years later bony fusion of the talar and calcaneal centres of ossification has taken place.

Fig. 5

Arteriograph of an amputated specimen of the lower leg showing a single major vessel forming the lateral plantar arch in the foot and a smaller vessel forming a vestigial medial component of the plantar arch which is incomplete.

Fig. 6

Longitudinal section of the foot showing the lower end of the fibula (F) and the fused calcaneotalar mass (CT); the gap between the two represents the synovial articulation.

RESULTS

Radiography. The initial plain radiographs taken shortly after birth in each patient showed a normal lower femur with a normal distal femoral epiphysis. The tibia was not visible (Fig. 2). A small ossific nucleus of the talus was present which, on the radiographs, appeared to be separate from the calcaneus. In one patient, who had initially refused disarticulation, it was possible to follow the radiographs from birth until the age of seven years. At the age of five years the talus and calcaneus were still clearly separate (Fig. 3); there was still complete absence of the tibia radiographically. By the age of seven years, bony fusion of the talus and calcaneus was seen on the radiograph (Fig. 4). The radiographs of the other two patients followed the same pattern up to the age of eighteen months when amputation was performed.

Arteriography. The findings were identical in all three legs. There were two major arteries in the calf: both vessels ran distally on the medial aspect of the fibula in the midcoronal section. The major vessel, which was identified at operation as the popliteal artery, continued into the foot, where it formed the lateral component of the plantar arch. The second vessel became progressively smaller forming a vestigial medial component to the plantar arch, which was incomplete (Fig. 5).

Morbid anatomy. Bony deformities. These were the same in all three legs. The tibia was completely absent with no evidence of a fibrous or cartilaginous anlage. There was a fibulocalcaneotalar synovial articulation (Fig. 6). The calcaneotalar synostosis extended up to the neck of the talus and no subtalar joint was apparent despite the separate centres of ossification seen on the early radiographs (Fig. 7). The cuboid bone was present but enlarged and fused to the lateral cuneiform. The navicular bone was very small and fused to the medial cuneiform. There was a small middle cuneiform. The metatarsals were normal, varying only in number and size. The bony and cartilaginous fusion between the talus and the calcaneus, the cuboid and the lateral cuneiform bones, and the navicular and the medial cuneiform bones was confirmed macroscopically and microscopically.

Muscular anomalies. In each specimen the tibialis anterior was either absent or atrophic and attached to the medial

Fig. 7

Dissected specimen of hind foot and lower fibula. F, fibula; TA, tendo Achillis (calcaneal tendon); T, talus; and C, calcaneus. Note the fibulocalcaneotalar articulation and that the talus and calcaneus are solidly fused.

aspect of the fused calcaneotalar mass. The calcaneal tendon was inserted laterally on the calcaneotalar mass with an extension passing medially and in addition, on the lateral side, a band attaching to the fibula. The peroneus tertius was absent in all three cases and in one patient the flexor hallucis longus was also absent. The tibialis posterior was duplicated and attached to the medial side of the calcaneotalar mass. In all three legs the flexor digitorum profundus arose from the medial side of the fibula and was attached distally in the normal way.

DISCUSSION

The correlation of the morbid anatomy with the plain radiographs was of particular interest. Although all three

limbs were radiographically Type 1b, no anlage of the tibia was found. This is at variance with the findings of Jones *et al.* (1978) where a tibial remnant was always present in association with the radiographic appearance of a normal lower femoral epiphysis. Therefore, the surgeon exploring a Type 1b leg should be prepared either to preserve the knee in the presence of an adequate tibial remnant or, in its absence, to proceed to disarticulation through the knee or reconstruction using the fibula as described by Brown (1965).

Early radiographs of our patients suggested the presence of a subtalar joint. However, the anatomical studies in all three patients and the radiographs in the child aged seven years suggest that absence of the subtalar joint is a feature of this condition. This is an important practical point which must be considered by the surgeon who attempts to obtain a plantigrade foot in this disorder.

The arterial pattern in each leg was remarkably similar. There was a major artery in the calf with a small secondary artery. The exact arterial supply to the fibula was not identified in any of the legs studied. These findings are similar to those described by Hootnick *et al.* (1980) in congenital short fibula; these authors described the absence of the anterior tibial artery, a single major artery in the lower leg and a smaller secondary artery which, in their patients, provided the nutrient artery to the tibia. Failure of formation of the plantar arch was a constant feature in both series. This lends support to the hypothesis of Hootnick and his colleagues that the arterial and skeletal systems are vulnerable to a teratogenic insult in the fifth week of embryonic life. This is the critical period for the initiation of the development of bone and the emergence of the adult arterial pattern. The presence of an arterial anomaly should be borne in mind by the surgeon undertaking any reconstructive procedure in patients with this type of limb deficiency.

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