Unusual fan shaped ossification in a female fetus with radiological features of boomerang dysplasia

Sylvie Odent, Philippe Loget, Bernard Le Marec, Anne-Lise Delezoïde, Pierre Maroteaux

Abstract
We report on a female fetus of 24 weeks whose clinical and radiological findings were compatible with boomerang dysplasia (BD). However, histopathology was unusual with a lateral fan shaped diaphyseal ossification. This has never been described either in typical atelosteogenesis I (AT-I) or in BD. The purpose of this report is to find out if this condition is a separate lethal bone dysplasia or another histological feature of the nosological group of AT-I and BD.

Keywords: boomerang dysplasia; atelosteogenesis; lethal chondrodysplasia; lethal dwarfism

Boomerang dysplasia (BD) is a lethal chondrodysplasia which was first reported by Kozlowski et al1 as a “new form of neonatal death dwarfism”. Three further male cases were documented by Tenconi et al2, Kozlowski et al3, and Winship et al4. The characteristic flat, curved shape of one or more of the long bones gives this syndrome its name. Hunter and Carpenter5 and Greally et al6 suggested that BD and atelosteogenesis I (AT-I) may represent part of a spectrum of bone dysplasias with a possible common cause. Recently, Silence et al7 reported a review of 25 cases of “atelosteogenesis syndromes” including seven other cases of BD.

The present case may be an early form of BD with characteristic radiographic features but in a female fetus and with an unusual diaphyseal ossification.

Case report

CLINICAL FINDINGS
A female fetus was medically aborted at 24 weeks of gestation. It was the first pregnancy of a 23 year old mother and a 26 year old father, both healthy and non-consanguineous. The gestation was complicated by polyhydramnios at 22 weeks and ultrasound study showed a marked shortness of the fetal long bones with abnormally shaped femora and mildly decreased ossification of the skull. The findings were interpreted as possible osteogenesis imperfecta. On amniocentesis, the karyotype was normal (46,XX).

External examination (fig 1) showed a 510 g (normal for dates) female fetus with macrocephaly, hypertelorism, elongated philtrum, micrognathia (C), and talipes equinovarus (D).

Figure 1  External examination of the fetus was remarkable for severe micromelia, broad and short hands and feet (A, B), macrocephaly, hypertelorism, elongated philtrum, micrognathia (C), and talipes equinovarus (D).

RADIOGRAPHIC FINDINGS
The radiographic study (fig 2) showed delayed ossification of the spine which was dysplastic. The thorax was narrow with 12 pairs of ribs. The iliac wings were triangular. Complete absence of ossification was noted in the humerus, radius, and ulna, except for one irregular ossification centre in the left upper limb. There were short ossification centres of some metacarpals and only the proximal and distal phalanges were ossified and wide. The femora were markedly short and curved. There was a triangular ossification centre instead of
the tibia and fibula. Study of the feet showed irregular ossification of the metatarsals and only the distal phalanges were ossified.

**HISTOPATHOLOGY**

The femora were markedly short (length 35 mm) and wide (width 17 mm). The frontal section showed an unusual and fan shaped diaphyseal ossification (fig 3). This fan shaped ossification indicated hemispherical ossification with a vertical diameter on one diaphyseal side.

The specimens were embedded in para after decalcification; sections were stained with H&E, PAS, alcian blue, and trichrome.

Microscopic examination confirmed an unusual distribution of the endochondral ossification (fig 4). In the resting cartilage, there was an abundant matrix with scattered, large chondrocytes. In the physeal growth zone there were many irregular vascular canals which disturbed the columnar arrangement of the chondrocytes in the proliferative and hypertrophic zones (fig 5). The hypertrophic chondrocytes were quite regular.

The chondro-osseous junction line was clearly drawn with insufficiency and disorganisation of diaphyseal ossification. The trabecular...
bone had become thin and fan shaped, converging on a fibrous diaphyseal endosteum (fig 6).

PAS and alcian blue stains were normally distributed. Myxoid degeneration of cartilage matrix and giant cells were not observed.

Discussion

Our case had clinical characteristics of both AT-I and BD including polyhydramnios, micromelic dwarfism, macrocephaly, micrognathia, depressed nasal bridge, and talipes, but no omphalocele or cleft palate which are more frequent in BD.67 Our radiological findings are more in favour of BD: very short, broad, and curved femora, triangular iliac wings, only one ossified long bone, and only the distal phalanges ossified.

This case was a female fetus and all reported cases of BD except one had been male. However, only 11 sporadic cases have been reported, which is not sufficient to conclude that BD has X linked recessive inheritance. Our case was also sporadic and could have been caused by a dominant mutation.

Our histopathological findings have never been described either in typical AT-I or in BD. In the two disorders, giant cells, generally in association with hypocellular or acellular areas of cartilage, disorganised growth plate maturation, and matrix degeneration, have been described, but in the case reported by Herzberg et al11 as a “variant of atelosteogenesis”, a photomicrograph of the femur of a 20 week fetus showed a short, irregularly shaped bone and probably lateral fan shaped ossification that might be similar to our case. This particular finding was not detailed by the authors. Greally et al2 in the radiographic study of their case, described the femora as “under-tubulated, short and hypoplastic in their distal aspect”. At necropsy, this fan shaped diaphyseal ossification was not mentioned but strongly suggested by the radiographic aspect of one femur.

Thus, the present case does not conform exactly to any previously reported severe lethal chondrodysplasia, but could be a “variant of boomerang dysplasia”. This particular lateral fan shaped ossification is perhaps another important histological feature of the nosological group of AT-I and boomerang dysplasia. It is quite similar to the histology of the femur in transgenic mice with overexpression of PTHrP (parathyroid hormone related peptide) described by Weir et al12. The discovery of new skeletal morphogenetic genes will help to explain the pathogenesis and classification of these lethal chondrodysplasias.

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