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The ossification of the metacarpal and phalangeal bones in human foetuses

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An evaluation was made of the ossification level of the metacarpal and phalangeal bones in human foetuses of both sexes from the 4th to the 9th month of gestation. Our results indicate that ossification of phalangeal bones 1 to 5 always started at the distal end of the phalanx and endochondral ossification prevailed in the proximal phalanx of the thumb.

Key words: human foetus, metacarpal bones, phalangeal bones, ossification

INTRODUCTION

Most human skeletal bones are ossified on a cartilaginous base [5, 14]. This is a complex process progressing dynamically in time and ossification constitutes the final phase of this complex process [3]. Thorough observation of the ossification of the foetal skeleton is made possible by means of the radiological method and evaluation of histological specimens [9]. This study presents the ossification of the metacarpal and phalangeal bones in human foetuses at different stages of gestation.

MATERIAL AND METHOD

Eighty-six hands were examined taken from human foetuses of both sexes aged from 4 to 9 months of gestation. The material included 46 hands of male foetuses and 40 hands of female foetuses (Fig. 1). Their age was determined on the basis of crown-rump length and total length according to Scammon and Calkins [1, 2]. The isolated foetal hands were placed in a formalin solution of 1.11 mol/dm^3 concentration for a period of two weeks. Sections

Figure 1. Roentgenogram of the foetal hand in a 7-month-old foetus; enl. 10 ×.

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Figure 2. Cartilaginous model of the 3rd metacarpal bone in a 4-month-old foetus; enl. 2 ×.

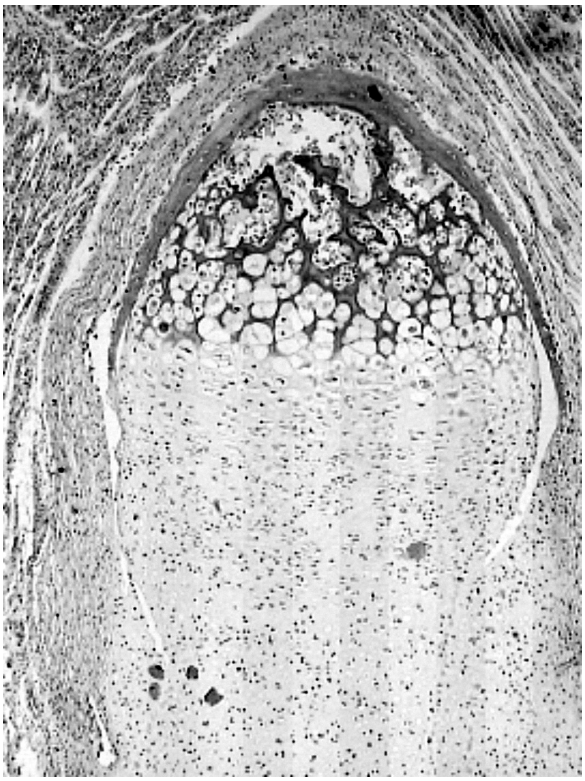

Figure 3. Ossification of the distal phalanx of the 4th finger in a 5-month-old foetus; enl. 40 ×.

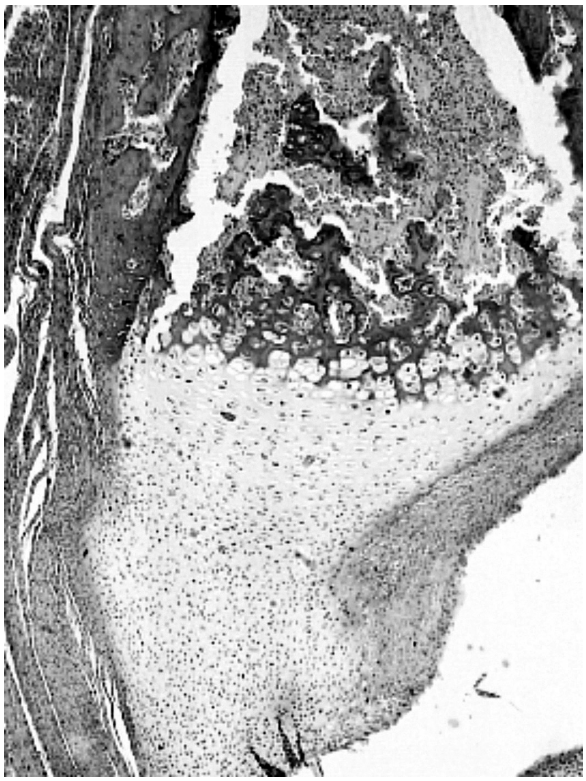

Figure 4. Ossification in the shaft of the 2nd metacarpal bone in a 5-month-old foetus; enl. 40 ×.

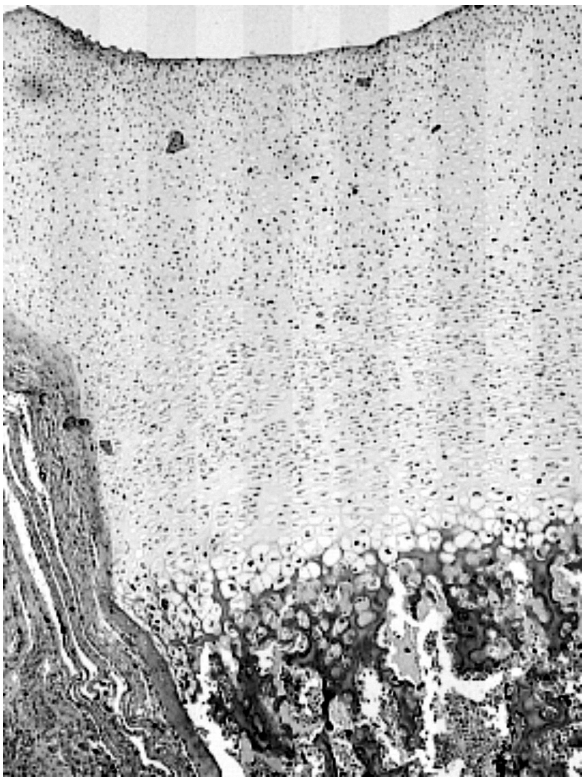

Figure 5. Ossification of the proximal phalanx of the 5th finger in a 7-month-old foetus; enl. 40 ×.

of 5 mm thick were then obtained by cutting the hand parallel to the long axis of the bone. The specimens underwent decalcification in nitric acid at a concentration of 1.15 mol/dm^3 for 2 days and were subsequently sliced into further sections 2 μm thick and stained with HE to assess the process of ossification.

RESULTS

It was observed that at the beginning of the 4th gestational month the cartilaginous model constituted the stroma of the phalangeal and metacarpal bones (Fig. 2). In the 5th gestational month the formation of osseous tissue was seen to be proceeding from the distal phalanges of fingers 1 to 5 (Fig. 3). In the shaft of these phalanges as well as in the proximal phalanges of fingers 2 to 5 ossification was not observed. However, in the proximal phalanx of the thumb endochondral ossification prevailed (Fig. 6). Ossification typical for long bones was found in the metacarpal bones. The shafts of all the metacarpal bones were surrounded by an osseous cuff (Fig. 4). During the 6th and 7th gestational months numerous osseous and cartilagino-osseous trabeculae were observed in the shafts of all the phalanges of fingers 1 to 5 (Fig. 5). During the 8th and 9th gestational months further reconstruction of bones took place in the phalanges of the fingers and in the metacarpus. In the epiphysis of the metacarpal bones ossification points appeared and in the shafts an advanced stage of the process of ossification was observed. Marrow cavities were noted.

Figure 6. The hand of a 5-month-old foetus: a — ossification of the proximal phalanx of the thumb; b — ossification of the distal phalanx of the thumb; enl 10 ×.

DISCUSSION

A number of authors have dealt with the histogenesis of bones and the early stages of development of the human skeleton [5, 8, 10–12]. The development of the skeleton at an early gestational age has been assessed in many different ways [6, 9, 13]. Mayer and O'Rahilly [9] examined the hands and feet of human foetuses in the 3rd month of gestation using the 3 main techniques of staining with alizarin red, preparing a series of histological specimens of bone sections and the radiological method. They recommended histological techniques as the most appropriate for the assessment of the early stages of ossification. Mall [7] described the ossification of various bones, including the bones of the hand, in embryos in the first 100 days of foetal life. He observed that the 2nd and the 3rd metacarpal bone are formed at the same period and all 5 bones can be distinguished from the 64th day of foetal life. He also found that the phalanges appear first before any other bones of the hand. O'Rahilly at al. [15], describing the phases of ossification in the hand, claimed that the only points where ossification can clearly be seen during foetal life are the ends of the distal phalanges. Mall's findings [8] confirmed O'Rahilly's observation in this respect. Mall stated that ossification starts at the distal ends of the phalanges, not in the middle of the shaft, as with other long bones. This process progresses only in one direction — medially. The early ossification of the distal phalanges was also noticed by Garn and Burdi [4], who examined the process mainly on male foetuses. The timing and sequence of the skeletal development of the hand presented by O'Rahilly and Gardner [12] as well as by Mall [8] are consistent with our observations. However, our examinations showed a slightly different process of ossification of the phalanges in the thumb.

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