

**ULTRASOUND EXAMINATION OF THE WRIST IN ORDER TO DETERMINE BONE
AGE OF HEALTHY CHILDREN (AGES 0-7 YEARS)**

Preliminary report

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Abstract

The authors introduce a new method for determining bone age based on the US examination of the wrist. In addition to the technical description the ultrasound-anatomy of the carpal region and the changes in the course of growth are outlined. The time of appearance of the ossification centers and the size of the those present are arranged in tabular form.

Key words: ultrasound, bone age, wrist.

X-ray of the wrist is still a routine examination in pediatric radiology. It provides valuable information regarding ossification and growth. In case of many pediatric clinical conditions - as endocrine disturbances, rickets, surgical and orthopedic diseases - the examination is justified. Among the numerous recommended procedures to determine bone age the Greulich (GP) and the Tanner-Whitehouse methods are the most widely used methods [1,2,6,10]. We developed a new method in which the ossification centers of the wrist were examined by ultrasound and their longitudinal and transverse diameters were measured.

The goal of our examinations was to obtain a picture of the age- dependent and quickly changing normal anatomy.

As a result of more than 2 years of work we set our recommended examination standard and summarized the numerical data (average in mm) characteristic to the normal population in tabular form.

Subsequently this can serve as a basis of screening for ossification disorders, determination of the delay and progression of bone age, following up rickets changes and the effectiveness of treatment [12].

Patients and method

The wrist of 423 children were examined by ultrasound. Patients suffering from chronic diseases (as malignancy, malabsorption syndromes, etc.) and from vitamin D deficiency as well as low- birt-weight preterm infants were taken out of the data to be analyzed. Only data of healthy children who had received adequate vitamin D supply were used. In this way data of 359 patients (151 boys and 208 girls) got into the table after careful selection. They were between the neonatal period and the age of 7 years.

Examinations were performed by ATL UM-9 HDI and ATL 3000 equipments, using 10 MHz linear transducer, in sagittal and transverse planes. Documentation was made by videoprinter.

Examination technique: the child is in recumbent position, arms are by the side of the body, straight extended; palms are facing down. Examination begins in sagittal then in the transverse plane. First in dorsopalmar direction the distal part of the radial bone and the ulna then the ossification centers of the wrist and the epiphyseal centers of the metacarpo-phalangeal (MCP) joint are imaged.

Results

In our publication results of 2 years were summarized. Width of the calcification zone, the carpal bones and ossification centers present, the epiphysis of the radius and the MCP joints as well as the greatest longitudinal and transverse diameters of the epiphyseal cartilage of the radius were measured.

Datas are summarized in tables I-II. Similarly to the radiography of the wrist used nowadays the same parameters can be determined by ultrasound. The time of appearance of the ossification centers, the changes of their number and size can be observed.

Discussion

The growth of bones decisively happens by the enchondral type of ossification. The growth-zone can be divided into 3 parts (going from the epiphyseal ossification center):

- zone of chondral proliferation / proliferating cartilage zone
- zone of chondral degeneration / degenerating cartilage zone
- zone of calcification

The enchondral type of ossification gives a well-known picture on the radiography of healthy children's wrist. The metaphyses of the radius and the ulna, the calcification stripe and the calcified ossification centers are well visible. In case of normal ossification the calcification zone is shown

intensively with clear contour. The appearance and size of the ossification centers are characteristic to the age. Many publications study this fact [2,4,8]. Among these the GP method is prompt and easily applicable, while the Tanner-Whitehouse method is more time-consuming, but more accurate as well.

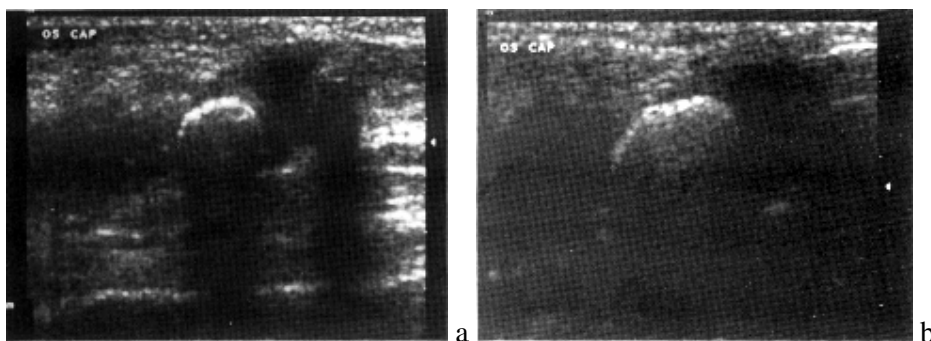
There were publications [7] about ultrasonic determination of bone age that was based on the measurement of the femur's epiphyseal cartilage, but this method was not considered to be as accurate as required by the authors partly because only one epiphysis was examined.

Our method is based on the examination of several ossification centers simultaneously just as the radiography of the wrist, on the other hand there is no radiation exposure.

We haven't found any publication about methods using ultrasonography of the wrist in order to determine bone age.

Our method makes it possible to examine and measure the same ossification centers as on the currently used radiography of the wrist [11]. The depicted calcification zone and the contour of the ossification centers can be examined, the width of the calcification zone and the longitudinal and transverse diameters of the ossification centers can be measured.

Our experiences show that the contour of the appearing ossification centers due to their less calcium content are not perfectly clear, thus the measurement is not completely accurate but on the other hand the time of their appearance can be depicted, that is crucial in determining exact bone age. The longitudinal and transverse diameter of the larger (around 2 millimeters) ossification centers can be measured properly. The smaller ossification centers are still round and the longitudinal and transverse diameters are nearly the same. The change of form and various difference between the longitudinal and transverse diameters that develops with age can be well visualized (Fig. 1.).



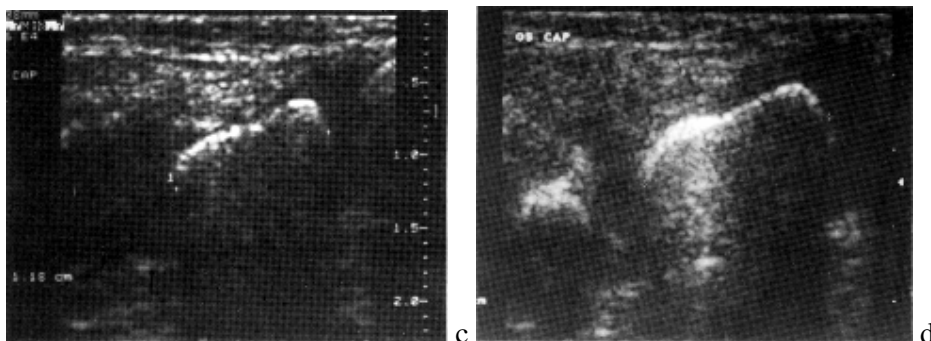


Fig. 1: US sagittal scan of the os capitatum: a, 18 month old girl; b, 27 month old girl; c, 41 month old boy; d, 60 month old girl.

Conclusion

With proper experience ultrasonography of the wrist can be an accurate method for determination of bone age that is easy to carry out. Considering that it is based on the simultaneous measurement of several ossification centers it has an advantage over every method that tries to study skeletal maturation by examining only one ossification center. At the same time in contrast to the conventional method based on the X-ray of the wrist it doesn't require radiation exposure. In our opinion this method is a remarkable one that is becoming more precise in analyzing more cases - in many instances it can be a substitute for conventional radiography.

Supported by grant "OTKA". T. 019 245

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