STUDY OF THE CORRELATION BETWEEN FETUS AGES AND OSSIFICATION CENTER OF ATLANTO-AXIAL VERTEBRAE USING MRI

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Introduction: The malformation of the spine is one of the most common congenital malformations and its pathological changes are associated with many diseases[1]. Therefore, the development of spine is an important part in the prenatal routine examination. The better understanding of the spine development process could be a reference for abnormal prenatal disease detection. Previous studies mainly relied on ultrasound and X-ray equipment[2]. The advantages of ultrasound make it became the first choice for screening in the clinical examination. However, its low tissue contrast and low spatial resolution do not meet the requirements of clinical diagnosis. On the other hand, X-rays, with the risk of radiation, can only distinguish the ossification center of spine. As a non-invasive, radiation-free technique, MR has become a popular tool for assessing and monitoring fetal development. But currently, the question of when the ossification center of atlanto-axial vertebrae appears and could be detected by MR in human fetuses hasn't been fully answered yet. In order to address this question, we used the three-dimensional T2-weighted MR imaging technique to investigate the development process of ossification center in postmortem fetuses.

Materials and method: 29 post-mortem fetuses with normal anatomical structures (gestational ages: 16~40weeks) were collected from hospitals of Shandong Province. The MR images were collected on a MAGNETOM Skyra 3T MR scanner (Siemens Healthcare, Erlangen, Germany) with 32-channel head coil. The whole spine of each fetus was scanned by using T2-SPACE with the following parameters: TR/TE 13.95/5.2ms, Flip angle=30°, FOV=220x220mm^2, slice number=128, matrix=512×512, number of excitations=2, voxel size=0.4×0.4×0.4mm^3. Then the 3D T2-weighted MR images were reconstructed in three orthogonal views so that the ossification centers could be observed from different views. The candidate regions for detecting the development of the ossification centers include: lateral mass, anterior and posterior arch of the atlas, centrum, neural arches and the dens of the axis. Three experienced anatomists reviewed all images and reported independently.

Abbreviations: pAA (posterior arch of atlas), aAA (anterior arch of atlas), VAOC (Vertebral arch ossification center), VBOC (vertebral body ossification center), OOC (odontoid ossification center), LMOC (lateral mass ossification center), CAT (cartilage).

Results: During the development of fetus, atlas and axis consist of four ossification portions. The ossification center of C1 lateral mass could be detected on MR images as early as 16 weeks of gestational age (GA). The anterior and posterior arches are completely cartilaginous even at the end of the fetal stage (Fig.2). The ossification center of centrum and neural arches of the axis could be found as early as 16 weeks of GA, the dens is ossified about in the 18 weeks of GA, and the appearance rate could be 100% after 22 weeks of GA (Fig.3). The synchondrosis between the dens and the axis body has not been fused at the end of fetal stage (Fig.4). The areas of the ossification nuclei increased with the number of GA.

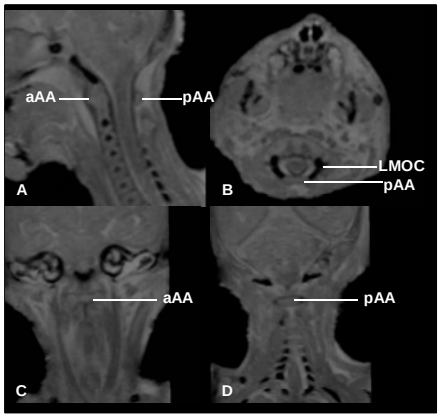

Figure 1. Sagittal (A) and Axis (B) view of Atlas and Coronal view of aAA (C) and pAA (D) of 18-week fetus

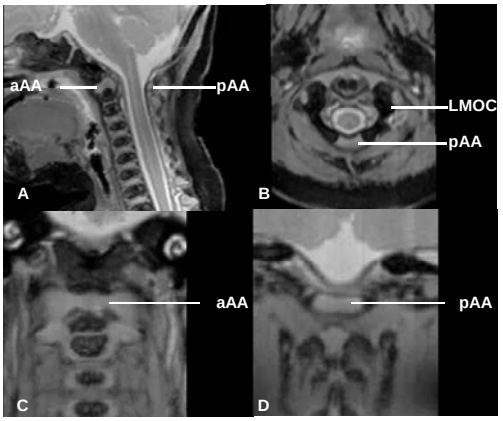

Figure 2. Sagittal (A) and Axis (B) view of Atlas and Coronal view of aAA (C) and pAA (D) of 40-week fetus

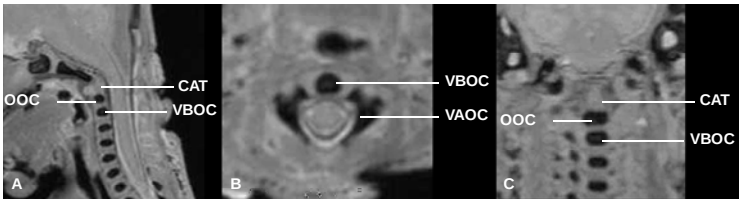

Figure 3. Sagittal (A), Axis (B) and Coronal view of axis of 24-week

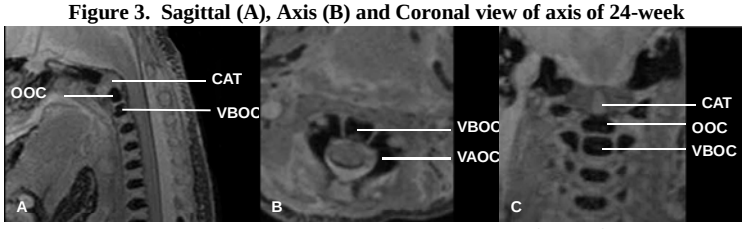

Figure 4. Sagittal (A), Axis (B) and Coronal view of axis of 34-week

Conclusions: By using a high-spatial-resolution T2-SPACE MR protocol, the changes of the ossification center of atlas and axis during fetus developing could be observed clearly. The results demonstrate the relationship between GA and the development of spine structures. The emerging time of the ossification center of the axis dens could be a good sign for determining the fetal age.

References: 1. Kaplan KM, et.al, Spine J 2005;5:564-76. **2.**Vignolo M, et. Al, Ultrasound Med Biol 2005;31:733-8.