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Diagnosis of congenital abnormalities with post-mortem ultrasound in perinatal death

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Autopsy

Abstract
Purpose: To determine the sensitivity and specificity of post-mortem ultrasound in the diagnosis of major congenital abnormalities of fetuses using conventional autopsy as the standard of reference.
Material and methods: All fetuses coming from terminations of pregnancy or intrauterine fetal deaths in a single institution were included. A total of 75 fetuses were included during the study period. The results of post-mortem ultrasound examinations were compared to those of conventional autopsy that served as standard of reference.

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Results: Gestational age of the fetuses ranged from 15 to 38 weeks gestation. A complete post-mortem ultrasound assessment was possible in all fetuses. Regarding detection of brain abnormalities, post-mortem ultrasound had a sensitivity of 81.5% or 4/5 (95% CI: 63.3—91.8%), and a specificity of 97.9% (95% CI: 89.1—99.6%). Specificities for the diagnosis of thoracic, cardiac, urinary tract, spinal and bone abnormalities were 100%.
Conclusion: Post-mortem ultrasound shows high sensitivity and specificity for the diagnosis of congenital structural abnormalities as compared to conventional autopsy, with the exception of congenital cardiac diseases.

There is currently a growing interest in providing minimally-invasive alternative techniques to traditional autopsy in adults, children or fetuses owing to falling rates of uptake of standard autopsy, with difficulties for obtaining consent or because of cultural objections [1—4]. Post-mortem imaging examinations are increasingly used in forensic medicine as a preliminary step of autopsy. In this regard, multidetector-computed tomography or conventional radiology are used to complement or substitute to complete body opening.

Fetal ultrasound, although used widely in both antenatal and neonatal contexts, is not commonly used in the post-mortem setting. Post-mortem ultrasound is therefore better suited to fetal and perinatal post-mortem imaging than pediatric post-mortem imaging. A skilled sonographer can obtain an excellent overview of the cranial contents, spine, limbs, chest and abdomen [5]. However, normal post-mortem changes in the body can cause difficulties at ultrasound, including hyperechoic abdominal and thoracic walls, gas distension of the digestive tract, and putrefaction of the subcutaneous tissues in infants [4].

As far as perinatology is concerned, there is strong evidence in the literature regarding the accuracy of post-mortem magnetic resonance imaging (MRI) [6—10]. Few reports indicate a possible use of post-mortem computed tomography—angiography (PMCTA) [11—14], and only two publications refer to the use of ultrasound [15,16], and specifically three-dimensional (3D) ultrasound [16].

The purpose of this study was to determine the sensitivity and specificity of post-mortem ultrasound in the diagnosis of major congenital abnormalities of fetuses using conventional autopsy as the standard of reference.

Materials and methods

Patients

From January to December 2014, we prospectively included fetuses, coming from terminations of pregnancy (TOP) and intrauterine fetal deaths (IUFD) in a single referral hospital. After institutional approval, we enrolled consecutive cases for which informed consent was obtained from parents to undergo both autopsy and post-mortem ultrasound. Since the study was preliminary, the only exclusion criterion was refusal from parents. Corpses were stored in the fetopathology unit at 4 °C, for not more than 60 hours before imaging.

Imaging protocol

We performed a post-mortem ultrasound using first, high-frequency linear transducers, then curved probes were used if image quality was suboptimal. We used several ultrasound devices including Aplio 500® (Toshiba Medical Systems Corporation, Tokyo, Japan, with 7—10 MHz curved and 10—15 MHz linear probes), Aixplorer® (Supersonic Image, Aix-en-Provence, France, with 6—10 MHz curved and 11—15 MHz linear probes), and Voluson E8® (GE Healthcare, Little Chalfont, UK, with 5—10 MHz curved and 10—14 MHz linear probes). Each fetus was first placed in a supine position. The probe was put in contact with gel and the fetal region of interest. Fetal brain was scanned through skull fontanels, as for neonates. Posterior fossa was approached through the sphenoid and/or posterior fontanels. Fetal chest, abdomen and pelvis were scanned anteriorly, providing axial, sagittal and possibly coronal planes. Each fetus was then placed in a prone position and scanned from neck to bottom in axial and sagittal planes, especially for kidneys, adrenals and spine. A single experienced pediatric radiologist (15 years of experience in fetal and neonatal imaging, 8 years in post-mortem imaging) performed all the post-mortem ultrasound scans blinded from the prenatal data. Total ultrasound scanning time was about 20 minutes for each fetus.

Images were acquired and interpreted trying to reproduce the pediatric radiological approach: for the liver, planes passing through hepatic veins, portal bifurcation, inferior vena cava, abdominal aorta, right kidney long axis and short axis, gall bladder; for the spleen, coronal and axial planes; for both kidneys, sagittal and axial planes; for the pancreas and mesenteric vessels: oblique axial and axial planes; for the retroperitoneum, axial and sagittal planes; for the bladder: sagittal and axial planes; for the spine: sagittal and axial planes. For each organ are evaluated size, limits, echogenicity and parenchymal differentiation.

Autopsy

Conventional autopsy was performed according to the French National Authority for Health (Haute Autorité de santé) guidelines [17], conducted by experienced perinatal pathologists, blinded to post-mortem ultrasound data. Clinical history and relevant antemortem information were available to them. The pathology procedures included external examination, open dissection and macroscopic

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