New technique for the assessment of the growth capacity and development of fetal lungs under compressive circumstances using MRI and 3D models

Nova técnica para avaliação da capacidade de crescimento e desenvolvimento de pulmões fetais sob circunstâncias compressivas utilizando RM e modelos 3D

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INTRODUCTION

Bronchial atresia is a rare condition characterized by the absence of communication between the distal bronchi and proximal airway and can affect any segment of the bronchial tract. The severity of malformation is related to the site of obstruction of the proximal airways. Segmental obstruction affects a small volume of the lungs and is usually related to late incidental diagnosis in children and adults(1). Obstruction of the mainstem or proximal lobar bronchus is a rare condition in intrauterine life and in neonates, in whom it causes respiratory difficulties. Such obstruction usually results in severe, lethal conditions(2). The live birth of a neonate with bronchial atresia who thrives with the anatomical repercussions of the malformation and survives the surgical treatment after birth is even more uncommon, only one case having been described.

Ultrasound is the gold-standard method for the diagnosis of bronchial atresia. However, in late pregnancy, polyhydramnios is common due to bronchial atresia-induced mediastinal deviation, which limits the accuracy of ultrasound. Magnetic resonance imaging (MRI) can be a helpful method, adding information regarding the spatial relationship between the enlarged affected lung and the adjacent organs and overcoming the limitations imposed by the increased quantity of amniotic fluid.

TECHNIQUE

Fetal MRI can improve the diagnostic accuracy of prenatal imaging, offering high spatial and contrast resolution(3). Images can also be acquired in three-dimensional (3D) sequences, which makes it possible to segment regions of interest for the planning of surgical interventions and for the counseling of parents. The 3D images acquired can be exported to external software, which can make them more comprehensible by better demonstrating the spatial relationships between malformations and the surrounding organs and tissues(4). Here, we present a case of right-sided mainstem bronchial atresia in which the images from prenatal MRI and postnatal computed tomography (CT) were used in order to demonstrate the capacity of a compressed lung to grow over the course of a pregnancy. The images presented (Figure 1) were acquired at 25 and 35 weeks of gestation by fetal MRI, performed in a 1.5-T scanner (Magnetom Aera; Siemens Healthcare, Erlangen, Germany) and in the second week of life by CT (Brilliance; Philips, Solingen, Germany) at a tube current and voltage of 30 mAs and 80 kVp, respectively. They show that the affected lung continued to grow, despite the malformation, and that the contralateral lung grew at an impressive rate, despite the compressive conditions.

The images from T2-weighted true fast imaging sequences and CT scans were exported into Digital Imaging and Communications in Medicine files. The fetus, lungs, and bronchocele were manually segmented with the 3ds Max 2019 software package (Autodesk, Mill Valley, CA, USA). The files were then transferred to the MeshLab program, version 2021.07 (Visual Computing Lab, Pisa, Italy), which was used for surface reconstruction and texture mapping, as previously described(4). The final images are shown in Figure 2.

CONCLUSION

The growth of congenital pulmonary malformations normally peaks around 25 weeks of gestation(5). Using various techniques, we have demonstrated impressive development of the normal lung in a case of mainstem bronchial...
Bronchial atresia. The software employed here allows clinical MRI and CT images to be reconstructed in 3D, and the results graphically demonstrate the capacity of the fetal lungs to develop during the second half of pregnancy even under pronounced compression and in severe conditions such as bronchial atresia.

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