Fetal MRI to assess fetal airway obstruction
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Objective
Fetal MRI is being increasingly employed as an adjunct to ultrasound imaging, including for cases were fetal airway obstruction is suspected. There are a number of case reports and case series suggesting that MRI is helpful in assessing the airway and novel sequences such as cine-MRI and image processing techniques such as virtual bronchoscopy have been described. However, no objective assessment of MRI performance in airway evaluation has been reported. This study aims to assess MRI and compare to ultrasound in evaluating airway patency.

Methods
25 fetuses with suspected airway obstruction due to mass or atresia imaged at one of two fetal medicine units with both ultrasound and MRI were included. Two paediatric radiologists independently reviewed each MRI and assessed a number of parameters regarding the airway, lungs and a mass if present. Fetal medicine clinicians reviewed images and reports of the most detailed ultrasound scan available and the ultrasound closest in time to the MRI. Clinical data was retrospectively reviewed from patient records. Inter-observer variation of MRI findings, agreement with ultrasound findings and agreement with clinical outcome were assessed using a Kappa score for agreement for categorical parameters. The significance of the difference between continuous variable parameters between fetuses which went on to have difficult airways and those that did not were assessed using a t-test.

Results
Inter-observer agreement was very good for presence of flow artefact close to the mouth which was seen in 8 / 25 MRIs and the presence of fluid in the mouth / pharynx which was seen in 15 / 25 MRI. In 22 / 25 MRI there was an overall subjective impression that the mouth & pharynx were accessible with perfect agreement. A continuous fluid column in the airway was identified in 10 / 25 with good inter-observer agreement (Kappa 0.84) however, the minimal internal diameter of airway was measured at average 2.0 mm with wide variation between observers ranging from 0 – 47% difference between observers. The airway was subjectively assessed as being displaced in 6 with perfect agreement however attempts to quantify this using the ‘tracheosophageal displacement index’ resulted in very high inter-observer variation, with difference in measurements ranging from 8% to 200% with a mean of 75%. The lung volume could be assessed for 23 / 25 MRIs, the mean volume was 65cm3 with mean difference in measurements between observers of 17% and a maximum difference in measurement of 37%. 19 masses were evaluated. Volume measurements were in better agreement than single largest diameter in axial plane or single longest measurement in longitudinal plane. Overall the airway was subjectively assessed to be difficult to manage (not intubateable) in 15 / 25 with very good agreement (Kappa= 0.83). Clinical follow up data was available for 14 fetuses with neck masses. 8 of these required fetoscopic procedures to facilitate later airway management or had a complicated airway at birth (difficult intubation or tracheostomy placement). Of this group of 14 fetuses, based on the MRI, 8 were thought to have an airway which would be difficult to manage. Agreement between MRI and US was poor with only 56% of the observations agreeing (Kappa= 0.18). Agreement between MRI and the clinical outcome was also poor with agreement in 54% of observations. Agreement between ultrasound assessment and clinical outcome was also poor with agreement in only 44% of observations. Regarding assessment of accessibility to the mouth and pharynx, agreement between MRI and ultrasound was moderate (Kappa 0.435), however there was poor agreement between the MRI and the clinical outcome with only 50% of observations agreeing (Kappa 0.08). There was also poor agreement between MR and clinical outcome for presence of flow voids at close to the mouth and tracheal displacement. The MRI observed to expected lung volume was significantly larger (149%) for the in fetuses requiring fetoscopic procedures to facilitate airway management or who had a complicated airway at birth than those that did not (49%) (p = 0.02). There was no significant difference in mass size.
Conclusion
With regards to assessing airway patency there are numerous objective measurements and subjective assessments that can be made from the MRI. The inter-observer variation varies from good for subjective assessments to large when small structures at the limits of MRI resolution are measured. However, agreement with ultrasound findings and with clinical outcome is poor. MRI has a role for mass assessment, however this days suggests it is not useful for the assessment the airway itself.