Assessment of Fetal Lung Development by In Utero Magnetic Resonance Imaging

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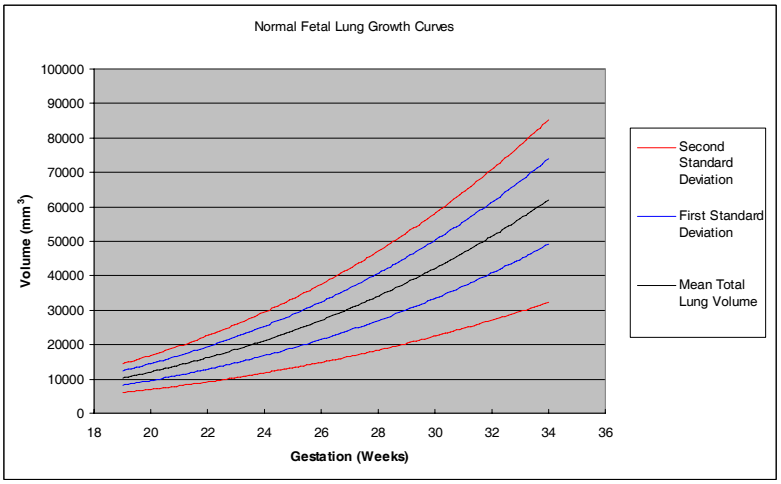
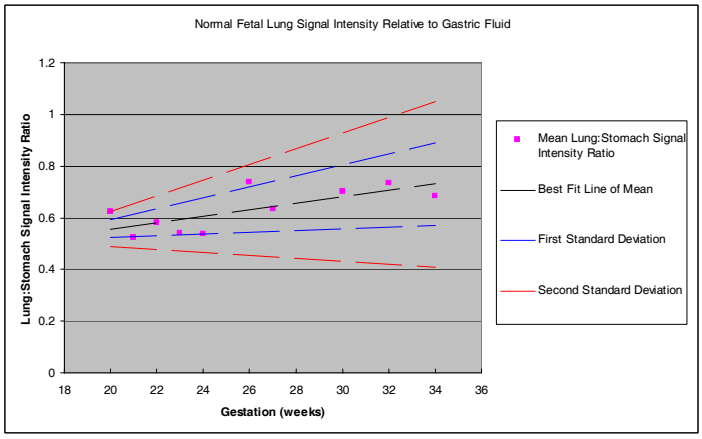
Purpose: To assess the feasibility of using in utero magnetic resonance imaging for the detection of normal fetal lung physiological development, and so provide a basis upon which a non-invasive technique of fetal lung maturity measurement can be further explored. This study aims to establish the normal range of total lung volume and magnetic resonance signal intensity for fetuses in the second and third trimesters.

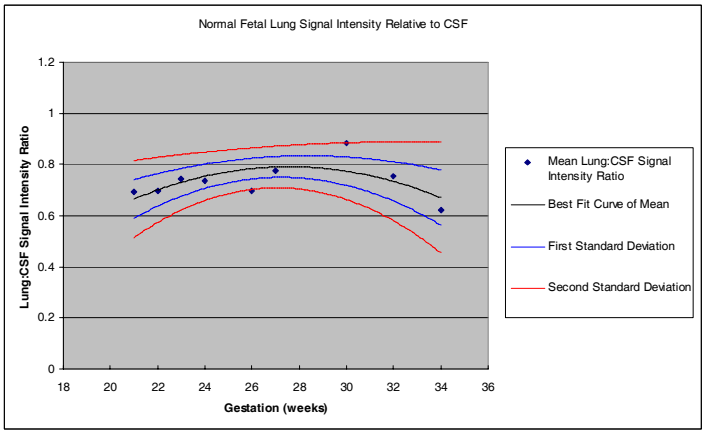
Methods and Materials: 273 measurements of fetal lung volume were obtained using a planimetric technique from 104 in utero MRI scans, with a range of gestational age from 19 to 35 weeks. 151 measurements of fetal lung signal intensity were obtained relative to both fetal cerebrospinal fluid and fetal gastric fluid, from a total of 51 scans using a T2 weighted single shot fast spin echo technique.

Results: Normal mean total lung volume V was fitted to a power curve $V=1.43G^3$ mm^3 (R^2 = 0.90), where G is gestational age in weeks. The first and second standard deviations were calculated to lie approximately 25% and 50% above and below this mean volume. The potential error associated with a single measurement of total lung volume was estimated to be in the order of 20%.



Signal intensity ratios showed large variations between scans, but also between slices of the same scan. Underlying trends were detected indicating a slight rise in lung signal intensity relative to gastric fluid from 19 to 35 weeks, and a rise in lung signal intensity relative to CSF in late second trimester which falls again in early third trimester, but these did not reach statistical significance.





Conclusion: Fetal lung volume measurement by planimetry proved to be a reproducible technique with satisfactory levels of normal variability and measurement error to permit construction of normal growth curves. The technique used to measure fetal lung signal intensity however proved to be of low precision, and no statistically significant variations with gestational age were found. Although the underlying trends detected for lung signal intensity relative to fetal cerebrospinal fluid and fetal gastric fluid could reflect changes in fetal lung fluid composition and parenchymal development, confirmation of this would require a more robust technique of signal intensity measurement.