Predicting Lung Volumes Using Dynamic MRI in Duchenne Muscular Dystrophy and Unaffected Controls

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INTRODUCTION

- DMD is a fatal X-linked disorder, affecting 1 in every 5,000 male births.
- A mutation in the DMD gene totally precludes dystrophin production, a protein responsible for bridging the intracellular actin cytoskeleton to the extracellular matrix, helping muscle cells withstand contraction forces. The protein is found primarily in skeletal and cardiac muscles.
- Cardiac and respiratory muscles are affected in DMD. Fibrosis and fatty infiltration occurs in affected muscle groups.
- Respiratory failure is a major cause of death among individuals, secondary to cardiomyopathies.
- Ventilatory aids and the use of corticosteroids have ameliorated symptoms and expanded life expectancies, though clinical tests point to a sustained functional decline in lung capacities after the loss of ambulation occurs.
- AIM: Given that there is much yet to learn about respiratory impairment in the DMD population, aside from what can be gleaned from clinical tests such as FVC measurements, MRI scans presents a novel way of non-invasively imaging different muscle groups that may be implicated in the disease progression. Unlike clinical tests which provide limited information concerning why or what muscles are involved, MRI scans can yield data regarding chest expansibility and diaphragm function. Thus, we are trying to determine if 2D MRI scans of lung area can accurately measure volumes in 3D systems.

METHODS

- DMD Participants: 10/33 ambulatory, 29/33 using corticosteroids (32 Channel Cardiac Coil Used)
- 2D Scans were taken in the sagittal plane of the right lung. The slice was placed in lung apex, and angled to cross the middle of the lung’s base. 150 frames were acquired over ~30 seconds → ~5 frames/ second. Images were obtained during normal free breathing, generating tidal volume (TV) and functional residual capacity (FRC) data, and during maximum inspiration/expiration.
  - Slice Thickness = 8mm; Resolution = 1.8mm x 1.8mm.

- 3D scans were taken in the transversal plane, starting under the lungs and ending just above the apex → multiple cross-sectional slices. Black Blood scans were taken during normal free breathing, while breath hold scans occurred during maximum inspiration/expiration and lasted ~12 seconds.
  - Black Blood Slice Thickness = 6mm; Resolution = 2mm x 2.5mm.
  - Breath Hold Slice Thickness = 8mm; Resolution = 2mm x 2.3mm.
  - MRI scans were later traced on OsirX to generate 2D area and 3D volume data.

RESULTS

- A Comparison of 2D Area and 3D Volumes Between Control and DMD Participants:

CONCLUSION

- Analysis of control data indicates strong correlations between multiple 2D areas and corresponding 3D volumes, suggesting that 2D scans may be used to infer 3D values.
- The same correlations among DMD participants were not as strong as those of the controls, though still positive. This may be due to the fact that boys with DMD have different lung and rib cage morphology.
- More exploration is needed into why the relationships are not as strong in DMD participants as in controls.

REFERENCES