Editorial for issue 9#3

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There are times when an article appears in a journal that is of major interest to readers of *Spine Deformity*. Recently an article on a technique for measuring lung volume appeared in *Radiology* “Quantitative Dynamic Thoracic MRI: Application to Thoracic Insufficiency Syndrome in Pediatric Patients”. This could not be reprinted in the journal, so we obtained permission to publish the abstract and link to the article.

Below is the abstract with a commentary by Dr. Greg Redding.

Tong Y, Udupa J K, McDonough J M, et al. Quantitative Dynamic Thoracic MRI: Application to Thoracic Insufficiency Syndrome in Pediatric Patients. *Radiology* 2019, 292:206–213

Abstract

Study design

Retrospective cohort study.

Objectives

To evaluate the use of quantitative dynamic MRI to depict changes in regional dynamic thoracic function before and after surgical correction of thoracic insufficiency syndrome (TIS).

Summary of background data

Available methods to quantify regional dynamic thoracic function in TIS are limited.

Methods

Images from free-breathing dynamic MRI in pediatric patients with TIS (July 2009–August 2015) were retrospectively evaluated before and after surgical correction using vertical expandable prosthetic titanium rib (VEPTR). Eleven volumetric parameters were derived from lung, chest wall, and diaphragm segmentations, and parameter changes before versus after operation were correlated with changes in clinical parameters. Paired analysis from Student’s *t* test on MRI parameters and clinical parameters was performed to detect if changes (from preoperative to postoperative condition) were statistically significant.

Results

Left and right lung volumes at end inspiration and end expiration increased substantially after operation in pediatric patients with thoracic insufficiency syndrome, especially right lung volume with 22.9 and 26.3% volume increase at end expiration ($P=0.001$) and end inspiration ($P=0.002$), respectively. The average lung tidal volumes increased after operation for TIS; there was a 43.8 and 55.3% increase for left lung tidal volume and right lung tidal volume ($P=0.001$ for both), respectively. However, clinical parameters did not show significant changes from pre- to post-treatment states.

Thoracic and lumbar Cobb angles were poor predictors of MRI tidal volumes (chest wall, diaphragm, and left and right separately), but assisted ventilation rating and forced vital capacity showed moderate correlations with tidal volumes (chest wall, diaphragm, and left and right separately).

Conclusions

Vertical expandable prosthetic titanium rib operation was associated with postoperative increases in all components of tidal volume (left and right chest wall and diaphragm, and left and right lung tidal volumes) measured at MRI. Clinical parameters did not demonstrate improvements in postoperative tidal volumes.

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Commentary

An important article was published in Radiology in 2019 that pertains to children with early onset scoliosis [1]. The authors have devised an analytic program that measures the relative excursion of the chest wall and diaphragm using dynamic MRI images during tidal breathing. This is an important advance as it addresses the three-dimensional structural changes in the thorax in children with spine deformities over time, i.e. a four-dimensional analysis. The authors have confirmed previous findings that insertion of distracting growth friendly devices (only VEPTRs in this report) increase intrathoracic lung volumes when breathing at rest [2]. The presence of asymmetric lung function between the left and right lungs has also been reported previously [3]. However, they also report on increases in tidal volumes after spine surgery, particularly in the right lung and primarily due to improved diaphragm excursion. An increase in tidal volume might have been accompanied by a reduced respiratory rate, but respiratory rate at rest did not statistically decline 18 months after surgery. The change in tidal volume did not correlate with changes in forced vital capacity but that should not be surprising, as vital capacity measures ventilatory reserve rather than moment-to-moment breathing patterns at rest. An increase in tidal volume at rest is an important finding as humans breathe in patterns that minimize respiratory work. We can infer from these results that perhaps work of breathing was reduced with surgical intervention as children chose to breathe more deeply at rest. The article has its limitations as children < 5 years old were sedated and received positive pressure ventilator support, which does not reflect their inherent breathing efforts. It is unclear from the article how many children were passively ventilated during the MRI procedure.

This does not diminish the potential advance that dynamic imaging without radiation exposure may introduce. Early onset scoliosis is associated with reduced chest wall excursion and spine fusion may aggravate this problem [4].

Maintaining mobility of the chest wall and the diaphragm is a worthy therapeutic goal and by studying different surgical strategies and perhaps devices at different times in the treatment journey of these children, we may become much more precise in the timing and sequence of our current surgical treatments. Age limitations still persist in evaluating children too young to cooperate. However, this new technology brings together structure and respiratory function of different regions of the lung, spine, and thorax more completely than previous imaging techniques. It is a welcome new tool in our armamentarium which has been limited to date.

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