The relative impact of respiratory muscle activity on tidal flow and lung volume in infants
Hutten, G.J.
Chapter 3

Cross talk of respiratory muscles. It is possible to distinguish different muscle activity?

Gerard J. Hutten, Leo A. van Eykern, Jan M. Cobben, Wim M. C. van Aalderen

Department of Pediatric Pulmonology, Emma Children’s Hospital, University Hospital,
PO Box 22.660, 1100 DD Amsterdam, The Netherlands

With great interest we have read the paper from Nobre and colleagues that was recently published in Respiratory Physiology & Neurobiology. In their paper the authors have described a study in which they have analyzed regional pulmonary ventilation and electromyographic (EMG) activity of respiratory muscles during an inspiratory muscle endurance test in 10 young women. Regional pulmonary ventilation was measured with a radioaerosol (99mTc-DTPA) and was compared with EMG activity from the muscles of the lower rib cage. The findings of the authors suggest that the inspiratory muscle endurance test is associated with a greater radioaerosol deposition in the medium third and intermediate and central segments of the lower rib cage and with increase in respiratory EMG activity of the lower rib cage.

Unfortunately, it is not clear what the authors exactly mean by “EMG activity of the lower rib cage”. EMG activity of the lower rib cage contains activity of intercostal muscles, diaphragm (frontal and dorsal) and, last but not least, abdominal muscles. For many investigators it appeared to be difficult to distinguish the separate signals from these three different muscle groups. This phenomenon is referred to as cross talk of the respiratory and abdominal muscles.

In an earlier study in school children with asthma, we showed that it is possible to distinguish the EMG signals from intercostal muscles and from the diaphragm and that with increasing airflow limitation the signal of the intercostal muscles becomes more prominent. Methods of measuring were in detail published elsewhere. However, the discussion on cross talk of respiratory and abdominal muscles continues.

Recently, we had an opportunity for diaphragmatic EMG studies in a child with a rare condition, Spinal Muscular Atrophy with Respiratory Distress type I (SMARD1).

A 3.5 month old girl was admitted to our hospital because of progressive dyspnoea and tachypnea. She was the second child of healthy consanguineous parents, first cousins.
From birth on she had a weak cry and generalised hypotonia resulting in feeding difficulties. In the first few months dypsnoe and tachypnoea became evident. At the age of 3.5 months a diaphragmatic hernia was diagnosed and surgically corrected in our hospital. After this operation she became and stayed dependent on artificial ventilation. Muscle biopsy of the quadriceps muscle at the age of 4.5 months showed neurogenic atrophy. DNA analysis of the SMN1 gene did not show a homozygous deletion, but DNA analysis of the IGHMBP2-gene revealed a homozygous pathogenic missense mutation: c499+1G>T. The diagnosis SMARD1 was thus proven. The girl died at the age of 7 months of respiratory insufficiency.

At the age of 4.5 months ultrasound of the diaphragm had showed reduced movement of the right diaphragm and no movement of the left diaphragm. EMG measurements of the diaphragm showed no electrical activity of frontal and dorsal diaphragm (Fig 1a), while activity of both intercostal and abdominal muscles was clearly demonstrated. Interestingly, the peak activity of the intercostal muscles coincides with the trough value in the EMG of the abdominal muscles indicating that air flow is produced by alternating activity of these muscle groups. Fig 1b shows respiratory muscle activity of a healthy girl of the same age, without any respiratory distress. The reading shows hardly any intercostal muscle activity, normal diaphragmatic activity (frontal and dorsal) and hardly any abdominal muscle activity.

This case clearly and elegantly illustrates distinguishing the EMG activity of abdominal muscles and the diaphragm.

More detailed information about the role of the different respiratory muscles may enhance the insight of muscle mechanics during different respiratory performances in health and disease.
Figure 1

Figure 1a shows electrical activity of muscles of the infant with SMARD1; there is no activity of the frontal and dorsal diaphragm. Figure 1b shows the electrical activity of a healthy infant, with a normal function of the diaphragm; there is no activity of the abdominal muscles, the detectable (positive) electrical activity in the abdominal readings is cross talk of the diaphragm.
References


