Title: EFFECT OF SPINAL ANESTHESIA ON CHEST WALL DISPLACEMENTS IN INFANTS

Authors: R.C. Pascucci, M.D., M.B. Hershenson, M.D., N.F. Sethna, M.B. and A.R. Stark, M.D.

Affiliation: Departments of Anaesthesia and Pediatrics, Harvard Medical School, The Children's Hospital, Boston, Massachusetts 02115.

INTRODUCTION. It is likely that the volume response to CO_2 in infants depends on rib cage muscle activation.[1] The role of the intercostal muscles in expanding the rib cage during tidal breathing, however, is less clear. Rib cage expansion may result from either (a) recruitment of the intercostal muscles, or (b) the appositional and insertional effects of the diaphragm on the rib cage.[2]

During spinal anesthesia, motor activity of the intercostal muscles, but not diaphragm, is decreased. If spinal anesthesia decreased outward thoracic displacement during inspiration, rib cage expansion could not solely be the result of passive movement of the rib cage by the diaphragm, but must be a consequence of inspiratory rib cage muscle activity. We therefore examined the effect of spinal anesthesia on chest wall displacements in awake infants.

METHODS. After informed parental consent, 7 unpremedicated infants, (postnatal age 12±5 weeks, weight 2.8±1.3 kg, mean±S.D.) were studied. All were born prematurely (gestational age 25-33 weeks); two had chronic lung disease. All received spinal anesthesia as the sole anesthetic for inguinal hernia repair.

Spinal anesthesia was induced using a hyperbaric mixture of 1.0-1.2 mg/kg tetracaine with 40 mcg of epinephrine. Sensory level was monitored using a standardized train of four stimulus. Respiratory rate, heart rate, blood pressure, O_2 saturation of hemoglobin (FiO_2 = 0.21, pulse oximeter) and rib cage and abdominal displacements (respiratory inductive plethysmography) were monitored with infants awake in the supine position, both before and 10 minutes following tetracaine administration. Rib cage bands were placed around the upper thorax just under the axillae, and abdominal bands were placed at the level of the umbilicus. Data were recorded on a tape recorder and polygraph. Rib cage vs. abdomen respiratory loops were displayed on an oscilloscope. We analyzed 30 seconds of tidal breathing both before and during spinal anesthesia, excluding sighs and body movements. An unpaired t test was used to make within-subject comparisons of inspiratory rib cage movement. Group comparisons were made using a paired t test.

RESULTS. All anesthetics were administered without complication. A sensory level of T2-T4 was achieved in each infant. Spinal anesthesia had no effect on respiratory rate (control, 71±27 breaths/min.; spinal, 59±20 breaths/min., NS), heart rate (control, 158±10 beats/min.; spinal, 158±17 beats/min, NS) or hemoglobin saturation (control, 98±3%; spinal, 98±2%). Systolic blood pressure decreased signficantly (control, 84/46 mmHg; spinal, 74/39 mmHg; $p<0.05$).

Prior to spinal blockade, the rib cage moved outward during inspiration in 6 of 7 infants. Spinal anesthesia decreased inspiratory movement of the rib cage in all 6 of these infants ($p<0.001$, paired t test, Table). In 4 of these 6 infants, spinal anesthesia induced paradoxic (inward) rib cage movement during inspiration, as demonstrated by rib cage vs. abdomen respiratory loops (Figure).

DISCUSSION. Spinal anesthesia was performed in 7 infants, without significant alteration of respiratory rate or O_2 saturation. In all but 1 infant, intrathecal tetracaine significantly reduced rib cage inspiratory movement, changing inspiratory rib cage movement from outward to inward in 4 infants.

Because spinal anesthesia reduced or abolished outward thoracic displacements during inspiration, rib cage expansion prior to spinal anesthesia could not have been the result of passive movement of the rib cage by the diaphragm. Instead, our data suggest that in supine, awake infants, the inspiratory muscles of the rib cage serve to stabilize and inflate the thorax.

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REFERENCES. 1. Hershenson, M., A. Stark, A. Colin, J. Mead. Rib cage movement limits abdominal pressure swings in newborn infants. Fed Proc 46: 513, 1987 (abstract).

2. Loring, S. and J. Mead. Action of the diaphragm on the rib cage inferred from a force-balance analysis. J Appl Physiol 53: 756-760, 1982.

TABLE. Effect of spinal anesthesia on inspiratory movement of the rib cage (mm of pen displacement). (Individual subjects are identified on x-axis; *$p<0.001$, unpaired t).

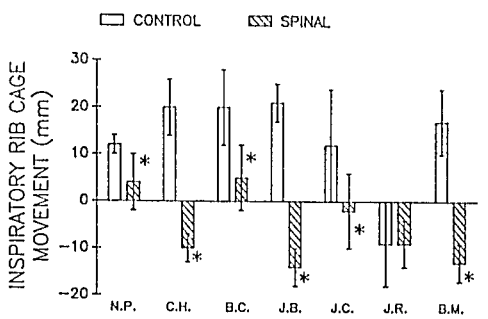

FIGURE. Typical rib cage (RC) vs. abdomen (ABD) plots before and during spinal anesthesia. (Arrows indicate direction of loops. Closed circles represent end-expiration. Small horizontal lines mark end-inspiration.)