Effect of tilting on oxygenation in newborn infants

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SUMMARY Transcutaneous (tc) PO2 in newborn infants increased on head up tilting (median increase 0·5 kPa at term, 1·0 kPa preterm). Head down tilting was associated with an equivalent fall in tcPO2. There was no change in tcPCO2. Tilting of infants mechanically ventilated for respiratory distress syndrome or surgery produced no consistent change in PO2.

Newborn infants are often nursed on a head up tilt. This study investigated whether a head up or head down tilt produced a change in PO2 and PCO2 in healthy prone newborns and in those with respiratory problems.

Patients and methods

Seventeen healthy term infants and seventeen healthy preterm infants (mean birth weight 1300 g) were studied at the Department of Neonatology, Ullevaal Hospital, Oslo. Each term infant lay prone and at least five tilts were performed. Each position: horizontal, 30 degrees head up, and 30 degrees head down, was held for five minutes before the next tilt. The term infants were studied on day one and day five in active and in quiet sleep. The preterm infants were studied on one day only and tilted 20 degrees head up in their incubators. Transcutaneous PO2 and PCO2 were measured in the interscapular region. Values were recorded every 30 seconds. Tilts associated with any body movement or change in sleep state were not included.

To investigate the possibility that tcPO2 might be influenced by changes in skin circulation from hydrostatic pressure or reflex vasoconstriction due to a baroreceptor response we measured tcPO2 from two electrodes, one in the interscapular region and one on the buttock in five infants. TcPO2 values from both sites followed each other exactly (fig 1) thus ruling out a gravitational effect on local skin perfusion.

Further studies of PO2 and head up tilting were carried out in 10 infants receiving intensive care at Hammersmith Hospital, London. Seven of these infants had an umbilical artery catheter with an oxygen electrode at the tip in the descending aorta. The remaining three infants were studied using a transcutaneous PO2 system.

Results

Fig 1 shows a typical response with PO2 rising and
Fig 1  Simultaneous transcutaneous PO₂ measurements from the interscapular site and from the buttock of a healthy full term infant during sequential tilts.

Fig 2  Transcutaneous PO₂ measurements from a full term infant through seven tilts. The sequence is indicated by the arrows.

falling with tilting head up and head down, respectively. In the term infants there was no difference between day one and day five and between sleep states. The median increase in PO₂ on tilting 30 degrees head up was 0-5 kPa (95% confidence limits 0-2 to 0-8 kPa). The decrease was similar on tilting head down (median -0.6 kPa, 95% confidence limits -0.4 to -1.0 kPa). The increase in PO₂ when tilting from head down to horizontal was the same as when tilting from horizontal to head up. The increase in PO₂ when tilting through 60 degrees from 30 degrees head down to 30 degrees head up was twice the increase observed with a 30 degree tilt (fig 2). These changes in oxygenation were confirmed by pulse oximetry. When tilting head up saturation increased on average by 2%, and it fell by 5% on head down tilt. The preterm infants increased their PO₂ on head up tilting by a median value of 1-0 kPa (95% confidence limits 0.9 to 1.1 kPa) and this was confirmed by arterial PO₂ in one case. Tilting had no effect on tcPCO₂.

One preterm infant receiving slow ventilation did show a small rise in PO₂ on head up tilting. None of the six preterm infants receiving mechanical ventilation for respiratory distress syndrome had an increase in PO₂ with head up tilting. The two full term infants, with normal lungs, who were being mechanically ventilated did not show a rise in tcPO₂ with head up tilting but did so when off the ventilator and breathing spontaneously.

Discussion

This study has shown that PO₂ in healthy term and preterm newborn infants increases on head up tilting. Tilting head up causes gravity to act on the lower zones of the lungs improving the matching of
ventilation and perfusion and slightly increasing PO₂. If the above effect were the only explanation one might expect the same or less effect in the preterm infant than in the term infant. The opposite was the case. Tilting presumably reduces the weight of abdominal contents on the diaphragm thus tending to increase functional residual capacity. If the functional residual capacity was not fully stabilised in many preterm infants in the first few days tilting would be expected to have a greater effect on it and on oxygenation in preterm infants than in term infants who stabilise their functional residual capacity early. Improving suboptimal functional residual capacity would increase PO₂.

The rise in PO₂ with tilting was not found in infants who were receiving mechanical ventilation because of respiratory distress syndrome. This may be due to stiffness of the lungs, pulmonary hypertension, or to the effects of mechanical ventilation. Any or all of these factors could overcome the relatively slight gravity dependent changes.

The observation that a rise in PO₂ with tilting was not found in two term infants with normal lungs while being mechanically ventilated could be due to positive pressure ventilation overcoming the effects of gravity on functional residual volume.

In conclusion, head up tilting increases PO₂ in healthy term and preterm infants, but it does not benefit infants ventilated for respiratory distress syndrome.

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References

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