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Congenital diaphragmatic hernia in newborn infants: Variable endotracheal tube and umbilical venous catheter positions

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LIST OF ABBREVIATIONS

CDH	Congenital diaphragmatic hernia
ETT	Endotracheal tube
UVC	Umbilical venous catheter

In fetuses with congenital diaphragmatic hernia (CDH), the herniation of abdominal contents in the chest alters the relative position of the thoracic and abdominal organs (1) and could give rise to an unusual radiographic appearance of the indwelling support apparatus [endotracheal tube (ETT), umbilical venous catheters (UVC)] (2). In this study we reviewed the radiographs of infants with CDH and reported the position of the ETT and the UVC. The preoperative chest and abdominal radiographs of infants born with CDH at King's College Hospital (KCH), London, UK were evaluated by a Consultant Radiologist (MK) and a Consultant Neonatologist (TD). The deviation of the ETT and UVC from the midline was measured with the Sectra PACS software (Sectra AB, Linköping, Sweden) at the level of the second-third thoracic vertebra for the ETT and at the level of the tenth thoracic vertebra for the UVC (figure 1). Rotated radiographs were excluded from the study. The insertion of the ETT in the trachea was confirmed with end-tidal carbon dioxide ($ETCO_2$) monitoring. The position of the umbilical artery catheter was not measured as it has been reported to be universally normal (2). The study was registered as a service evaluation with the Clinical Governance Department of KCH. From 1 January 2006 to 31 July 2018, 143 infants with CDH were treated at KCH. Twelve infants were excluded because of rotated radiographs or lack of images. One hundred and thirty-one (77 male) infants with a median (IQR) age of 36 (34-39) weeks (range 25-41 weeks) were included in the study. They had a median (IQR) birth weight of 2.68 (2.20-3.14) kg (range 0.75-4.01 kg). **Infants with left-sided CDH (n=116, 89%):** the ETT deviated to the right in 104 (90%) with a median (IQR) distance from the midline of 7 (6-10) mm (range 1-11mm), deviated to the left in six (5%) infants with a median (range) distance from the midline of 2 (1-14) mm and in another six (5%) infants the ETT did not deviate from the midline. The UVC deviated to the left in 86 (74%) with a median (IQR) distance from the midline of 16 (10-24) mm (range 1-45 mm), deviated to the right in 25 (22%) with a median (IQR) distance from the midline of 10 (3-14) mm (range 1-

30 mm) and in 5 (4%) infants the UVC did not deviate from the midline. **Infants with right-sided CDH (n=15, 11%):** the ETT deviated to the left in 12 (80%) with a median (IQR) distance from the midline of 3 (1-6) mm (range 1-8mm), deviated to the right in one (7%) infant with a distance from the midline of 1 mm and in another two (13%) infants the ETT did not deviate from the midline. The UVC deviated to the right in 12 (80%) with a median (IQR) distance from the midline of 14 (8-18) mm (range 1-37 mm), deviated to the left in two (13%) (17 and 19 mm) and in one (1%) infant the UVC did not deviate from the midline.

In conclusion, we report that in infants with CDH there is a wide variation in the radiographical position of the ETT and the UVC and the ETT or UVC can be found on either side of the midline. Predominantly, in left-sided CDH the umbilical vein is deviated to the left and the trachea to the right. Conversely, in right-sided CDH the umbilical vein is usually deviated to the right and the trachea to the left. As our results show, however, this is not a universal finding and there is significant variation in the magnitude of deviation. This knowledge is clinically important so that catheters are not removed unnecessarily as affected infants are commonly severely unwell and require central venous access, (3) but equally we hope these data may reduce reintubation or at least promote the use of $ETCO_2$ monitoring to identify correct ETT placement (4).

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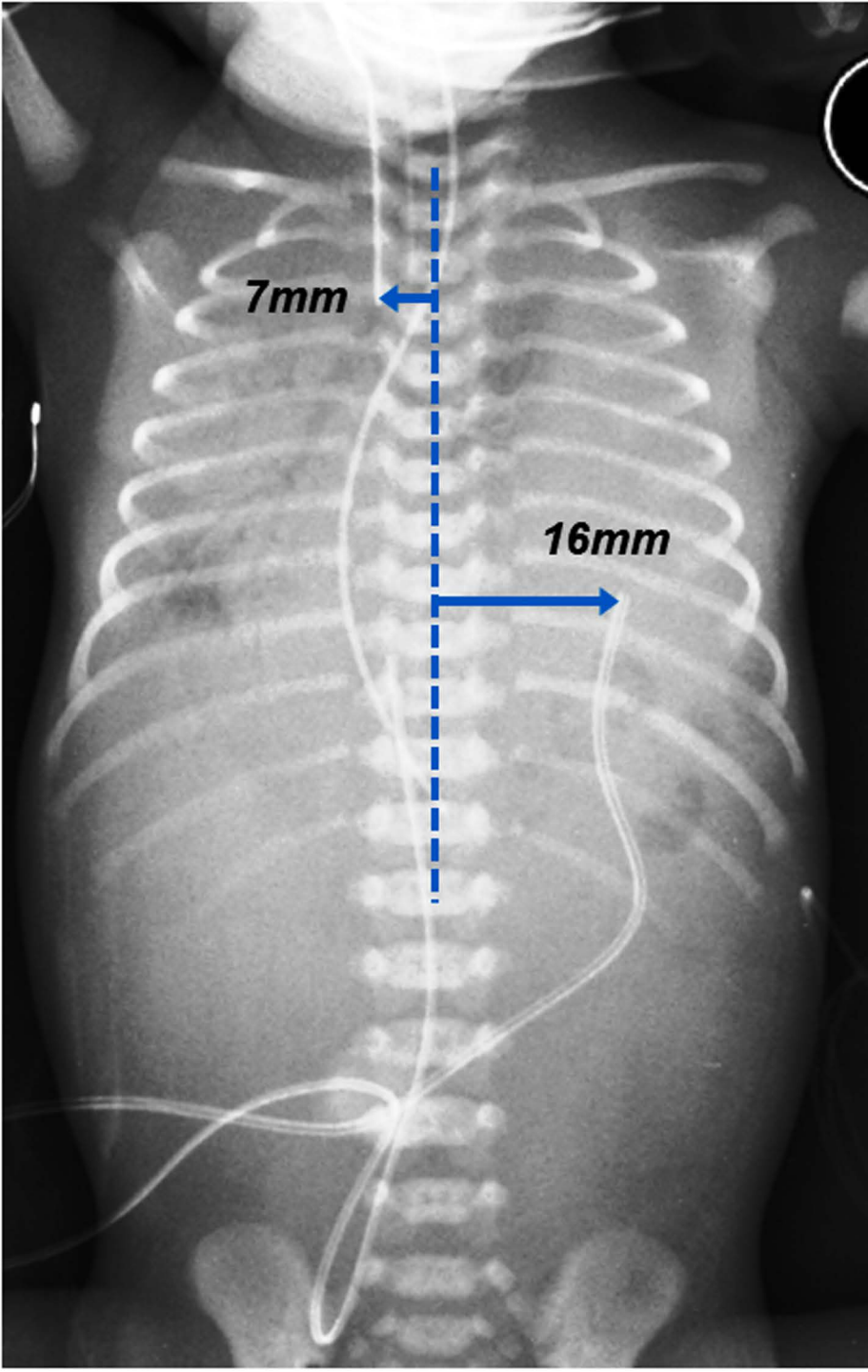
FIGURE LEGEND

Figure 1: A chest and abdominal radiograph of an infant with a left-sided CDH taken on the first day of life. The measurements of the distance of the ETT and the UVC from the midline are schematically presented along with the median values of the study cohort with left-sided CDH.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