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Hazardous Course of an End-tidal Carbon Dioxide Catheter in a Premature Infant

To the Editor:—We would like to present a brief report highlighting a potential adverse effect of end-tidal carbon dioxide monitoring in extremely low-birth-weight infants and the need for vigilance in this high-risk population.

A male infant born at 25 weeks of gestation, weighing 680 g at birth, was referred for patent ductus arteriosus ligation on day 28 of life. At surgical intervention, he weighed 1,038 g and required approximately 50% inspired oxygen and a mean airway pressure of 9 cm H_2O. Reintubation was performed with a size 3.0 endotracheal tube in the operating room because of oxygenation difficulties, and an end-tidal carbon dioxide catheter was inserted. The distal free end of a 19.0-gauge catheter (Becton Dickinson Intracath; Franklin Lakes, NJ) was trimmed by the attending anesthesiologist to a presumed length that would extend just beyond the tip of endotracheal tube tip. The catheter was then introduced through the side port of adapter in the circuit and was connected to the end-tidal carbon dioxide monitor. Surgical intervention proceeded uneventfully. The immediate chest radiograph taken 1 h after surgical intervention was reported as normal. The infant's clinical status deteriorated 9 h postoperatively, with an increased oxygen requirement to 100% and development of respiratory acidosis. He required transition to high-frequency oscillation ventilation at an increased mean airway pressure of 12 cm H_2O. A repeat chest radiograph (fig. 1) showed right upper lobe collapse, left lung hyperinflation, and a foreign body extending from the midtracheal region into the right main bronchus, where it coiled back on itself, finally terminating in a branch of the left main bronchus. An ultrasound scan of the neck region confirmed the presence of a foreign body in the trachea that had the appearance of a catheter. All clinical events in the operating room and postoperatively were reviewed, in particular the placement of any nasal or oral tubes and all suctioning episodes. Emergency rigid bronchoscopy was performed at the bedside, and a severed "distal-type" end-tidal carbon dioxide catheter, measuring 12 cm, was extracted. This catheter had been placed by the attending anesthesiologist to monitor carbon dioxide levels, because the routine proximal trace was inadequate. Although there was residual collapse of the right upper lobe, this improved with gentle physiotherapy and modified ventilation strategies. On further examination of the initial postoperative chest radiograph (fig. 2), a foreign body was identified *within* the endotracheal tube that did not extend beyond the tip.

Although neonatal foreign body management has previously been reported,[1–3] this is the first report of airway compromise as a result of a migrated end-tidal carbon dioxide catheter. The role of end-tidal carbon dioxide monitoring in neonates is debatable especially when there is hemodynamic instability.[4,5] Monitoring of end-tidal carbon dioxide is a standard practice, for general anesthesia requiring endotracheal placement, at our institution. It is routine to insert a catheter into the endotracheal tube if the trace from the proximal catheter is inadequate.

The catheter that was used in this patient was a Becton Dickinson Intracath central venous catheter (1.1 mm × 30.5 cm) made of radiopaque Vialon biomaterial with a through-the-needle introducer system with wire stylet. Becton Dickinson Vialon, a unique proprietary biomaterial, has been proven to have a lower incidence of phlebitis and is less susceptible to mechanical distortion compared with Teflon-based catheters when used for intravenous access.[6] Because these catheters are not manufactured for very low-birth-weight infants, the introducer system must be removed and the catheter must be cut to an estimated length from the mouth to midsternal region, which should approximate the end of the endotracheal tube. This catheter is then introduced through the side port of adapter in the circuit so that the hub fits snuggly inside the side port hole. It is impossible to be completely certain about causality in

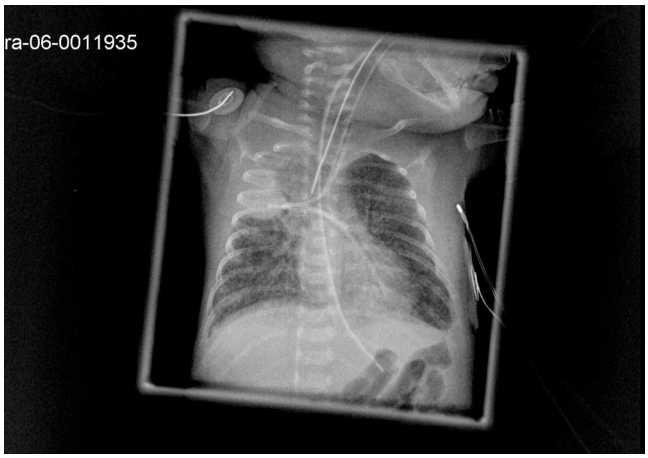

Fig. 1. Chest radiograph taken 9 h postoperatively showing right upper lobe collapse, left lung hyperinflation, and a foreign body extending from the midtracheal region and into the right main bronchus, where it coiled back on itself, finally terminating in a branch of the left main bronchus.

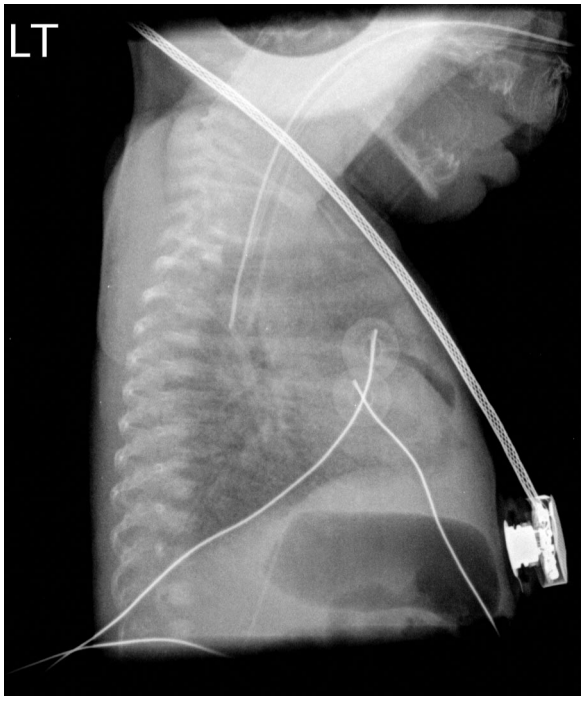

Fig. 2. The chest radiograph taken 1 h after the procedure showed the presence of a catheter within the endotracheal tube but not extending beyond the tube tip.

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this case. We speculate that the catheter may have been only partially cut before insertion, and the whole length of the catheter was then inserted through the endotracheal tube adapter. On postoperative removal, the distal segment became separated completely and was left behind within the endotracheal tube. Routine endotracheal suctioning may then have led to migration of the catheter into the distal airway. It is also possible that the catheter snapped at the junction with the hub upon removal, because this junction is usually considered a weak point. Unfortunately, there is no documentation of the length to which the catheter was trimmed before insertion to decide which mechanism was most likely.

This case demonstrates an important complication of distal end-tidal carbon dioxide monitoring in the very low-birth-weight infant and reemphasizes the dangers of using catheters that were not developed for use in this population. Because there are no custom-made catheters for this population, it does emphasize the need to ensure that if a catheter is cut, the distal end should be accounted for and appropriately disposed of. It particularly stresses the importance of measuring the length to which the catheter is cut before insertion, and the need to remeasure catheter length upon removal. It also emphasizes the need to review all aspects of the x-ray, in particular the status of indwelling tubes and line.

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Ultrasound-guided "Low Approach" Femoral Vein Catheterization in Critical Care Patients Results in High Incidence of Deep Vein Thrombosis

To the Editor:—Central venous access has traditionally been performed using puncture of a central vein, passing the needle along the anticipated line of the relevant vein using surface anatomical landmarks and by knowing the expected anatomical relation of the vein to its palpable, companion artery.[1,2] If the surface landmark technique is not helpful, ultrasonic devices are widely used to cannulate central veins. Furthermore, reports have advocated that real-time ultrasound-guided placement of central venous catheter can be achieved quickly with low failure and complication rates in critical care patients.[3]

The low femoral approach for catheterization of the femoral vein 10–15 cm below the inguinal ligament has been used for renal therapy in the intensive care unit.[4] At this point, the companion artery is not palpable, and the anatomical landmarks guiding location of the femoral vein are also absent. Therefore, when performing this technique, the use of ultrasound guidance is considered indispensable. Finally, there are no extensive data indicating whether the application of the low femoral approach may result in a lower incidence the rate of central venous catheter–associated infection and/or thrombosis as compared with the classic method of catheterization of the femoral vein, which is performed 2 cm below the inguinal ligament. Therefore, we examined the above hypothesis in a series of critical care patients.

Institutional review board approval for the investigation was obtained by the intensive care unit department of the General State Hospital and by Athens University School of Medicine, Athens, Greece. We were planning to recruit 100 patients in each group of patients over a period of 3 yr. All patients recruited in the study were admitted for trauma not involving the lower extremities and were catheterized using the same technique as previously described.[5] Patients were randomly assigned on a one-to-one ratio and stratified with regard to age, sex, and body mass index (by means of a computer table).[5] Family members provided written, informed consent for all patients. Patients were excluded from the study if they had undergone a femoral catheterization in the past; if there was a local or systemic infection, recent surgery, or hematoma in the groin area; if there was ultrasonographic and clinical evidence of deep vein thrombosis (DVT); or if there was a known anatomic abnormality, a known hypercoagulable state, or history of congestive heart failure.

Forty patients (aged 40.3 ± 10.4 yr; body mass index, 22 ± 4.1 kg/m^2; 18 female) underwent with the classic approach, and 40 patients (aged 41 ± 11.2 yr; body mass index, 22.5 ± 5 kg/m^2; 16 female; all P nonsignificant) were catheterized by the low femoral approach (10–15 cm below the inguinal ligament). Catheters were placed in both positions with the aid of ultrasound. All patients were receiving prophylactic treatment with low-molecular-weight heparin. Visualization of thrombus formation, noncompressibility of the vein, no spontaneous Doppler flow, and lack of augmentation response were used as diagnostic criteria of DVT. Central venous catheter–associated bloodstream infections were defined as only those bloodstream infections for which other sources were excluded by careful examination of the patient record, and where a culture of the catheter tip demonstrated substantial colonies of an organism identical to those found in the bloodstream.[5] The mean observational period was 40 ± 15 days. All patients were monitored every 48 h after the placement of the catheter for identification of a possible clot formation, and at the same time intervals, surveillance cultures were undertaken.

No mechanical complications were observed in the study population. There were no significant differences in the incidence of central venous catheter–associated bloodstream infections between the two groups (5 patients [12.5%] in the classic group and 6 patients [15%] in the low femoral group; $P < 0.08$). However, the incidence of DVT was significantly higher in the low femoral group compared with the classic group (13 patients [32.5%] *vs.* 4 patients [10%], respectively; $P < 0.001$). In 9 of the 13 patients of the low femoral group and in 1 of 4 patients of the classic group, the thrombus was located around the catheter and was detectable after 9 ± 4.5 days of insertion (fig. 1).

The current study was randomized but not blinded. The discontinuation criteria of this study were increased incidence of mechanical complications and/or catheter-associated DVT and/or infection. The high rate of thrombosis observed in the low femoral group of patients was alarming; hence the monitoring board, comprised of intensive care unit physicians, and the institutional review board have decided to

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