Using Lateral Radiographs to Determine Umbilical Venous Catheter Tip Position in Neonates

Abstract:
G Butler, N Al-Assaf, A Tarrant, S Ryan, A El-Khuffash
Department of Neonatology, Rotunda Hospital, Parnell St, Dublin 1

We aimed to assess the difference in measurement of the distance of the UVC tip from the diaphragm between (Anteroposterior) AP and lateral radiographs and to determine the reliability of the measurement of UVC tip distance from the diaphragm between the two views. A retrospective review of paired AP and lateral radiographs taken to assess UVC tip position was carried out in 25 infants. The study included infants who required an umbilical venous catheter (UVC) insertion for vascular access for neonates in the first few days of life for administration of parenteral nutrition, fluids and medications. The ideal position of the UVC tip is in the right atrium (RA)/atrio-venous (AV) junction just above the diaphragm. There is evidence that lateral radiographs provide a clearer view of the peripherally inserted central catheters (PICC) than AP films. In our unit, we introduced into our clinical practice lateral radiographs in addition to AP to determine UVC tip position in relation to the diaphragm. In this study, we aimed to determine the intra- and inter-observer reliability of the measurement of UVC tip distance from the diaphragm between the two views.

Methods
Any infant requiring an umbilical venous catheter between November 2012 and March 2013 was eligible for inclusion. Anteroposterior and lateral radiographs were performed on infants following insertion of umbilical venous catheters. All radiographs were scored by an observer who was blinded to the catheter tip position recorded on the fluid charts. The observer assessed the perpendicularity of the catheter tip to the diaphragm when viewed on the lateral radiograph. The catheter tip position was determined on the AP and lateral radiographs using the ruler function and measurement were performed offline using Fujifilm, Synapse (PACS software version 5.1.24-9). The ruler function used the same monitor and views were optimized by adjusting window level and image magnification to improve accuracy of measurements. Measurements were calculated two weeks apart by one observer to assess intra-observer reliability and avoid recall bias. A second observer performed a set of measurements as an intra-observer repeat measurement to improve the accuracy of measurements. Intra-observer and inter-observer reliability was accepted if the intraclass correlation coefficient (ICC) version 2.1 > 0.8 and the 95% limits of agreement were < 10 mm. Results are expressed as mean ± standard deviation (SD) if normally distributed and median [inter-quartile range] if skewed. Means were compared using a paired t-test. Intra- and inter-observer reliability analysis yielded similar results. The results of the study are illustrated in Table 1. The two methods were then compared using the Bland-Altman analysis which provided a mean difference of 1.7±4.7 mm and limits of agreement of ±9.6 mm. The results are presented in Table 2. Inter-observer reliability analysis results are presented in Table 3.

If the tip was below the diaphragm, the measurement was given a positive sign. A negative sign was given if the tip was above the diaphragm. Radiographs were viewed using the same monitor and views were optimized by adjusting window level and image magnification to improve accuracy of measurements. Measurements were calculated two weeks apart by one observer to assess intra-observer reliability and avoid recall bias. A second observer performed a set of measurements as an intra-observer repeat measurement to improve the accuracy of measurements. Intra-observer and inter-observer reliability was accepted if the intraclass correlation coefficient (ICC) version 2.1 > 0.8 and the 95% limits of agreement were < 10 mm. Results are expressed as mean ± standard deviation (SD) if normally distributed and median [inter-quartile range] if skewed. Means were compared using a paired t-test. Intra- and inter-observer reliability analysis yielded similar results. The results of the study are illustrated in Table 1. The two methods were then compared using the Bland-Altman analysis which provided a mean difference of 1.7±4.7 mm and limits of agreement of ±9.6 mm. The results are presented in Table 2. Inter-observer reliability analysis results are presented in Table 3.

Discussion
We demonstrated that lateral radiographs are more reliable in representing the relationship between the catheter tip and the border of the diaphragm when compared with AP films. In addition, AP radiographs tend to under-read the UVC tip distance above the diaphragm by a mean (SD) of 2.9 ±4.3 mm which is statistically significant. There is evidence that lateral radiographs are more reliable when compared with AP films, with an intra-observer ICC (95% confidence interval) of 0.83 (0.97, 0.97, p < 0.001) for AP and 0.99 (0.97, 0.97, 0.99, p < 0.001) for lateral radiographs. Inter-observer reliability analysis yielded similar results favouring the lateral radiographs (AP ICC: 0.99 [0.97–1.0, 0.99]) and lateral radiographs (Lateral ICC: 0.99 [0.97–1.0, p < 0.001]). The intra-observer repeated measurements bias and limits of agreement were higher in AP compared with lateral radiographs: 2.9 ±4.3 mm versus 1.7 ±4.7 mm (p=0.003) for AP films and 0.0 ±0.0 mm versus 1.7 ±4.7 mm (p=0.003) for lateral radiographs. The intra-observer repeated measurements bias and limits of agreement were higher in AP compared with lateral radiographs: 2.9 ±4.3 mm versus 1.7 ±4.7 mm (p=0.003) for AP films and 0.0 ±0.0 mm versus 1.7 ±4.7 mm (p=0.003) for lateral radiographs. The intra-observer repeated measurements bias and limits of agreement were higher in AP compared with lateral radiographs: 2.9 ±4.3 mm versus 1.7 ±4.7 mm (p=0.003) for AP films and 0.0 ±0.0 mm versus 1.7 ±4.7 mm (p=0.003) for lateral radiographs. The intra-observer repeated measurements bias and limits of agreement were higher in AP compared with lateral radiographs: 2.9 ±4.3 mm versus 1.7 ±4.7 mm (p=0.003) for AP films and 0.0 ±0.0 mm versus 1.7 ±4.7 mm (p=0.003) for lateral radiographs.
day. As a result, reliance on radiographs to determine catheter positions will remain standard of care for the foreseeable future. Measurement of the distance between the tip and the diaphragm is more reliable when using lateral radiographs with less intra and inter observer variability between the repeated measurements when compared to AP films. This is of particular importance in centres where the person inserting the UVC remains at the bedside in a sterile environment while receiving instruction from another colleague reviewing the radiographs and providing instruction on line manipulation distance.

The more accurate appraisal of the tip position using lateral films may result in fewer post insertion manipulations and reduce the overall number of radiographs taken. This may result in a reduction of the radiation burden these infants are exposed to. AP films remain necessary during the initial assessment to ensure that the catheter has not coursed medially or laterally into a hepatic vein as this may be difficult to establish on lateral films. We suggest that lateral radiographs may be a useful in conjunction with AP films to aid in determining and manipulating UVC tips. In addition, following manipulation, we recommend the use of lateral radiographs alone to assess UVC tip distance.

Correspondence: A EL-Khuffash
Department of Neonatology, Rotunda Hospital, Parnell St, Dublin 1
Email: afif@physicians.ie

References