

RADIOLOGICAL IMAGING ON UMBILICAL VENOUS CATHETER'S PLACEMENT IN PRETERM INFANTS IN THE NEONATAL INTENSIVE CARE UNIT



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ABSTRACT

Umbilical vessel catheterization is a technique used for neonatal reanimation, in neonatal intensive care units. Imaging techniques provide a strong support for the performance of this practice. In this case, radiography is the most widely used instrumental investigation for the evaluation of umbilical venous catheter placement. By protocol, the image is acquired with an antero-posterior projection of the thoraco-abdominal district, with perpendicular radius to the median sagittal plane. The following descriptive study has been carried out on 20 newborn patients of the Neonatal Intensive Care Unit of the University Hospital "San Giovanni di Dio e Ruggi d'Aragona", born between December 4th 2020 and March 31th 2021. This study describes the effectiveness of the "thoraco-abdominal" radiological technique for the assessment of neonatal umbilical catheter placement. The basic premise for patients' recruitment was the request for evaluation of umbilical venous catheter placement in preterm infants.

INTRODUCTION

Umbilical vessel catheterization is a technique used for neonatal reanimation, in neonatal intensive care units. Imaging techniques provide a strong support for the performance of this practice. In this case, radiography is the most widely used instrumental investigation for the evaluation of umbilical venous catheter placement. By protocol, the image is acquired with an antero-posterior projection of the thoraco-abdominal district, with perpendicular radius to the median sagittal plane. The following descriptive study has been carried out on 20 newborn patients of the Neonatal Intensive Care Unit of the University Hospital "San Giovanni di Dio e Ruggi d'Aragona", born between December 4th 2020 and March 31th 2021. This study describes the effectiveness of the "thoraco-abdominal" radiological technique for the assessment of neonatal umbilical catheter placement. The basic premise for patients' recruitment was the request for evaluation of umbilical venous catheter placement in preterm infants. Introduction: Catheterisation of umbilical vessels is an irreplaceable technique, often used during neonatal reanimation, in intensive care, sub-intensive care and neonatal pathology departments. The main indications for placing a catheter in the umbilical vein are manifold, such as: pharmacological reanimation in the delivery room, the need for exsanguination-transfusion (EXT), partial or total parenteral nutrition for infants weighing less than 1500g, infusion of liquids with high osmolarity or drugs and blood products, frequent blood draws, measurement of central venous pressure. Contraindications to

umbilical venous catheter (UVC) placement include: omphalitis, omphalocele, necrotizing enterocolitis (NEC), and peritonitis. Before performing exsanguinotransfusion (which cannot be carried out if the catheter tip projects into the portal system or intrahepatic veins), it is essential to always check the placement of the catheter, through radiography or ultrasonography. Once placed, the catheter could never be removed and reinserted. An umbilical venous catheter can also provide rapid intravenous access during reanimation. In these circumstances, it is inserted only a few centimeters from the umbilical entrance and, therefore, it is not necessary to perform radiographs to verify its placement. The ideal location of the end of the catheter is at the inlet of the inferior vena cava (IVC) in the right atrium, at the cavo-atrial junction; the end of the catheter should be prevented from reaching the hepatic veins, portal vein, and foramen ovale; if the catheter does not progress, forcing it should be avoided. In emergency situations, to administer essential drugs, one must place the tip 2-3 cm from the skin plane and, before infusing, check for blood reflux. Once fixed, the UVC can only be pulled out. In addition, the catheter must be removed within 48 hours; this deadline will be procrastinated if strictly necessary. The location of the catheter tip can be above the diaphragm (FIG 1), at the junction of the IVC and right atrium, between T9 and T10, (FIG 2), or peripheral, 2-3 cm from the skin plane, before the liver (FIG 3). Localization in the portal system is the most frequent abnormal location of an umbilical venous catheter (FIG 4) and can be responsible for

severe hepatic damage, one of the most frequent is portal vein thrombosis. Catheters are inserted without imaging guidance and, given the small size of infants, a little variation in catheter length may result in significant misplacement. Alternatively, the catheter may not travel along the intended route. The best placement of the umbilical venous catheter tip is typically in the cephalic portion of the inferior vena cava (FIG. 2) or the right atrial junction of the inferior vena cava. Typically, only the antero-posterior projection is performed in order to minimize the child's exposure to radiation.

Patient positioning and management

The X-ray Technician, prior to submitting patient for radiologic examination, must be sure about the identity of the newborn and he has to verify that there is a match between the request and patient. Correct positioning of the patient is essential for a successful radiographic examination and is one of the crucial elements to avoid repeated and undue exposures to the patient. Most radiographs are performed on newborns in their cot or incubator. The X-ray technician therefore provides guidance to the ward nurse for the positioning of the newborn to avoid problems associated with either incorrect positioning or the interposition of medical devices in the field of investigation. It is possible to use aids for immobilizing the infant, such as synthetic "nests" or pediatric sandbags. Unfortunately, however, it isn't always possible to perform the X-ray in perpendicularity with the median sagittal plane, so the image may be rotated, which creates problems of diagnostic interpretation. In fact, if the trunk of the newborn is rotated, the mediastinum protrudes to one side or the other. In such cases the radiogram should be repeated. Only in very outstanding cases the infant may be immobilized with the support of an operator, in which case the operator must wear protections from diffuse radiations and he must remain outside the primary beam. It is strictly forbidden for pregnant women to carry out this task. For good practice, in order to reduce the risk associated with infection or problems in the neonate and to ensure reproducibility of the diagnostic examination, the cassette holder, if available, should be used during the X-ray examination. If the cassette holder is not available, or if there are specific requirements for the performance of the examination, it is possible to perform the X-ray with the infant's contact detector. In this case, the detector should be wrapped in a polyethylene or similar bag, preferably sterile, to ensure maximum safety in order to limit the risk of infection.

Acquisition technique

In special cases, the "thorax-abdomen" with a single exposure may be appropriate to verify the correct position of tubes and catheters, such as the umbilical venous catheter. It is executed with the supine patient, the beam is perpendicular to the median sagittal plane and it cuts just below the diaphragm. The indications for the collimation of the thoraco-abdominal examination are as follows: - Upper limit: below the chin; - Lower limit: at the level of the pubic symphysis; - Lateral limits: include the lateral portions of the thorax and abdomen. Beam limiting to the affected anatomical district is an important and

delicate operation. The beam must not extend beyond the area of the diagnostic question and, at the same time, it must cover the area sufficiently according to the indications of the examination for not to compromise the diagnosis or necessitate a second exposure. The diagnostic image must also clearly show the position indicators (right and left). In children, 40% of the red marrow is in the long bones and skull. It is therefore necessary to follow the above indicated collimations, not including the limbs or head/neck in the radiogram. In cases where it is necessary to determine whether the catheter has folded into the peripheral or central circulation, the point of insertion should be included in the radiogram. The exposure parameters depend on: - The modality of execution with the detector in contact with the newborn or inserted in the cradle cassette holder determines important differences in the dose delivered to the disadvantage of the latter; - The detection system used: nowadays, DR systems allow the best ratio between image quality and dose. Optimisation is only possible by studying technological system, and overall, the applied voltage can vary from 50 to 65 kVp and the load to the tube from 0.5 to 3 mAs with a focus-to-film distance of 100 cm.

Radiation Protection

The exposure of gonads of the newborns, and in particular preterm infants, raises concerns about potential long-term adverse effects. In this regard, it should be borne in mind that the placement of screens for the male gonads is complicated because, especially in preterm infants, the gonads are located close to the pubic symphysis and it's very difficult to exclude them completely from radiogram's field of view. In the case of female gonads, however, it's very difficult to screen the ovaries without covering the entire pelvis. The incoming dose from a neonatal abdominal X-ray is generally very low and the probability of a long-term effects from this exposure is negligible. During examinations, patients into ward can't be removed, so during irradiation, the remaining patients in the room are exposed to the beam scattered by the examination patients in the immediate proximity. The use of mobile screens (e.g. bulkheads) doesn't appear necessary if the incubators are at least 1 m apart each other. However, the use of anti-X cloths is not recommended because the expected benefit of reducing the scattered dose, by about a factor of 100 from an already low value, doesn't compensate for the risk due to the loss of visual contact with the patient and interference with vital signs monitoring equipment. The application of the principles of patient radiation protection, as expressed by Italian (D.LGS 187/00) and international legislation, requires that all individual medical exposures must be justified in advance, taking into account the specific objectives of the exposure, the characteristics of the concerned patient and the diagnostic pathway that the patient is undergoing. Following the choice of an appropriate examination, the principle of optimisation must be respected, which means that all measures must be taken to keep doses as low as possible, consistent with the proper outcome of the examination. In addition, certain critical points that may lead to a higher dose to the patient must be avoided: incorrect patient positioning, inaccurate or missing light centring device, presence of material

or equipment that pollutes the images, damage to the detector caused by accidental dropping, artefacts due to poor detector cleaning.

■ MATERIALS AND METHODS

The following descriptive study has been carried out on 20 newborn patients of the Neonatal Intensive Care Unit of the University Hospital "San Giovanni di Dio e Ruggi d' Aragona", born between December 4th 2020 and March 31th 2021. The basic premise for patients' recruitment was the request for evaluation of umbilical venous catheter placement in preterm infants. A portable X-ray machine dedicated to bedside examinations in the Neonatal Intensive Care Unit was used to produce the radiological images. This study, therefore, describes the effectiveness of the "thoraco-abdominal" radiological technique for the assessment of neonatal umbilical catheter placement.

■ RESULTS AND DISCUSSIONS

The sample period was from December 2020 to March 2021. The total number of patients enrolled for the study is 20: - 8 are male (40%); - 12 are female (60%). From the anamnestic control, it appears that all 20 infants were early born and, for this reason, umbilical venous catheterisation was implemented. The "thoraco-abdominal" X-ray on newborns is the most widely used instrumental investigation for the identification of the exact position of the umbilical venous catheter tip and therefore allows pharmacological reanimation to be performed into delivery room, exsanguinationtransfusion (EXT), partial or total parenteral nutrition for infants weighing less than 1500 g, infusion of liquids with high osmolarity or drugs and blood products, frequent blood sampling and measurement of central venous pressure.

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