ABSTRACT
Objective: to describe the profile of results of Transfontanelar Ultrasounds. Method: A descriptive, quantitative retrospective study based on the records of TFUS exams performed on newborns. The data were presented in figures. Results: The study included 52 medical records of newborns. Regarding the ultrasound diagnosis, 63% of NBs presented a normal result. Abnormal TFUS (37%) were classified into five types of injuries: Intracranial Hemorrhage (ICH) and Periventricular-intraventricular hemorrhage (PV-IVH) accounting for 9% of those affected; Hypoxic-ischemic Encephalopathy (HIE including Periventricular Leukomalacia) with 17%; Ventricular Dilation (VD) with 9% and Cerebral malformations with 2% of the population. Conclusion: it was possible to identify the most prevalent diseases diagnosed by the TFUS exam. These data are of great value for their guiding power in the care for the newborn patient. Descriptors: Nursing; Neonatology; Newborn; Neurology.

RESUMO
Objetivo: descrever o perfil dos resultados das Ultrassonografias Transfontanelarias. Método: estudo descritivo, de abordagem quantitativa, retrospectivo, no levantamento documental, no livro de registro de exames de USGT realizadas nos recém-nascidos. Os dados foram apresentados em figuras. Resultados: o estudo contemplou 52 prontuários de RN. Quanto ao diagnóstico ultrassonográfico, 63% dos RNs apresentaram resultado normal. As USGT anormais (37%) foram classificadas em cinco tipos de injúrias: Hemorragia Intracraniana (HIC) e Hemorragia Peri intraventricular (HPIV) perfazendo 9% dos afetados, Encefalopatia Hipóxico-isquêmaca (EHI, incluindo Leucomalácia Periventricular) com 17%, Dilatação ventricular (DV) com 9% e Malformações cerebrais com 2% da população. Conclusão: foi possível neste estudo identificar as doenças mais prevalentes diagnosticadas pelo exame de USGT. Esses dados são de grande valia pelo seu poder norteador na prática da assistência ao paciente recém-nascido. Descritores: Enfermagem; Neonatologia; Recém-Nascido; Neurologia.

RESUMEN
Objetivo: describir el perfil de los resultados de Ultrasonidos Transfontanelares. Método: Un estudio retrospectivo descriptivo y cuantitativo basado en la observación de exámenes TFUS realizados en recién nacidos. Los datos se presentaron en cifras. Resultados: El estudio incluyó 52 expedientes médicos de recién nacido. Respecto al diagnóstico por ultrasonido, el 63% de los RN presentó un resultado normal. Los TFUS anormales (37%) se clasificaron en cinco tipos de lesiones: hemorragia intracraneal (ICH) y hemorragia intraventricular (PV-IVH) representan el 9% de los afectados; Encefalopatía hipóxico-isquémica (EHI incluyendo leucomalacia periventricular) con 17%; Dilatación Ventricular (VD) con 9% y Malformaciones Cerebrales con 2% de la población. Conclusión: fue posible identificar las enfermedades más prevalentes diagnosticadas por el examen TFUS. Estos datos son de gran valor para su poder de guía en el cuidado del paciente recién nacido. Descriptores: Enfermería; Neonatología; Recién nacido; Neurología.
INTRODUCTION

In the last decades, thanks to numerous advances in the area of Medicine and Neonatology, there has been a decrease in worldwide neonatal mortality, with a consequent increase in the survival of newborns (NB) previously considered unfeasible.

Faced with the findings related to pathological anatomy, diagnostic tools are key elements in the improvement of care for the newborn. The creation of neonatal intensive care units (NICUs) in the 1970s was a boost in technological advances due to the need for care for increasingly critical and unstable patients. Ultrasonography (USG) and Computed Tomography (CT) appear in the 1980s, with the 1990s being the decade of investment in prenatal diagnosis and the expansion of non-invasive diagnostic techniques.1

With the technological progress in diagnostic methods, it was only possible to intervene in the evolution of the pathology, but it was also possible to improve the prognosis and the future quality of life, meaning that Neonatology could exercise its curative and, mainly, preventive function. Neuroimaging plays an important role in the diagnosis and identification of brain lesions in at-risk neonates, in addition to predicting changes in neurodevelopment in the long term.

USG is one of the most widespread diagnostic methods because of its advantages. As it is non-invasive method, it allows the evolutionary study of lesions with sectional images obtained in any spatial orientation and acquisition of images in real time. It is possible to perform at the bedside using portable devices, maintaining the thermal and hemodynamic status of seriously ill NBs. In addition, it does not present any harmful effects such as the use of ionizing radiation. It is known that small doses of radiation are potentially harmful to the neonate, particularly when many examinations are required. The effective dose of radiation and its deleterious effects have cumulative action, i.e., doses will have harmful effect for the rest of the life.2

Because it is a specific diagnostic medium, this technique is operator-dependent, since for good interpretation of the clinical findings it is necessary to have anatomical-pathophysiological knowledge, good technique, and the knowledge of the limitations of the device, which is the appropriate model for which type of structure, and cases where complementary tests are required. USG appliances have an average life of five years. Transfontanellar USG (TFUS) is indicated in cases of preterm or birth weight of less than 1500g, with incidences of hyaline membrane disease, seizures, meningitis, and suspicion / diagnosis of vertically transmitted infections / TORCH. In addition to newborns with congenital malformations and specific cases such as cranial trauma, intrauterine growth retardation, thrombocytopenia and neurological disorders.3

The area of contact between the transducer and the cephalic region where sound transmission is possible is called an acoustic window. In newborns, these windows are represented by fontanelles and sutures, or even by craniotomy openings.4 The use of this diagnostic technique is limited to the closure of these structures.

The interest in the study of neurological injuries arose from the author’s experience as a resident nurse in the neonatology department working in the assistance of serious NB in a reference hospital in the state of Bahia. The fact that the author was working in an environment that has risk factors for the occurrence of neurological injuries, such as prematurity, which is the most prevalent diagnosis in the Units of Neonatal Intensive Care Units (NICU) at this hospital, led to this research.

METHOD

A descriptive, quantitative, retrospective study using data collected from the registration book of TFUS exams from a public reference hospital in Salvador, Bahia, from July to December 2009. The subjects of the study were the newborns submitted to TFUS for the investigation of cerebral neurological diseases, and the inclusions criteria included NBs who were hospitalized in the same hospital in neonatal intensive and semi-intensive care units.

The exclusion criteria were newborns who did not take the TFUS exam until the 28th day of life and the absence of the diagnostic report of the TCUS or description of the result of the examination in the medical records of the NB.

The study of the medical records evaluates the diagnosis from the ultrasonographic report, as well as the gestational age, birth weight, gender and the clinical diagnosis of the newborns in the study, which established the independent variables.

For the descriptive analysis of the data, dependent variables were used, which are characterized by diagnoses from altered...
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The pathologies found will be classified in five classes: Intracranial hemorrhages, Hypoxic ischemic encephalopathies (including Periventricular Leukomalacia), Ventricular Dilations and Cerebral malformations.

RESULTS

The study included 52 newborns, 65% being males and 35% being female.

Regarding the birth weight, 54% of the hospitalized NBs weighed between 1500g - 2500g, a range considered as under weight according to the World Health Organization. 17% of the studied NBs weighed above 2500g and 15% weighed between 1000g - 1500g. About 14% of the NBs weighed under 1000g which is classified as extremely under weight.

The gestational age with the highest prevalence was below 37 weeks (87%), considered to be premature. 13% of newborns were identified as full term newborns.

Regarding the ultrasound diagnosis, 63% of the NBs presented a normal result. Abnormal TFUS (37%) were classified into five types of injuries: 9% presented with Intracranial Hemorrhage (ICH) and Periventricular-intraventricular hemorrhage (PV-IVH), 17% presented with Hypoxic-ischemic Encephalopathy (IHD including Periventricular Leukomalacia), 9% presented Ventricular Dilation (DV) and 2% presented with Cerebral malformations.

For a better understanding of the facts involved in the etiology of the brain lesions diagnosed in the TFUS, the NBs which had an altered ultrasonography report had their clinical diagnoses investigated, classified according to the cause of hospitalization, described in the patient’s authorization of hospital admission of which 33% were hospitalized due to respiratory conditions (including apnea and respiratory distress at birth); 31% due to Prematurity; 21% were hospitalized due to risk of infection; 10% presented with early or delayed jaundice and 5% presented with congenital malformation as a clinical diagnosis.
The neurological lesions which can be diagnosed by TFUS are conditions responsible for neonatal morbidity and mortality. Therefore, professionals involved in the care of at-risk NB should be alert to clinical signs, which are often non-specific, alerting all the team to the possibility of these lesions occurring. In addition, knowledge of the pathophysiology, treatment and prognosis will guide the specific management of the case which is of paramount importance.

Most of the brain injuries diagnosed by TFUS are classified as hypoxic-ischemic encephalopathy, including periventricular leukomalacia (17%), followed by ventricular dilation and intracranial hemorrhage, both involving 9% of the study population. In comparison, one study reports the occurrence of a higher prevalence of subependymal cysts, periventricular leukomalacia, perinventricular hemorrhage. Another study describes the prevalence of hemorrhages with cerebral ischemia, cystic periventricular leukomalacia, and diffuse lesion of the white matter.

In a study performed in Campinas, São Paulo, identified changes in an ultrasound examination in a NB with findings similar to those found in this study. At the Maternidade de Campinas, 23% of the studied NBs obtained an altered diagnostic report. At the Centro de Atención Integral à Saúde da Mulherat the State University of Campinas, 34% of the newborns presented withencephalic pathology visible in the TFUS, in both 1998 and 1999. In both institutions, the most prevalent brain pathologies were Intracranial Hemorrhage, Hypoxic-Ischemic Encephalopathy and Ventricular Dilation.

**Hypoxic-ischemic Encephalopathy (HIE) and Periventricular Leukomalacia (PVL)**

PVL consists of an ischemic infarction in the area of cerebral white matter adjacent to the lateral ventricles. Vascular factors that increase the risk of cerebral hypoperfusion and the vulnerability of immature oligodendrocytes in the white matter region are involved in the genesis of the ischemic lesion.

Systemic hypoperfusion causes a decrease in cerebral blood flow due to innumerable factors such as cerebral vascular immaturity in premature infants, septic shock, persistent apnea, seizures, hypopcapnia and congenital heart defects.

The development of cerebral vasculature is directly related to gestational age, with precarious vascularization and increased predisposition to the occurrence of PVL in NB with 24 to 30 weeks of gestational age. From the 32nd gestational week, there is a significant vascular development, with the appearance of longer and anastomized vascular branches. This fact corroborates the prevalence of HIE-like neurological lesions in 88% of newborns in this study born between gestational age of 24 and 30 weeks.

An incidence of 55% of premature newborns weighing less than 1000 g and 22.2% of newborns weighing between 1000 g and 15000 g were affected by periventricular leukomalacia. This high incidence is reported in the literature.

The incidence of newborns weighing less than 1500 g with PVL, presented with Cerebral Palsy in 52 to 100% of the cases. Approximately 25% of newborns with a birth weight of less than 1,500 g present moderate or severe motor deficits such as spastic dysplasia. At school age, 25-50% of children diagnosed with PVL have cognitive and learning deficits. Studies have presented the relation of this pathology with visual and auditory impairments. The ischemic damage of the periventricular zone, limited to the dorsal and lateral tracts near the lateral ventricles,
usually affects the descending motor fibers of the cortex and fibers of the visual, auditory and somesthetic functions, impacting the development of perceptive abilities, and interfering in the psycholinguistic abilities.12,13

In a study of 19 newborns, ten of whom were diagnosed with PV-IVH and PVL and nine with no neurological abnormalities, the results of the Dubowitz and Dubowitz neurological tests were evaluated. Compared to neonates without neurological abnormalities, infants diagnosed with PV-IVH and / or PVL had more items classified as abnormal, with significant changes being suggestive of deficits in neuro-motor behavior, proving that these babies are more prone to neurological deficits.14 The presentation of PVL is subclinical, therefore the diagnosis is obtained by neuroimaging exams. Early diagnosis of PVL can be obtained by TFUS used in the neonatal period as screening for brain lesions. Periventricular hyperechogenic areas appear in the TFUS which later evolve into periventricular cysts and / or hyperechogenic lesions diffused by white matter. 

♦ Intracranial Hemorrhage (ICH) and Periventricular-intraventricular hemorrhage (PV-IVH)

From the late 1970s until the mid-1980s, epidemiological studies showed variations of 34 and 49% in the prevalence of PV-IVH15 however, studies with variable prevalence can be found. In the present study, 25% of the newborns with altered TFUS had the diagnosis of intracranial hemorrhage, in NBs weighing less than 2300g and GI below 35 weeks. It is noted that the incidence of PV-IVH increases as gestational age decreases. Studies have shown that around 50% of newborns with gestational age equal to 26 weeks are affected by PV-IVH, mostly appearing in the first 72 hours of life, with prematurity being the main predisposing factor.16,17 Studies have shown that hemorrhagic lesions are more common in neonates with gestational age below 28 weeks.18

It should be emphasized that the presentation of a large range in the prevalence of PV-IVH (variation of 20 to 52%) may be related to the non-standardization of the study population, contemplated by some authors studies involving infants weighing less than 1500g and others with infants with weighing less than 2500g. In order to have reliable data referring to the prevalence of these pathologies it is necessary to carry out comparative studies based on similar populations and standardized range of the variables of birth weight and gestational age.

The importance of studies on PV-IVH is mainly due to the numerous risks, complications and long-term sequelae, such as motor and cognitive deficits. The etiology of PV-IVH is proposed by two basic mechanisms: cerebral vasodilation due to hypoxia or systemic hypercapnia, causing rupture of germinal matrix capillaries and the presence of systemic hypotension secondary to ischemia, followed by rupture after blood pressure has been restored.19

Circulation in the brain of the newborn is regulated by arterial oxygen concentration, CO2 blood pressure, glucose levels and systemic arterial pressure. The drop in arterial oxygen concentration results in vasodilation and increased cerebral blood flow. Increased CO2 blood pressure also causes cerebral vasodilation, mediated by relaxation of the smooth vascular musculature, with consequent decrease in cerebrovascular resistance. The occurrence of hypoglycemia increases cerebral blood flow due to vasodilation.19

Risk factors for the onset of intravascular, vascular and extravascular PV-IVH genesis are described. Intravascular factors are related to increased cerebral blood flow triggered by handling, painful procedures, tracheal aspiration, systemic complications such as pneumothorax or seizures or in cases where there is a need for therapy with volumetric expanders or exogenous transfusions; fluctuations in the cerebral blood flow velocity with changes in systolic and diastolic cerebral and systemic flow velocities, triggered by mechanical ventilation, hypercapnia, agitation and patent ductus arteriosus.

Intravascular factors include increased cerebral venous pressure in the presence of cardiac and respiratory disorders; Decreased cerebral blood flow with subsequent disruption after brain reperfusion in cases of perinatal asphyxia.

Vascular factors are involved in the genesis of PV-IVH. The capillaries of the germinal matrix are formed by simple endothelial cells, without smooth muscle and collagen coating, justifying the fragility attributed to the microvasculature of the germinal matrix. Precarious vascular support, increased fibrinolytic activity, and decreased tissue pressure are extravascular factors that increase the possibility of a premature organism developing PV-IVH.19 All cases of PV-IVH found in this study were clinically diagnosed with Prematurity and Respiratory Conditions, which corroborates...
with the findings in the literature, identifying them as important etiological factors connected with this type of brain injury.

The manifestations may present asymptptomatically, characterized as the silent syndrome. (PV-IVH) is suspected in cases of decreased hematocrit or lack of blood levelling following blood transfusions.

The ideal age for performing the first TFUS for PV-IVH screening should be between the 4th and 7th day of life, as this type of brain injury occurs in more than 90% of cases in the first week of life. The literature recommends that the second examination is performed after the 3rd to 5th day after the initial diagnosis of PV-IVH, as in 20 to 40% of the cases the bleeding progresses.7

♦ Ventricular Dilation or Ventriculomegaly

Ventricular dilations occur due to increased pressure in the ventricular system related to increased production or obstruction of bloodflow, secondary to hemorrhagic processes, infectious and congenital malformations.

Ventriculomegaly may be defined as a rapid growth in lateral ventricular size observed in the TFUS within seven days after PV-IVH or the continued progression of ventricular dilatation after 14 days or more of PV-IVH with a change in the classification of ventriculomegaly (mild to moderate or severe).

The major cause of this encephalic pathology in the NB is related to PV-IVH, which may be a reflection of a widespread white matter lesion, accompanied by macrocephaly and unfavorable cognitive prognosis.

The incidence of intraventricular dilatation in our study was 25%. From the NB diagnoses with Ventricular Dilation, 60% were underweight.

One author describes in his study that among low birth weight infants diagnosed with PV-IVH, 51% had ventricular dilatation at some stage. From this 51%, 38% did not receive treatment and had spontaneous regression of ventricular dilatation and 62% had persistent ventriculomegaly.21

This association between PV-IVH and ventricular dilatation was not possible during the present study as the TFUS exams found did not have enough data for this type of analysis. Another study describes the fourfold increase in the risk for delayed psychomotor development and three fold risk for mental retardation in those infants diagnosed with moderate and severe ventriculomegaly. There are reports that more than 90% of newborns with ventriculomegaly develop motor disorders.22

Therefore, the relevance of understanding this pathology is observed, since in addition to involving considerable mortality rates, the associated comorbidities are numerous, compromising the future life of the newborn and its interrelations in social, personal and family life.

**CONCLUSION**

Due to the increase in the survival of premature and very low birth weight infants, the understanding of cerebral pathologies is of paramount importance in neonatal intensive care. The most intriguing factor in the advancement in neonatology is that despite declining mortality and increased survival, indicators of quality of life and sequelae after hospital discharge are unsatisfactory. These sequelae may be related to hospital admission and to the pathology itself, and are sometimes due to delayed diagnosis and early intervention.

In this study it was possible to identify the most prevalent brain pathologies diagnosed by the TFUS exam, in a reference hospital in Neonatology and Neurosurgery in Bahia. These data are of great value for their guiding power in the practice of care for the newborn patient.

However, it is necessary to standardize the data which is put in the TFUS exam registration book. In order to specialize care for this type of clientele it would be beneficial to specify, next to the patient’s name, if there was a neurological alteration and if so, what type, so that there would be a quarterly or half-yearly identification of the most prevalent neurological lesions in this hospital.

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