ULTRASONIC EVALUATION OF INTRAACRANIAL PATHOLOGY IN PREMATURE NEWBORNS

Thesis

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بسم الله الرحمن الرحيم

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LIST OF ABBREVIATIONS

CRO : Cathod Ray Oscilloscope

CT : Computed Tomography

SEH : Subependymal Haemorrhage

HMZ : Mega Hertz

ICH : Intracranial Haemorrhage

IVH : Intraventricular Haemorrhage

LV : Lateral Ventricle

LVR : Lateral Ventricular Ratio

OFC : Occipitofrontal Circumference

PVH : Periventricular Haemorrhage

PVL : Periventricular Leukomalacia

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INTRODUCTION AND AIM OF THE WORK

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Until recently, the most widely accepted method for evaluating intracranial abnormalities in infants has been computed Tomography. In the past 5 years the introduction of high resolution real time ultrasound has revolutionized intracranial diagnosis in the neonate through passing the ultrasound beam through the open fontanelle (or fontanelles). Thus saving the infants the hazards and complications of the other procedures which are usually used as X-ray, ventriculography and C.T scanning since sonography proved to be a non hazardous, non invasive technique besides being portable and cheap (Babcock et al., 1983).

Germinal matrix haemorrhage and intraventricular haemorrhage are lesions of prematurity, and are the major cause of mortality and morbidity in premature infants. It occurs in high incidence of infants with gestational age less than 32 wk. (Babcock et al., 1980 and Skolnick et al., 1979).

Post haemorrhagic hydrocephalus is a major complication of cerebral intraventricular haemorrhage in prematures (Papile et al., 1978; Ahmann et al., 1980 and Papile et al., 1980) while periventricular leukomalacia is the second most frequent lesion in prematures after Germinal matrix haemorrhage (Richard et al., 1984).

All these lesions and others as brain oedema, brain atrophy, and intracerebral cysts are accurately diagnosed by ultrasonography.

This work aims at demonstrating the value of real time ultrasound scans in the diagnosis of intracranial pathology of premature infants especially Intracranial haemorrhage, and illustrating normal and abnormal details found during examination.

REVIEW OF LITERATURE

BASIC PRINCIPLES OF ULTRASONOGRAPHY

Just over 30 years ago French et al. (1951) reported the detection of cerebral tumours by the use of ultrasonic pulses on the exposed brain at postmortem. Since then ultrasonography has advanced rapidly as a diagnostic tool in many specialties including fetal medicine, and neonatology.

The Equipment

A probe equipped with a piezoelectric crystal produces ultrasound waves in short pulses. During quiescent periods between pulses the crystal detects any reflected sound wave incident on its surface. As ultrasound waves are almost completely reflected by gas it is necessary to use a coupling medium between the probe and the skin surface to enable waves to travel unimpeded into the soft tissues.

Types of Ultrasound Scans

A-Mode Scan

When ultrasound travels through the soft tissues small amounts of the ultrasound energy are reflected at the interfaces between adjacent tissues. The energy which is not reflected travels on and may be reflected at deeper levels. The reflected energy or echo is detected by the crystal and displayed on a cathode ray oscilloscope (CRO) as a deflection along a horizontal time base. The velocity of ultrasound in soft tissues is virtually constant (1460-1615m/s), so the time taken for a sound wave to travel to a tissue interface, be reflected and return to the probe is proportional to twice the distance of the interface from the probe. This type of display is known as an "A-scan" and is used to measure the depth and size of internal organs (Leksell, 1956 and Gordon, 1959).

Midline structures within the skull can be identified and midline shift detected by this method which was originally described in 1956 by Leksell. The size of the cerebral ventricles can be measured and the results obtained correlate well with measurements made by computerised tomography (CT) and air encephalography (Lapayowker et al., 1966; Sjogren et al., 1968; Hanson et al., 1975; Skolnick et al., 1979 and Erasmie et al., 1980).

The limitation of the A-mode scan is that it provides only a one dimensional image.

B-Mode Scan

A two-dimensional cross-section image is obtained using a mobile probe. Bright spots appear on the CRO which correspond partially to the positions of the reflecting interfaces. By moving the probe across the site many lines of bright spots are produced and two-dimensional image is built up in this way. Images of the brain were first described by this method by de Vlieger et al. (1963) who suggested that the technique would be useful for the assessment of hydrocephalus.

With the grey scale equipment currently in use the echoes are processed in relation to their amplitude in different shades of grey. Low amplitude signals, hitherto unrecognized, are now registered and more tissue detail is obtained. For instance, small differences in echo patterns in the soft tissues of the brain permit identification of such structures as the thalamus, caudate nucleus and cerebral pedicles (Kossoff et al., 1974 and Garrett et al., 1975). Ultrasound is attenuated by bone and so good grey scale ultrasound pictures of the brain can be achieved only in the infant and young child in whom the skull vault is thin and where the anterior fontanelle provides a bone-free window to the brain.

Although the quality of the image with grey scale scans is excellent they do have some practical disadvantages. The equipment is large and immobile and so the patient must be taken to it, the patient must not move during the scan, and selecting the correct plane of the scan can be very much time-consuming. These disadvantages are largely overcome with real-time ultrasound (Lombroso et al., 1968).

Real-time Ultrasonography

The probe contains a number of piezoelectric crystals which are activated sequentially; each contributes to a small part of the image. At intervals of approximately 1/50 second the image is refreshed and therefore the site being examined is effectively viewed in real-time. In a linear array scanner the crystals are aligned in a row within the examining probe and rectangular image is produced. The mechanical sector scanner has crystals aligned on one or more wheels which rotate and emit ultrasound pulses through a window at the base of the probe. There is another type of sector scanner in which the crystals are activated by electrical phasing - the phased array sector scanner. The image produced by a sector scanner is wedge-shaped.

High resolution real-time ultrasonography is an ideal modality for imaging the brain of a neonate for the following reasons:

1. There is no mechanical scanning gantry and so the equipment is compact and mobile. Even the very sick neonate can be examined without removing him from the incubator.
2. The image is instantaneous and so patient movment does not interfere with the examination.
3. The probe is easily and quickly moved over the skin surface to select the optimum plane of scan and so display the appropriate anatomy.
4. Because a moving image is produced, vascular pulsation can be appreciated which help in the recognition of anatomical landmarks. Abnormal pulsation may be seen in certain pathological conditions.

There are now many reports of real-time ultra-sonography of the neonatal brain including those by Pape et al. (1979);