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Scanning Electronic Microscopy (SEM) Analysis of the Ventriculo Peritoneal Shunts

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Abstract: Ventricular peritoneal derivations may determine conditions in the tissues, which may then create fibrous tissues around them. They include cases with catheters of the SEM and they show that when the fibrous tissues are formed, the outer surface is irregular. However, they are not determined through phystolosis or irregularity inside the surface.

Key words: Ventriculo peritoneal shunts, hydrocephalus, silicone, fibrous tissues, surface

INTRODUCTION

There are four cerebral ventricles: lateral ventricles, which are in the cerebral hemispheres, the third is situated in the diencephalon and the fourth ventrical is situated between the cerebral aqueduct (aqueduct of Sylvius) and the dorsal roof and hilus of the cerebellum.

The lateral ventricles communicate with the third ventricles through interventricular foramina, also known as Monro. The third ventricle communicates with the fourth through the aqueduct of Sylvius, which flows through the midbrain. The fourth ventricle communicates with the ependymal canal as well as with the subarachnoid space through three foramina especially the lateral opening (Luschka) and the median aperture (Magendie), which are situated in the hindbrain of the fourth ventricle. These ventricles contain a lining by macroglia elements called ependymitis. These are linked between them in order to form a thin layer, which functions like an obstruction. The ependymal canal is thin and it passes into the spinal cord (Fig. 1).

The choroid plexus is a vascular tissue found in all cerebral ventricles, which is the major site of cerebral spinal fluid formation. They are vascular formations, which are enveloped by the pia mater and extends to the medial wall of the lateral ventricles as well as the roof of the third and fourth ventricle, which is between the ependymal lining and the brain matter. The cerebrospinal fluid is developed at a constant rate as well as by the ventricular cavity. The fluid passes from the fourth ventricle through the foramina of Luschka and Magendie to the cisterna magna and then circulates into the cerebral and spinal subarachnoid spaces. The drainage passes through the arachnoid villi, as known as Pacchioni's granulations. They are small villuslike projections of the cranial arachnoid, which go through the dura. The arachoid villi are similar to plasma except that there is very little protein and it acts as a protective hydrodynamic function to the nerve tissue. In fact, it constitutes a liquid layer around the nerve tissue, which attributes to the effects of sudden accelerations and decelerations as well as diffuse the weight on the whole surface uniformly.

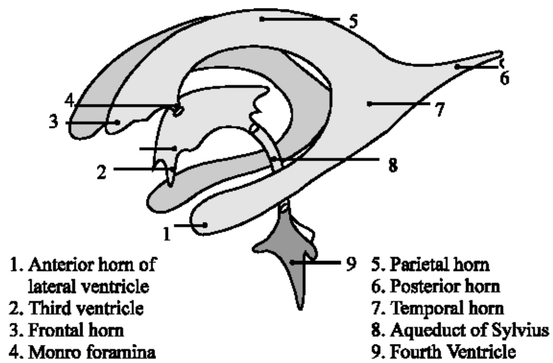

Fig. 1: Ventricles of brain

The term hydrocephalus comes from the Greek word meaning water and cephalis, which means head. Therefore, this condition is the abnormal accumulation of cerebrospinal fluid in the ventricle.

Surgical treatment of Normal Pressure Hydrocephalus (NHP) may be relieved by surgically implanting a shunt, which is placed into the lateral ventricle and the peritoneal cavity to drain excess cerebrospinal fluid (Hashimoto, 2008; Sasaki and Yamashita, 2008; Zhang and Wang, 2008; Fulkerson and Boaz, 2008).

This tubing has had positive response especially when diagnosed at an early stage. The purpose of the surgery is to obstruct endocranical pressure, which may cause an increase of intraventricular pressure, which causes the shunt to reduce pressure. The cerebral spinal fluid withdrawn from the lateral ventricle helps the

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pressure become normal. The cerebral spinal fluid from the lateral ventricle drains into the watery peritoneal cavity (Kazui, 2008; Sondhi *et al*., 2008; Menezes, 2008; Chomicki *et al*., 2007). The shunt contains a valve and a draining tube, which links to another cavity. The valve allows the flow of the cerebral spinal fluid to flow in one direction, which is from the ventricle to the peritoneal cavity. Its opening is only at a certain pressure (Pujari *et al*., 2008; Kariyattil *et al*., 2008; Udayasankar *et al*., 2008; Piatt and Garton, 2008). The opening is in relation to the shunts that is, 5 mmHg for low pressure; 10 mmHg for average pressure and 15 mmHg for high pressure (Greenberg and Williams, 2008; Abderrahmen *et al*., 2008).

Since the 1950's, silicone catheters have been used in neurosurgery. Silicone is quite flexible and has chemical stability (Hamilton *et al*., 2008; Wen, 2008; Perrini *et al*., 2008; James and Bradley, 2008). Therefore, there have been a series of structural and morphological changes in the drainage, which have brought to have the shunts be substituted with time. There was a reduction in the flexibility in the catheters, which were removed as well as modifications on the surface. In order to understand, this condition better, we have analyzed the catheters, which were removed from 1994-2006 by using a stereo-microscope and an electronic and scan microscope.

MATERIALS AND METHODS

In this analysis, 30 catheters, which were surgically removed either because of malfunction or because the patient outgrew them were examined (Fig. 2a, b and 3). All of the catheters were studied by using a stereo-microscope. Wild added a special software, which included analysis of the images to his personal computer. The observations took place by enlarging the images by 6.4, 16 and 40 times. In every sample, they were analyzed horizontally and longitudinally cross-sections especially the inside, the outside and the intramural part. The thickness of the wall and the parameters were analyzed and compared to the ones at home by using the analysis of the images.

In order to evaluate formations by fistulas of the drainage, the samples were absorbed in methylene blue at 10% for 12 h without closure of the end of the drainage. Therefore, the piece was cleaned and a microscopic analysis was possible.

Afterwards, the samples were metalized and analyzed with an electronic microscope, which scanned by enlarging elements.

A histological analysis of the samples were carried out (Fig. 4). These were placed in formalin at 10% and there were series sections, which were 8-10 µ thick

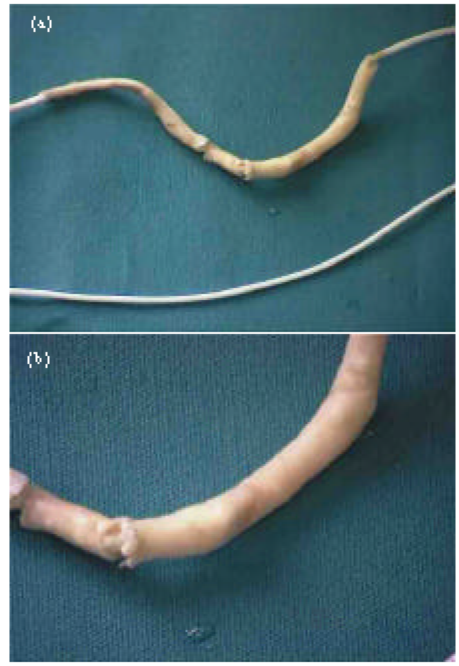

Fig. 2: a) Peritoneal ventricle shunt after 16 years. Notice the wide covering. Around the silicone, b) Drainage was not performed

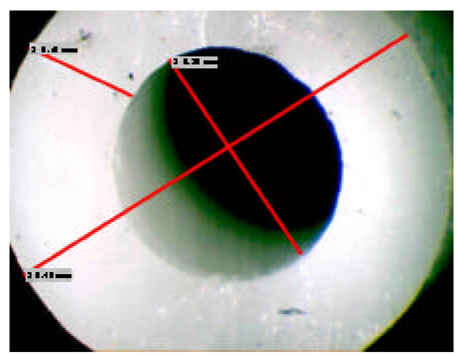

Fig. 3: A new ventriculo peritoneal shunts

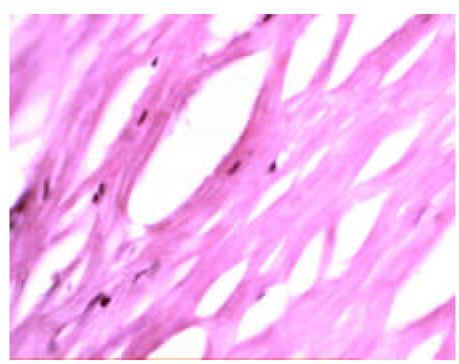

Fig. 4: Fibrous tissue around the drainge (hematosiline eosin) 400x

thanks to a microtome micron HM 360. This was included in the paraffin. The sections were placed in an heater at 37°C for a few hours and then were dyed with hematosiline eosin and Mallory-Azan staining method.

Software LEICA IM50 along with a Zeiss Axiophot microscope from a personal computer was used in order to analyze the images. This allowed us to study the details of the sections. Images were enlarged by 10, 20, 40 and 100x. Moreover, another software called optovar, in which images were enlarged by 1.25, 1.6 and 2x was also used.

RESULTS AND DISCUSSION

Silicone is a chemical compound, which may be used for various purposes. It has been utilized in Medicine for about 50 years and has shown to be biocompatible, effective, flexible, chemically stable, not very toxic and can be sterilized. Furthermore, it has been demonstrated that there have been a quite a few structural and morphological modifications in the drainage over time. Shunts may be necessary. As far as the surgically removed catheters are concerned, elasticity had been reduced and there have been modifications on the surface. In order to have a better understanding of these conditions, surgically removed catheters from 1994-2006 were examined by using a stereo-microscope as well as an electronic microscope with scanner.

No morphological modification is found inside the drainage (Fig. 5a and b). The outside part of the catheter is a bit rough and there is no continuity in thickness. In some cases, fibrous tissue envelopes the drainage (Fig. 6a and b). In all cases, there is no fistulas but there is a change in the outside part of the drainage (Fig. 7a and b, Fig. 8a and b). This shows irregularity of the surface but not of continuity.

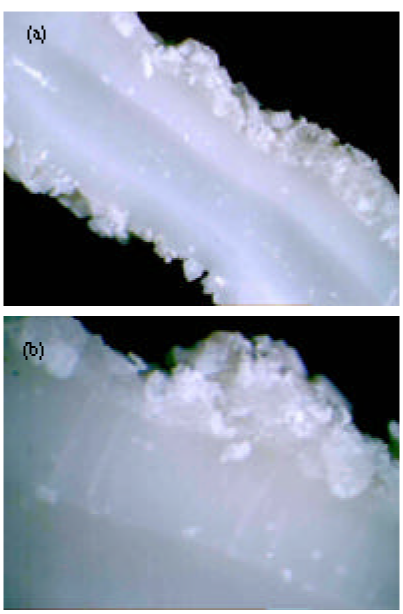

Fig. 5: Internal surface of the drainge, a) The surface is very regular b) particular of the precedent image

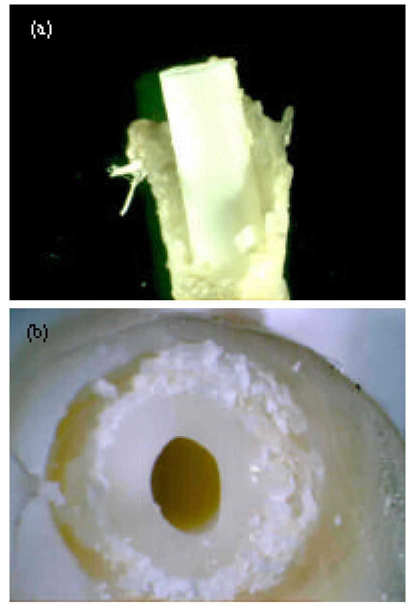

Fig. 6: The covering around the ventricolo peritoneal shunts. Images analyse by sterero microscope a) longitudinal section b) horizontal section

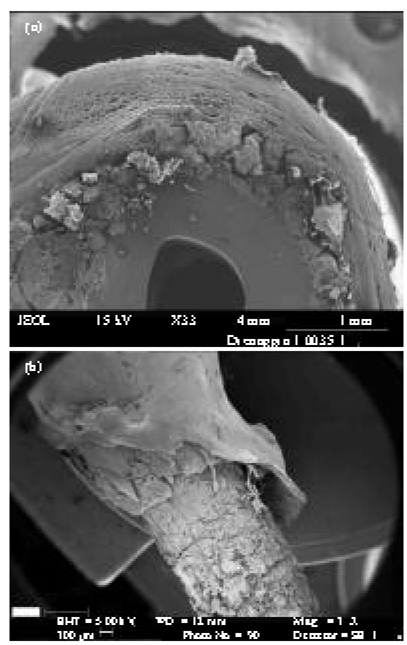

Fig. 7: SEM images Note the tissue around the drainge a) horizontal section and b) longitudinal image

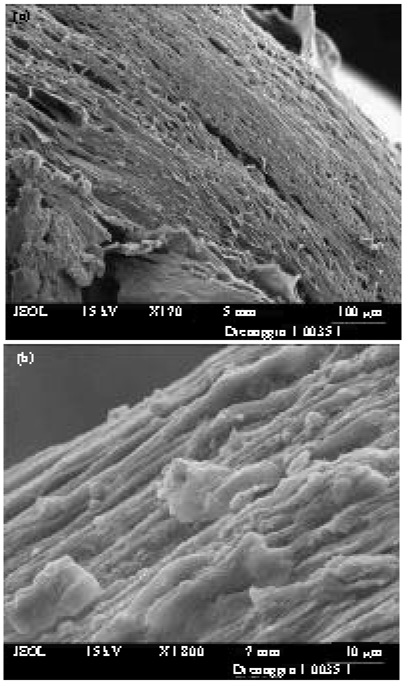

Fig. 8: The outside part of the catheter is a bit rough and there is no continuity in thickness, a) Fibrous tissue and b) particular of the precedent image

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