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Efficacy of the Lamina Terminalis Fenestration Associated With the Liliequist Membrane Fenestration in Reducing Shunt-Dependent Hydrocephalus Following Aneurysm Surgery in the Acute Phase of Aneurysmal Subarachnoid Hemorrhage

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Abstract

Chronic hydrocephalus is a common complication following aneurysmal subarachnoid hemorrhage, and contributes to the late morbidity and mortality. Some authors [2,3,5]. Report that microsurgical fenestration of Lamina Terminalis during aneurysmal surgery affords a reduction in the development shunt-dependent hydrocephalus. From January 2010 to January 2012 we performed microsurgical fenestration of Lamina Terminalis and Liliequist's Membrane, in 17 patients operated in the acute phase. CT scans were performed after 6 and 16 months. There was no development of hydrocephalus in this series. Microsurgical fenestration of the Lamina Terminalis and Liliequist Membrane during aneurysm surgery affords a reduction in the development of this late complication.

Keywords: *Hydrocephalus; Subarachnoid Hemorrage; Aneurysm; Fenestration; Lamina Terminalis; Liliequist Membrane*

Introduction

Hydrocephalus is a common complication of acute aneurysmal subarachnoid hemorrhage (aSAH). It may occur early (15-87%) or later (8,9-48%). The acute hydrocephalus needs immediate treatment [1].

The chronic hydrocephalus contributes with late morbidity and mortality in patients who suffered from aSAH. It is believed that it may be caused by fibrosis of the leptomeninges and the arachnoid granulations, impairing the cerebrospinal fluid (CSF) circulation and absorption [2]. The treatment is shunt placement [1].

An additional problem that contributes to late morbidity and mortality is represented by shunt complications (13%), both infectious and mechanical.

Some authors report that the microsurgical fenestration of the Lamina Terminalis during aneurysm surgery reduces the incidence of late hydrocephalus [2,3,5]. The Lamina Terminalis fenestration leads to an anterior ventriculostomy that may facilitate CSF dynamics, reducing subarachnoid fibrosis tissue and reducing vascular inflammation. [2,3]. Accordingly, we believe that the fenestration of the Liliequist Membrane can be an efficient complementary measure.

The Liliequist Membrane is located between the interpeduncular and chiasmatic cisterns. Yasargil., *et al.* Described that the Liliequist Membrane "stretches like a curtain from one mesial temporal surface to another".

Matsuno et al identified 2 distinct membranous sheets: the diencephalic, which extends superiorly from the posterior diencephalus to the mammillary bodies and separates the chiasmatic and the interpenduncular cisterns; and the mesencephalic, which extends backward to the pontomesencephalic junction, and separates the interpeduncular and the prepontine cisterns. Brasil and Schneider et al describe it as three continuous intercisternal walls: right and left carotid-interpeduncular walls and a central chiasmatic-interpeduncular wall [4].

The objective of this study is to determine the efficacy of the microsurgical fenestration of the Lamina Terminalis associated with the fenestration of the Liliequist Membrane in reducing shunt-dependent hydrocephalus in a series of 17 patients operated on in acute phase of aSAH.

Materials and Methods

In the period between January 2010 and January 2012, 80 surgeries were performed to treat 90 intracranial aneurysms in Hospital Central da Irmandade da Santa Casa de Misericórdia of Sao Paulo. The mortality rate was 17.5% (14 deaths).

Six patients developed chronic hydrocephalus, requiring shunt placement. None of them underwent either the fenestration of the Lamina Terminalis or the Liliequist Membrane.

The microsurgical fenestration of the Lamina Terminalis associated with the fenestration of the Liliequist Membrane was performed on 17 patients who underwent aneurysm clipping in acute phase. Most of them had an importante aSAH. (Table 1)

After the aneurysm clipping, a wide fenestration of the Lamina Terminalis was performed. In sequence, we fenestrated the Liliequist Membrane lateraly from the optic nerve and medially from internal carotid artery, up to the basilar artery until both sides P1 segment of the posterior cerebral artery were visible. In some cases, the fenestration of the Lamina Terminalis was performed before the aneurysm clipping in order to relax the brain. (Figure 1)

Fisher 1	2 patients
Fisher 2	4 patients
Fisher 3	9 patients
Fisher 4	2 patients
Total	17 patients

Table 1: *Fisher Scale on CT.*

The mortality rate in this series was 5,8% (one 84-year-old patient died on 18th post-surgery day of clinical complications, without signs of hydrocephalus on the CT).

We evaluated the late brain CT (6-16 postoperative months). None of the patients developed hydrocephalus.

Discussion

Hydrocephalus is a common complication following aneurysmal SAH. The treatment of acute hydrocephalus is an emergency treatment. The external ventricular shunt or the external lumbar shunt have been related with better clinical outcomes and decrease of the incidence of vasoespasm.

The treatment of chronic hydrocephalus is the shunt placement (ventriculoperitoneal shunt). Mechanical and infeccious complications can occur (13%) leading to rising of morbidity and mortality and treatment costs. It is reasonable to invest in prevention options.

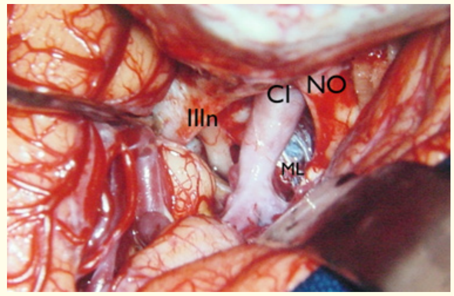

Figure 1: *Exposing the Liliequist Membrane (ML) between the internal carotid artery (CI) and optic nerve (NO). Lateraly the III nerve (IIIn).*

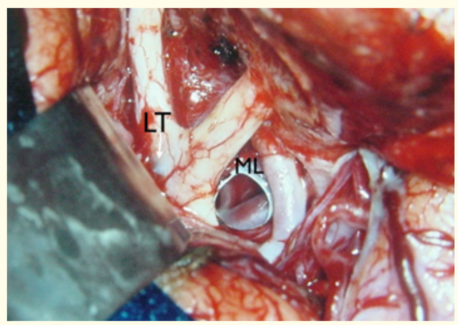

Figure 2: *Exposing the Lamina Terminalis (LT). Lateraly we see the fenestration of the Liliequist Membrane (ML), with visualization of basilar artery.*

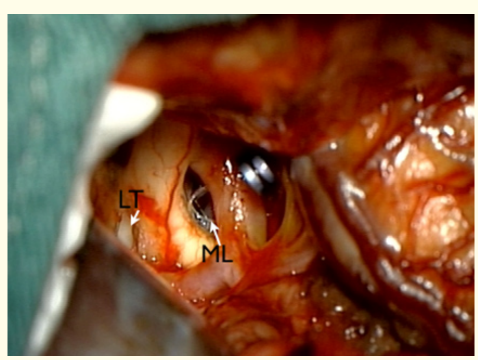

Figure 3: *Final aspect of the fenestration of the Lamina Terminalis (LT) and the Liliequist Membrane (ML).*

The fenestration of the Lamina Terminalis was proposed to reduce the incidence of chronic hydrocephalus. A sistematic review of 11 nonrandomized studies found no significant difference in shunt-dependent hydrocephalus among patients who had undergone fenestration of the Lamina Terminalis and those who had not [2].

The Liliequist Membrane became an anatomic reference for several neurosurgical procedures and participates in some pathologic processes:

1. Tumors that occupy the basal cisterns (craniopharyngiomas, meningiomas) frequently do not compromise the anatomic integrity of the Liliequist Membrane, serving as dissection plane parameters.
2. Endoscopic third ventriculostomy failure due to non-fenestration of the Lamina Terminalis [6].
3. Suprasellar arachnoid cyst: the Liliequist Membrane determines the classification of 2 types of cysts: A) intraarachnoid cyst of the diencephalic Membrane of Liliequist and B) the cystic dilation of the interpeduncular cistern (between the 2 leaves of Liliequist Membrane) [7].
4. Perimesencephalic hemorraghe: most frequently located in the interpeduncular and prepontine cistern. Shwartz and Solomon., *et al*. sugests that the Liliequist Membrane is capable of confining the interpenduncular cistern hemorrhage especially in low-pressure venous hemorraghes or low-volume hemorrhages. [4]. (Figure 4 and 5)

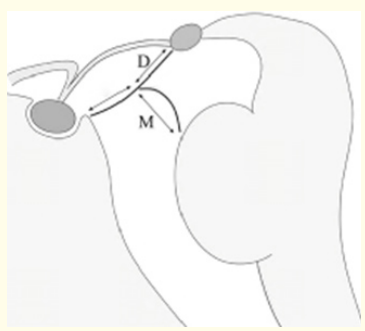

Figure 4: *Schematic illustration of the diencephalic leaf (D) and mesencephalic leaf (M) of the Liliequist Membrane.*

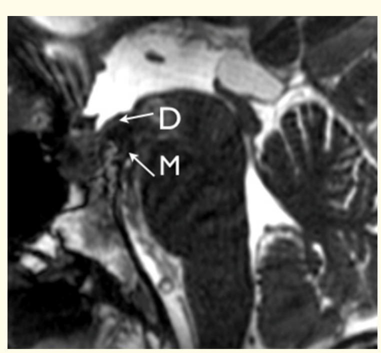

Figure 5: *Sagital FIESTA MR image of a patient with perimesencephalic hemorrhage showing the two leaves of the Liliequist Membrane circumcribing the hemorrhage.*

The Liliequist Membrane consists of a barrier between the supra and infratentorial basal cisterns. Its fenestration facilitates the infero-lateral acess to the floor of the third ventricle and provides an aditional way to CSF circulation. We belive that it represents a complement to the fenestration of the Lamina Terminalis, resulting in an efficient measure in preventing chronic hydrocephalus.

In this series, none of the patients developed hydrocephalus. The 6 patients that needed shunt placement had not been submitted to fenestration of the Lamina Terminalis nor of the Liliequist Membrane.

We observed that in several patientes, even after the dissection of the supratentorial cisterns, there was dammed CSF that flowed with the fenestration of the Liliequist Membrane. In all the cases, we performed a "maximized" mechanical cleaning of the cisternals clots (a recognized procedure in the prevention of hydrocephalus and ischemia) [5]. If these cases had been operated on in a later phase of aSAH, they may have had greatter chances of developing chronic hydrocephalus.

Conclusion

The microsurgical fenestration of the Lamina Terminalis complemented by the fenestration of the Liliequist Membrane consists of a sophistication of early surgery of ruptured aneurysm. In our series, it was efficient in preventing chronic hydrocephalus.

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