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COVER EDITORIAL

The Aqueduct

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Introduction

An aqueduct is a water supply or navigable channel created to convey water. The word is derived from the Latin *aqua* (water) and *ducere* (to lead).

The aqueduct of the central-Mexico City of Queretaro (designated as a UNESCO Heritage Site in 1996) is one of the longest aqueducts constructed during the Spanish colonial period in Mexico (http://en.wikipedia.org/wiki/Santiago_de_Quer%C3%A9taro).

The aqueduct was built between 1726 and 1735 under the auspices of Juan Antonio de Urrutia y Arana, a beneficiary of Queretaro and Cavalier of the Order of Alcántara and Marquis of the Villa del Villar del Aguila, in response to requests of the Capuchin Clarice Sisters [1].

The need for clean water during the second half of the seventeenth century in Queretaro, a prosperous and beautiful town of the New Spain, was the main reason for its being built.

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The aqueduct reached from *La Cañada*, a source of spring water, across the valley of *Carretas*, to the convent of *La Cruz*. It is 6,900 m long and is divided in three parts as follows: the initial canal, *the arches*, and the final canal [2, 3].

The most famous part of the structure, *the arches*, is 1,300 m long and the water canal (1.10-m wide) runs above 74 *arches* fashioned of masonry work and quarry stone and has a maximal height of 28.4 m. Under the arches, a modern avenue was built with two lanes and a median strip decorated with vegetation and magnificent illumination at night.

Between 1916 and 1917, on the order of the first Chief of the Constitutionalist Army, Don Venustiano Carranza, another arch (number 75) was opened, permitting access to the old road of Las Lagrimas, today the splendid Zaragoza Avenue [4] (Fig. 1 and cover figure).

The cerebral aqueduct

The eponym "aqueduct of Sylvius" refers to medieval anatomist Jacques Dubois (1478–1555), who referred himself with the Latinized version of his name: Jacobus Sylvius.

In 1650, Franciscus de la Boe Sylvius (May 11, 1614, Hanau, Germany—November 19, 1672, Leiden, Holland), the anatomist physician and scientist described a narrow passage between the third and fourth ventricles (the aqueduct of Sylvius). The most important work that he published was *Praxeos medicae idea nova* (*New Idea in Medical Practice*) in 1671 [5–7] (Fig. 2).

The *aqueduct*, about 15 mm in length (mean cross-sectional area, 0.5 mm^2 in children, and 0.8 mm^2; range 0.2–1.8 mm^2) in adults, comprises the residue of the primitive mesencephalic cavity [8]. In 1855, Gerlach subdivided the

Fig. 1 *The Arches*, the most representative part of the aqueduct in Queretaro, Mexico. At the beginning of the twentieth century (*left*) [5], and their current status (*right*)

aqueduct into three parts. Turkewitsch and Bickers recognized five portions, namely the *aditus ad aquaeductum or aditus aquaeducti*, the anterior part with a first constriction, ampulla, genu (second constriction), and the posterior part [9, 10]. The quadrigeminal plate appears to be relevant in aqueduct geometry; due to its protrusion into the aqueductal lumen, the superior colliculus is responsible for the first constriction (the narrowest), while the second constriction is caused by the protruding inferior colliculus. Between the two structures, the aqueduct enlarges into what is denominated the ampullam. The diameter of the two constrictions changes during fetal life: the anterior ranges from 0.4 to 0.8 mm, and the posterior from 0.5 to 1 mm. The diameter diminishes progressively from a fetal age of 2 months until birth. Postnatally, the aqueduct's diameter steadily increases with age [6]. Both constrictions are clearly observed on endoscopic navigation, and they are critical points where even a minimal accumulation of debris, clots, or mild inflammatory changes may cause obstruction [8] (Fig. 3).

As the narrowest part of the cerebrospinal fluid (CSF) pathway, the Sylvian aqueduct is the most common site of intraventricular blockage of the CSF [9, 11]. Stenosis of the aqueduct is responsible for 6–66 % of cases of hydrocephalus in children and for 5–49 % of these in adults [12–14] (Fig. 4).

The importance of the concept of the aqueduct relates to the CSF pathways and hydrocephalus. The aqueduct described previously served for circulation of water. This function is related to the cause of signs and symptoms within the context of hydrocephalus, in which the aqueduct may become stenotic as a consequence of compression from mass lesions or because of intrinsic pathology ("nontumoral aqueductal stenosis"). Intrinsic aqueductal stenosis may be congenital or acquired, idiopathic, or secondary to a known etiology.

Fig. 2 Franciscus Sylvius [1]

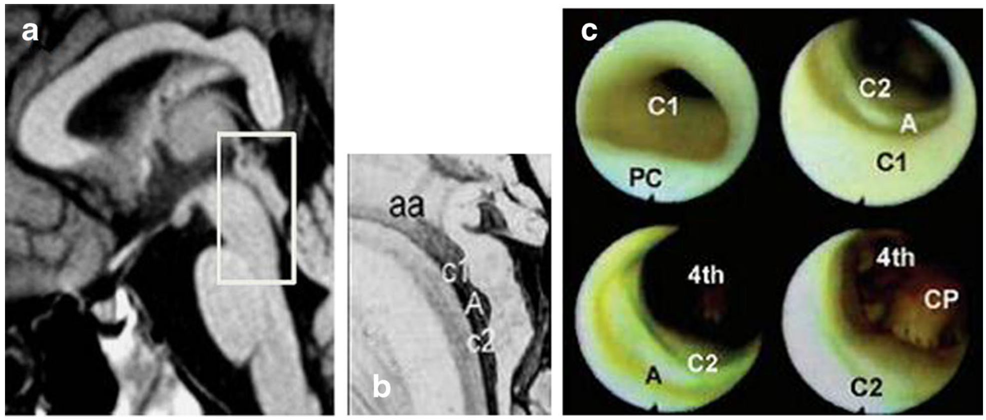

Fig. 3 The aqueduct in magnetic resonance imaging (*MRI*): **a** schematic view magnified for detail (**b**) and endoscopic navigation (**c**). *PC posterior commissure*, *aa Aditus aquaeducti*, *C1* first constriction: superior colliculi, *A* ampulla, *C2* second constriction: inferior colliculi, *4th* fourth ventricle, and *CP* choroid plexus [7]

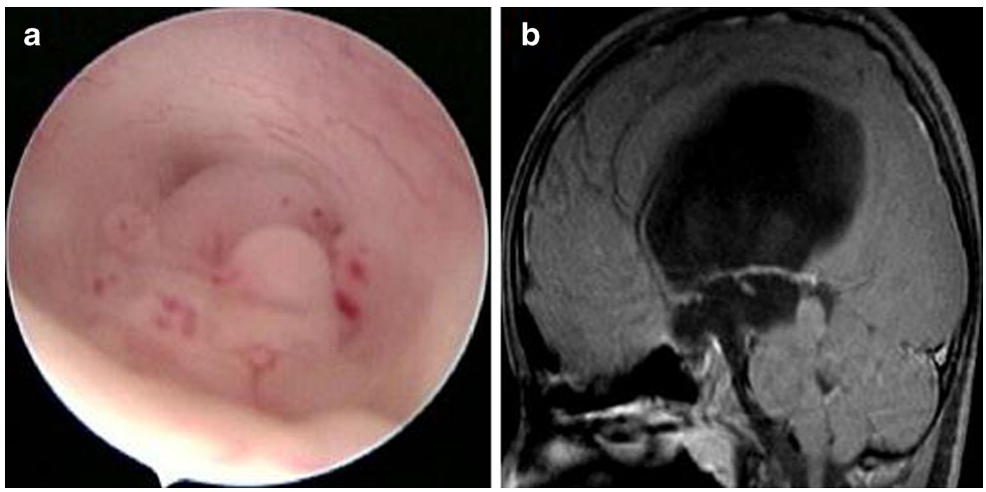

Fig. 4 **a** Endoscopic view of the posterior part of the third ventricle and the missing anatomy of the aqueduct due to obstruction by a tectal glioma that protrudes inside. **b** T1 mid-sagittal MRI showing the tectal glioma, obstruction of the aqueduct, and triventricular hydrocephalus (*right*)

References

1. Ramírez Montes G, Iturrate J (1979) Un ilustre ayalés en México, don Juan Antonio de Urrutia y Arana (1670–1743). Caja de Ahorros Municipal de Vitoria, Vitoria
2. Septien y Septien, M (1974) Acueductos y fuentes de Querétaro. Documentos de Querétaro. México, Colección de Documentos 10 (páginas 11 a 19)
3. Gómez, S (2009) Monumentos civiles más representativos de los siglos XVI al XVIII en la ciudad de Querétaro. Instituto Tecnológico de Querétaro
4. Ramirez Alvarez JG (2008) Queretaro en los Siglos. Ed. Caminos escritos (cantera rosa). p 123–27
5. Collice M, Collice R, Riva A (2008) Who discovered the Sylvian fissure? Neurosurgery 63(4):623–628
6. Longatti P, Fiorindi A, Perin A, Martinuzzi A (2007) Endoscopic anatomy of the cerebral aqueduct. Neurosurgery 61(3):1–7
7. Van Gijn J (2001) Franciscus Sylvius (1614–1672). J Neurol 248: 915–916
8. Emery JL, Staschak MC (1972) The size and form of cerebral aqueduct in children. Brain 95:591–598
9. Bickers DS, Adams RD (1949) Hereditary stenosis of the aqueduct of Sylvius as a cause of congenital hydrocephalus. Brain 72:246–262
10. Flyger G, Hjelmquist U (1957) Normal variations in the caliber of the human cerebral aqueduct. Anat Rec 127:151–162
11. Russell DS (1949) Observations on the pathology of hydrocephalus. Br J Surg 37(145):126
12. Hirsch JF, Hirsch E, Sainte-Rose C, Renier D, Pierre-Khan A (1986) Stenosis of the aqueduct of Sylvius (etiology and treatment). J Neurosurg Sci 30:29–39
13. Jellinger G (1986) Anatomopathology of nontumoral aqueductal stenosis. J Neurosurg Sci 30:1–16
14. Robertson JA, Leggate JRS, Miller JD (1990) Aqueductal stenosis—presentation and prognosis. Br J Neurosurg 4:101–106