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AJNR Am J Neuroradiol 1997, 18 (6) 1033-1034
<http://www.ajnr.org/content/18/6/1033.citation>

This information is current as
of June 7, 2023.

HISTORY

The Circle of Willis

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On St Martin's Day (November 11), volleys of gunpowder explosions disturb the quiet of Fenny Stratford, a small country town midway between Oxford and Cambridge close to Stony Stratford (1). The explosions are part of a curious celebration, which has taken place every year since 1734. The celebration consists of three events. The first is a sermon in the parish church for which the invited speaker receives the fee of one guinea. The next event is a turkey dinner at the Bull, the inn next door, where each attendee must pay his own alcoholic burden without compulsory aid from his companions (2). The third event is the firing by the town dignitaries of the "Fenny poppers," six muglike cannonades, forged from gunmetal, each weighing about 20 pounds and measuring 7 inches high with a $\frac{3}{4}$ -inch bore and 6 inches deep. The poppers are filled with a quarter pound of gunpowder, plugged with well-rammed newspaper, lined up in a protective trench, and fired at 12 noon, 2 PM, and 4 PM using a metal rod made red-hot in the church furnace. So is remembered in inimitable English fashion the death on St Martin's day in 1675 of Thomas Willis, the famous anatomist-physician and professor of natural philosophy at Oxford. (This, probably unique among medical memorials, was conceived by Browne Willis, Thomas Willis's grandson, a scholar and antiquarian of repute, as a monument to his grandfather [1] [Stephen Huckle, personal communication, 1996]. The rent from houses left in the will of Browne Willis in 1760 pays for the strange custom.)

Willis of course is famous for the arterial anastomosis at the base of the brain that bears his name. In medical and scientific research, originality of theme and content is of major importance. Fame is often derived from having a clinical sign, disease, or anatomic structure

named after the originator. Thus we have Lhermitte's sign, the Babinski reflex, the Chiari malformation, the Dandy-Walker syndrome, the aqueduct of Sylvius, the veins of Trolard and Labbé, and the circle of Willis. We believe the individuals whose names are attached to these signs, diseases, or structures to be the first to have described them. This is almost always true. Willis is thought by many to be the first to illustrate the arterial circle at the base of the brain that has his name. This attribution is in error.

Thomas Willis's fame is derived from multiple sources. Not only did his book *Cerebri Anatome* describe and illustrate the circle, but it marked the transition between medieval and modern notions of brain function. Willis was also the first physician to use the term *neurology* and was among the first to present the notion of a circulating hormone from the pituitary and gonads (3). Willis illustrated the 'circle' (which actually is nine sided, a nonagon) in his book published in 1664 (4). Von Haller in the late 18th century was the first to refer to the arterial anastomosis as the circle of Willis.

Before Willis, little was known about the physiology and function of the brain. Willis was the first to recognize the importance of the circle in maintaining collateral flow to the brain ("... if the Carotides of one side should be obstructed, then the vessels of the other side might provide for either Province..." [4]), and recorded the clinical histories of two patients in whom this anatomic arrangement had prevented apoplexy. Willis never claimed to be the first to describe the circle. Johan Jacob Wepfer of Schaffhausen in Switzerland in his book *Observationes Anatomicae ex Cadaveribus Eorum Quos Sustulit Apoplexia* in 1658 clearly described in detail the anastomoses that make up the circle; however, he failed to illustrate the circle (5). Even before Wepfer, Vesling in 1647 and 1651 illustrated an almost complete circle in his book *Syntagma Anatomicum*. (The circle

is *almost* complete because of a question as to whether the anterior communicating artery is shown in the illustration, or whether the apparent communication merely represents background shadowing [5]. There is no mention of a communication in the explanatory text.)

Delving further back into history we encounter Giulio Casserio (1545–1605), who in his elegant atlas published posthumously in 1627 illustrated an almost complete arterial circle in a book *De Humani Corporis Fabrica* published by Adrianus Spigelius. This illustration is probably the first documented illustration of the anastomoses, although 65 years earlier Gabriel Fallopius in 1561 and 1562 in his *Anatomical Observations* described an almost complete circle save for the posterior communicating artery, which he thought was only indirectly connected with the internal carotid artery through a network of small arteries. Casserio in his illustration corrected this mistake on one side but left it as Fallopius described it on the other side (the octagon of Casserio?). (It is quite possible that the posterior communicating artery was absent, a not infrequent anomaly, in the brain specimen that Casserio examined.)

Thus the correct recognition of the arterial ramifications at the base of the brain had a long

and gradual evolution, and it appears that many anatomists had a hand in describing and illustrating the circle (5). Originality is a more basic value than priority (6). While Willis might not have been the first to recognize the presence of an arterial circle at the base of the brain, it is his independence of thought and creativity in understanding the significance of the circle that has produced the scientific work of the most value and has generated the most lasting recognition. This alone provides sufficient historical justification for calling the structure the circle of Willis.

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