CEREBROSPINAL FLUID CIRCULATION IN A PIECE OF POPULAR ART: *THE MONA LISA,* PAINTED BY LEONARDO DA VINCI.

Category: History of Neurosurgery.

Author: Enoh N. Kingsly, MBBS, PGC

Neurosurgery Unit, Muhimbili Orthopaedic Institute (MOI),

Dar es Salaam, Tanzania.

Email: enohk2001@yahoo.com

Abstract.

Cerebrospinal fluid (CSF) is a clear colourless fluid that occupies the ventricles and the subarachnoid space of the brain and spinal cord. It acts as a shock absorber to the brain and provides basic mechanical and immunologic support. Undisturbed circulation of this fluid is of utmost importance in the maintenance of normal brain function and integrity and as such, has been studied since medieval times. From 1503 to 1519, Leonardo da Vinci, an Italian born artist, scientist and anatomist who had carried out brain dissections, painted the Mona Lisa, which was later described as the most popular painting in the world. This article looks at Leonardo da Vinci as an anatomist and correlates the landscape in the Mona Lisa with CSF circulation, an aspect that has never been touched despite several detailed studies and descriptions of this famous artistic masterpiece.

Key words: Cerebrospinal fluid circulation, Leonardo da Vinci, the Mona Lisa.

Introduction.

Cerebrospinal fluid (CSF) occupies the ventricles and the subarachnoid space in the brain and spinal cord. Thus, it surrounds the brain and spinal cord and constitutes the contents of the brain cisterns and sulci; the central canal of the spinal cord and the lumbar thecal sac (6). It acts a cushion to the Central Nervous System (CNS) (6,) and may have an immunologic protection, similar to that of the lymphatic system (2).

Cerebrospinal fluid is a clear colourless fluid with a pH of 7.33 to 7.35 and a specific gravity of 1.007 (6). It is formed by the choroid plexus of lateral ventricles (about 80%), the ependymal lining of ventricles and the dura of nerve root sleeves. The

volume of CSF is about 5 ml and 150 ml in the neonate and adult, respectively. The rate of production is about 25 ml/day in an infant and 250 ml/day in an adult. It has a pressure of about 9 to 12 cmCSF in a newborn and 8 to 20 cmCSF in an adult (6).

CSF circulation and absorption.

Under normal conditions, CSF circulates from its point of maximum formation (the choroid plexus of the lateral ventricles) to the third ventricle through the foramina of Monro. From the third ventricle, it passes through the aqueduct of Sylvius to the fourth ventricle. From the fourth ventricle, CSF flows to the subarachnoid space through the foramina of Luschka and Magendi. Thence, it is absorbed to the venous system through the arachnoid granulations.

The rate of formation of CSF, under normal conditions, is independent of intracranial pressure (11). However, the rate of CSF absorption is pressure dependent (7). Cerebrospinal fluid flow through the ventricles and foramina and the relationship between the rate of production or absorption with pressure, are surprisingly highlighted in the Mona Lisa, painted by Leonardo da Vinci, as we shall see in subsequent sections.

Sketch of the man Leonardo da Vinci.

Leonardo di ser Piero da Vinci was born on April 15th 1452 (4) in the hill town of Vinci, in the lower valley of the Arno River, in the territory of Medici, ruled by the republic of Florence (1). He was the son of a wealthy Florentine legal notary, Messer Piero Frusino di Antanio da Vinci and Caterina, a peasant woman (15, 1).

He has often been described as a man of unquenchable curiosity and feverish inventive imagination one of the greatest painters of all times and perhaps the most multitalented person to have ever lived (4, 9). His works include the Last Super, the Vitruvian Man, the Virgin of the Rocks and the Mona Lisa, amongst others. The Mona Lisa is often considered as the most famous painting in the world (1, 8).

In 1466, Leonardo joined the workshop of the famous Florentine artist Andrea di Verrocchio as an apprentice of art and in 1472, at the age of twenty, was admitted into the Guild of Florentine Painters, referred by some, to as the Guild of St Luke or the guild of artists and doctors of medicine (4, 9, 12).

During his apprenticeship days at Verrocchio's workshop, Leonardo formerly learned human anatomy and dissection (4, 9). He carried out several observations and dissections, and recorded his findings in his note books. He made several anatomical drawings of human muscles, tendons, bones, brain, skull and one of the first scientific drawing of the foetus in utero (9, 10, 13).He was also given permission as a successful artist to dissect human corpses at the Hospital of Santa Maria Nuova in

Florence and later in hospitals in Milan and Rome. Leonardo is said to have demonstrated the neurological phenomenon known as the Babinski's sign in his paintings, long before it was described by Babinski himself (3). His drawings and notes were left at the care of Francesco Melzi, his heir, for publication as a text of anatomy and were later published in France in 1632 (9, 10).

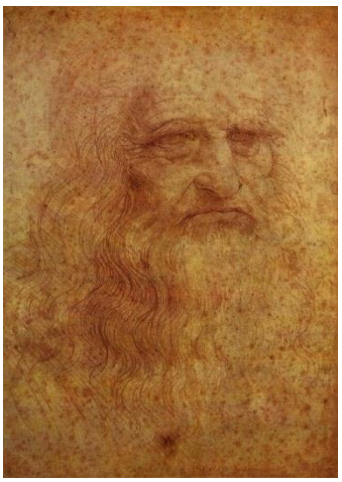
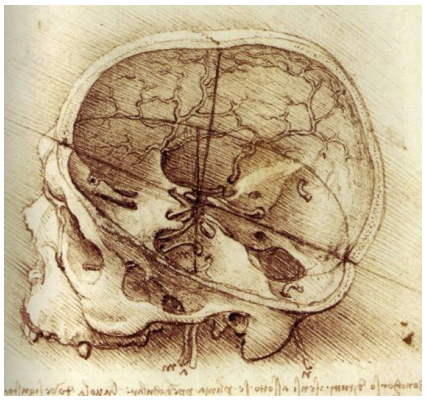


Fig 2. Leonardo da Vinci (1452-1519).

3



4

Figs 3. and 4 .Sketchs of foetus in utero and skull base respectively, by Leonardo.

A brief decription of the Mona Lisa.

The Mona Lisa, (also known as La Gioconda or La Joconde or Portrait of Lisa Gerhardini, wife of Francesco del Giocondo) is a painting of oil on poplar, painted by Leonardo da Vinci between 1503 to 1519 (1, 8, 12). On permanent display at the Musee de Louvre in Paris, France, it is popularly known to be the portrait of Lisa del Giocondo, the wife of Francesco del Giocondo, a wealthy Florentine silk merchant. The work is a half-length portrait of seated woman with enigmatic facial expression and characteristic half- smile. Behind the woman, in the background, is a beautiful landscape of icy rock and flowing water.

The painting has been extensively studied by artists and scientists, including Sigmund Freud (14), leading to a lot of speculations on what Leonardo had in mind as he worked on the Mona Lisa.

Fig 5. The Mona Lisa.

Correlation between landscape of the Mona Lisa and CSF circulation.

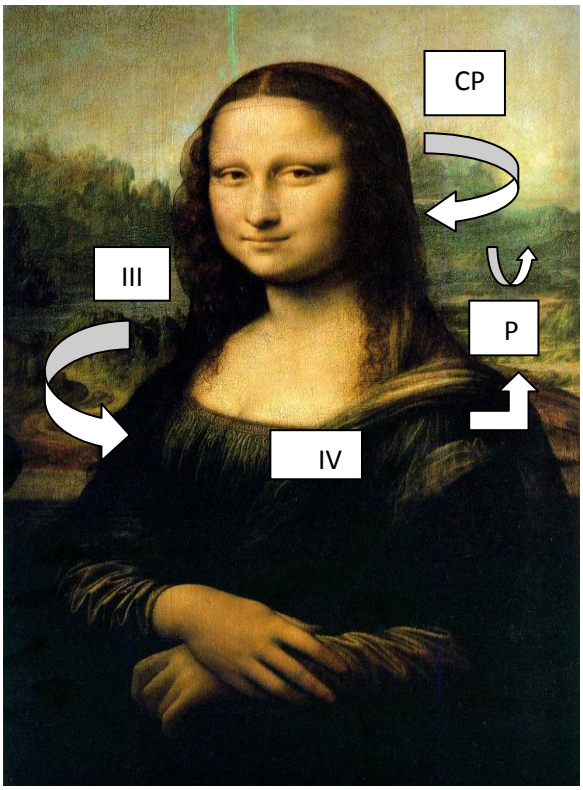


Fig 6. Correlation between landscape of the Mona Lisa and CSF circulation.

A critical look at landscape in the background of Mona Lisa (fig 6) will show that there is flow of water in the form of a tiny stream from the point marked CP (representing the choroid plexus where CSF is formed) in the direction of the arrow curved to the left (representing the foramina of Monro), to a small pool marked as III (representing the third ventricle). The flow continues in the direction of the biggest

arrow, curved to the right (representing the aqueduct of Sylvius) to a point in the Mona Lisa herself or behind her (representing the fourth ventricle).

The small stream continues to a point P, which is seen as a step (representing the pressure gradient during CSF absorption) and disappears in the icy landscape (point of absorption of CSF through the arachnoid granulations).

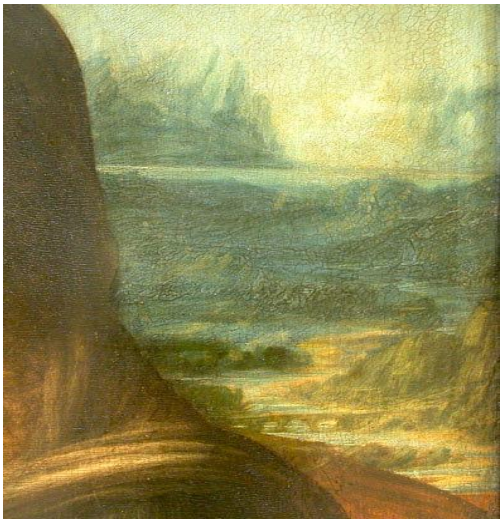


Fig 7. Details of the landscape behind the Mona Lisa, showing the "step", representing the pressure gradient during CSF absorption.

Discussion.

The popularity of the Mona Lisa has made it one of the most studied paintings in history. Studies by Sigmund Freud, Isabelle of Naples , Picasso, Salvador Dali to name but a few, lead to several speculations and subsequent caricatures, representing what was going on in Leonardo's mind as he painted the Mona Lisa (14, 9). Sigmund Freud, for example, believed that the famous half-smile of represented a recovered memory of Leonardo's mother (9, 14). Others speculated that the woman in the painting represented Leonardo himself (9).

Despite all these speculations, the fact that Leonardo da Vinci was a human anatomist, who had carried out several dissections on human cadavers both during the days as an apprentice in Verrocchio's workshop and after graduation as an artist still remains. This may lead to a new speculation that Leonardo da Vinci was thinking about CSF flow in a human cadaver he had dissected and represented it as a flowing

stream in the landscape behind the Mona Lisa. Perhaps, he had started painting the Mona Lisa after a dissection session.

Conclusion.

Speculations that Leonardo da Vinci represented medical and anatomical phenomena in his paintings outside his anatomical sketches are not new (3, 14). However, the speculation that the landscape in the Mona Lisa represents CSF flow and absorption is put here to appreciate the man Leonardo da Vinci as an extraordinary neuro-anatomist whose genius in the arts and sciences has greatly contributed to modern scientific endeavours including neuroanatomy and neurosurgery.

References.

1. Angela, O C: The Complete Paintings of Leonardo da Vinci. Mishariaka. Penguin (Non-Classics). 1986, p83.
2. Binhammer, R T: CSF anatomy with emphasis on relations to nasal cavity and labyrinthine fluids. Ear Nose Throat J 71: 292-9, 1992.
3. E Wayne Massey, Lynda Sander: Babinski sign in medieval, renaissance and baroque art. Arch Neul 46: 85-88, 1987
4. Edward Bolme: The Lost Notebook of Leonardo da Vinci. Mike Ponsmith, 1995.
5. Gardner, Helen: Art through the Ages. 1970 pp 450-456.
6. Greenberg, MS: Handbook of Neurosurgery.5th Edn. Berlin. Thieme, 2001.
7. Griffith, H B, Jamjoom, A B: The treatment of childhood hydrocephalus by choroid plexus coagulation and artificial cerebrospinal fluid perfusion. Br J Neurosurg 4: 95-100, 1990
8. http://en.wikipedia.org/wiki/Mona_Lisa.
9. http://en.wikipedia.org/wiki/Leonardo_da_Vinci.
10. Kenneth D Keele : Leonardo da Vinci's influence on Renaissance Anatomy, 1964.
11. Lorenzo A V, Page L K, Walters G V: Relationship between CSF formation, absorption and pressure in human hydrocephalus. Brain 93: 697-92, 1970.
12. Maurice Walter: Leonardo da Vinci. Forgotten Books AG, 2010. pp 3-4.
13. Mason Stephen: A History of the Sciences, New York. Collier Books, p550.
14. Nichol Charles: The Myth of the Mona Lisa. The Guardian UK. http://books.guardian.co.uk. London 2002.
15. Vezzosi Alessando: Leonardo da Vinci: The Mind of the Renaissance. New York. Harry N. Abrams. 1997