Neuroanatomical interpretation of Peter Paul Rubens's copy of „The Battle of Anghiari'' by Leonardo da Vinci

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Abstract

The object of this research is a drawing by Peter Paul Rubens, a copy of „The Battle of Anghiari'' performed by Leonardo da Vinci in 1503-1506. This work, dating from 1603, was based on an engraving of 1553 by Lorenzo Zacchia, which was taken from a cartoon by Leonardo da Vinci. The original fresco itself is lost. Since the individual details of the drawing matched the anatomical elements of the human brain we decided to perform an anatomical interpretation. With the help of the program Paint X we were able to move 23 elements of the drawing. The comparison revealed the similarity between the details of the obtained image and the anatomical elements of the brain. Our research shows that the Peter Paul Rubens's copy of „The Battle of Anghiari'' by Leonardo da Vinci is a harmonious mix of Art and Anatomy. We have established that the copy of the lost fresco, which was created six centuries ago, includes double content. By moving 23 details of the drawing in which the battle is depicted, an image is obtained. This image accurately describe the anatomical elements of the brain in the lateral view.

Keywords: Leonardo da Vinci; brain anatomy; Battle of Anghiari

Introduction

Ancient medical practitioners had contradictory views about the significance of the brain. Renaissance physicians began to dissect the brain with greater frequency at the end of the fifteenth century. During this period, Leonardo da Vinci started to dissect the brain. By the first decade of the sixteenth century, Leonardo's images were considerably anatomical. He sketched the brain from many different perspectives, looking closely at the ventricles and the origins of the nerves in the medulla.

Materials and Methods

The object of this research is a drawing by Peter Paul Rubens, a copy of ,,The Battle of Anghiari'' performed by Leonardo da Vinci in 1503-1506. This work, dating from 1603, was based on an engraving of 1553 by Lorenzo Zacchia, which was taken from a cartoon by Leonardo da Vinci. (Fig. 1). The original fresco itself is lost.

Since the individual details of the drawing matched the anatomical elements of the human brain we decided to perform an anatomical interpretation (Fig. 4- 1, 2, 3, 4, 9, 10, 12, 22, 24, 25, 35, 39). With the help of the program Paint X we were able to move 23 elements of the drawing. The details of the obtained image (Fig. 3) are compared to the anatomical structures of the human brain in the lateral view.

Fig. 1. Drawing by Peter Paul Rubens – copy of ,,The Battle of Anghiary'' by Leonardo da Vinci

Results

According to the research, the image is the right half of the human brain from the sagittal view. A detailed description of the brain elements is set in figure 4.

We think ,,The Battle of Anghiari'' is a usual puzzle of the wizard. By moving the details of drawing, elements are arranged in anatomical sequence. Slight displace on the top revealed that anatomical elements perfectly and precisely match each other (Fig 2 A, B).

Fig. 2 (A, B) The trajectory of displacement of the drawing elements

Finally, as a result, the image of the brain with its anatomical structure precisely repeating their natural disposition is obtained (Fig. 3, 4).

Fig. 3 Image after drawing elements moving

The sequence is between the details that correspond to the medulla oblongata (Fig. 4- 1), the pons (Fig. 4- 2), the midbrain (Fig. 4- 3), the basilar artery (Fig. 4- 4), the superior cerebellar artery (Fig. 4- 39), the hypophysis (Fig. 4- 5), the cerebral aqueduct (Fig. 4- 6), the optic chiasm (Fig. 4- 7), the hypothalamus (Fig. 4- 13), the central sulcus (Fig. 4- 15), the pineal body (Fig. 4- 16), the interthalamic adhesion (Fig. 4- 17), the cerebellum (Fig. 4- 19), the mamillary body (Fig. 4- 20), the median aperture (Fig. 4- 21), the fourth ventricle (Fig. 4- 22), the thalamus (Fig. 4- 23), the spinal cord (Fig. 4- 24), the vertebral artery (Fig. 4- 25), the flocculonodular lobe (Fig. 4- 31), the confluence of venous sinuses (Fig. 4- 32), the folium (Fig. 4- 33), the lamina of the tectum (Fig. 4- 34), the first cervical vertebra (Fig. 4- 35), and the parieto-occipital sulcus (Fig. 4- 36).

Above the thalamus there appears the fornix (Fig. 4- 30) and lateral ventricle (Fig. 4- 12). It is likely that two cranial nerves are presented here: the right optic nerve (Fig,. 4- 8), and right olfactory tract (Fig. 4- 9) with olfactory bulb (Fig. 4- 10). The contours of the painting correspond to the frontal (Fig. 4- 11), parietal (Fig. 4- 14), and occipital lobes (Fig. 4- 18).

The lower left sword of the painting corresponds to the right orbit (Fig. 4- 28) with the back wall forming a sphenoid bone (Fig. 4- 26), as well as the eye, witch which layers and anatomic elements are skillfully described - (Fig. 4- 29), the sclera (Fig. 4- 37), the cornea (Fig. 4- 38), the choroid (Fig. 4- 40), the retina (Fig. 4- 41), the lens (Fig. 4- 42), the ophthalmic artery (Fig. 4- 27), and the extracranial segment of the optic nerve (Fig. 4- 8).

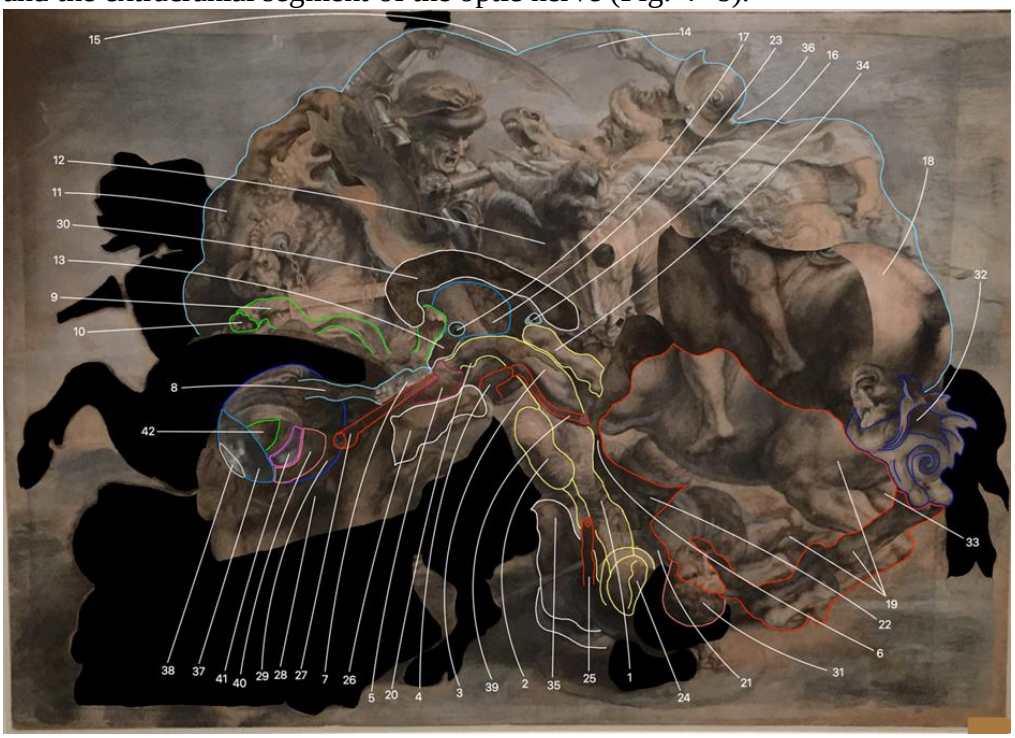

Fig. 4

1- Medulla oblongata; 2- Pons; 3- Midbrain; 4- Basilar artery; 5- Hipophysis; 6- Cerebral aqueduct; 7- Optic chiasm; 8- Right optic nerve; 9- Right olfactory tract; 10- Olfactory bulb; 11- Right frontal lobe; 12- Lateral ventricle; 13- Hypothalamus; 14-Right parietal lobe; 15- Central sulcus; 16- Pineal body; 17- Interthalamic adhesion; 18- Right occipital lobe; 19- Cerebellum; 20- Mamillary body; 21- Median aperture; 22- Fourth ventricle; 23- Thalamus; 24- Spinal cord; 25- Right vertebral artery; 26- Sphenoid bone; 27- Right ophthalmic artery; 28- Right Orbit; 29- Right eye; 30- Fornix; 31- Flocculonodular lobe; 32- Confluence of venous sinuses; 33- Folium; 34- Lamina of the tectum; 35- Superior articular process of the first cervical vertebra; 36- Parieto-occipital sulcus; 37- Sclera; 38- Cornea; 39- Superior cerebellar artery; 40- Choroid; 41- Retina; 42- Lens

Discussion

The Renaissance artists showed a great deal of interest in human anatomy and especially, the brain. An example of this is the fresco ‘Creation of Adam’ by Michelangelo Buonarroti, which brilliantly describes brain anatomy (Meshberger 1990).

The assertion proves that da Vinci had deep knowledge of human anatomy. Leonardo da Vinci (1452-1519) described a method of preserving the cadavers that he studied. His embalming fluids were mixtures made from turpentine, camphor, oil of lavender, vermilion, wine, rosin, sodium nitrate, and potassium nitrate (Brenner 2014). Da Vinci also used an injection of wax to the ventricles.

The description of methods of the cadaver preservation was used in Europe for almost 1200 years, started in about AD 500. They have been preserved in the writing of physicians (Brenner 2014).

In this period, anatomical knowledge in Europe was largely based on manuscripts from classical Greece and medieval Italy, the dissection of animals, and the intermittent dissection of the condemned criminal (Park 1994, Olry 1997). While criminals hung for murder were available for anatomical dissection, even by the 17th century there were not enough eligible hangings to accommodate the demand for bodies (Mitchell et al. 2011). Despite the fact that cadaver dissection was illegal in this epoch, physicians still managed to deepen knowledge in human anatomy. Leonardo fundamentally studied the anatomy of human brain and used this knowledge in the art.

Da Vinci's most penetrating anatomical studies began in 1506 with his dissection of 100-year-old man. He acquired first human skull in 1489 and around 30 corpses were dissected by him until 1513 (Jones 2012).

Leonardo's pioneering research of the brain led him to discoveries in neuroanatomy (frontal sinus and meningeal vessels) and neurophysiology (Todd 1983).

It is estimated that around the year 1480 Leonardo da Vinci painted Saint Jerome in the Wilderness, representing the saint during his years of retreat in the Syrian desert where he lived the life of a hermit. One may interpret Leonardo's Saint Jerome in the Wilderness as St. Jerome practicing self-chastisement with a stone in his right hand, seemingly punching his chest repeatedly. The stone, the lion and a cardinal's hat are conventionally linked to the saint. A skull was also almost always present with the image of the saint symbolically representing penance. With careful analysis of the painting, one can identify the skull which is hidden in an arc represented as a lion's tail. The image is of a hemi cranium (midline sagittal view) showing the intracranial dura, including the falx and tentorium, and venous system with the sinuses and major deep veins. This may have been the first time when the intracranial sinuses and the major deep venous vessels were illustrated (Valença et al. 2013).

Leonardo developed a unique, mechanistic model of sensory physiology. He undertook his research with the broad goal of providing physical explanation of how the brain processes visual and other sensory input and integrates that information via the soul. Leonardo began to examine the

relationship between the brain and the olfactory and optical nerves through different experiments (Pevsner 2002).

Leonardo da Vinci describes the pineal body corresponding to the eye of the horse. In the epithalamus of some species of amphibians and reptiles, it is linked to light-sensing organ known as the parietal eye, which is also called the pineal eye or third eye (Eakin 1973).

It is known that Leonardo collaborated with the anatomist Marcantonio della Torre in the 1510-1511 and it seems that he had access to a convict's head (Turner 1994). His illustrations of the human skull contain an outstanding amount of anatomical details (Del Maestro 1998, Tascioglu 2005).

Leonardo filled notebooks with carefully drawn two-dimensional representations of the organs, tissues, and skeletal formations uncovered during his dissections (Cothern 2008). He is considered to be the first scientific illustrator in the contemporary sense (Andrassy et al 1976, Ione 2010).

On 24 October 1503, in order to create the cartoons and preparatory sketches for the vast painting of the battle scene, Leonardo was given the keys to the Sala del Papa, adjacent to the Church of Santa Maria Novella in Florence. Here he set up a workshop to house himself and his assistants. Record show that the figures in the cartoon and subsequent painting were one and a half times life-size. Leonardo began to paint „The Battle of Anghiari'' in 1505. He completed the central part before leaving for Milan. His experimentation with paint pigments and formulas led to some of the paint ‚sliding' of the canvas, but the mural remained in place until at least 1549. The large cartoon was cut up and sold but a mystery still surrounds the whereabouts of the painting. It may be behind Giorgio Vasari's mural „Battle of Marciano" in Val di Chiana, 1563. Vasari had reconstructed the hall for Cosimo de' Medici. However, many historians believe that Vasari would not have destroyed Leonardo's work. Professor Maurizio Seracini believes that Vasari built a thin wall in front of Leonardo's work and applied his own painting to a screen in front of it (Ormiston 2017).

In our opinion, the master demonstrated the human brain in three dimensions through sfumato (the technique of allowing tones and colors to shade gradually into one another, producing softened outlines or hazy forms).

Conclusion

Our research shows that the Peter Paul Rubens's copy of „The Battle of Anghiari'' by Leonardo da Vinci is a harmonious mix of Art and Anatomy. We have established that the copy of the lost fresco, which was created six centuries ago, includes double content. By moving 23 details of the drawing in which the battle is depicted, another image is obtained. This image accurately describe the anatomical elements of the brain in the lateral view.

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