

Frederik Ruysch (1638-1731): Life and lessons from a memorable anatomist

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SUMMARY

Frederik Ruysch (1638-1731) was a Dutch surgeon, anatomist, and artist. His medical career followed a successful course, resulting in many awards and prizes. Advancements in his career afforded him a variety of privileges, including access to cadavers, on which he could perform dissections. During the 17th and early 18th century he made several discoveries and descriptions of human anatomy, physiology and pathology, in the different systems of the human body. He also developed an impressive fixative solution, enabling him to give a "life aspect" to the cadaveric pieces which he prepared. Finally, Ruysch could present his preparations in an artistic way, paying attention to details in order to create not only an image of a well-preserved cadaver, but a whole contextualized message, which could impress the people of his time and is still impressing people at the present. Professor Frederik Ruysch and his exhibitions were a revolution during his lifetime, presenting new discoveries in different fields, creating a new fixative solution and adding the artistic component into the anatomical science.

Key words: Embalming – Frederik Ruysch – History of Anatomy – Fixative solution – Surgery

INTRODUCTION

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Frederik Ruysch was born on March 23rd, 1638, in The Hague, Netherlands (Fig. 1). He was initially trained as a pharmacist but then went to the University of Leiden in 1661, where he embarked on the study of medicine and obtained his medical degree three years later, writing a thesis on pleurisy titled *De Pleuritide* (Houtzager, 1982).

After obtaining his degree, in 1666 was appointed as Praelector Anatomiae (Lecturer in Anatomy) of the Amsterdam Guild of Surgeons, where he taught anatomy to the surgeons of the town (Ijpm and van Gulik, 2013). Thereafter, he became chief anatomist (1667), inspector of those killed in personal quarrels, official city teacher of obstetrics (1668), master of midwives (1672), physician to the Court (1679), and professor of botany (1685) in Amsterdam (Mirilas et al., 2006). These positions not only promoted advancements in his rise in the medical career, but also allowed him access to the cadavers of executed criminals and victims of infanticide, which was fundamental to the development of his works and discoveries (Rifkin et al., 2011).

AWARDS

His passion for anatomy was the major motivation to create a collection of anatomical pieces, with the purposes of a scientific and artistic understanding of human body. The importance of his work to medical knowledge, as well his prestige at the time, can be justified by the abundant titles and awards that he received: association to the Leopoldine Academy in Breslau, Prussia (now Wrocław, Poland, 1705), nominee to the Royal

Submitted: 7 January, 2014. *Accepted:* 13 February, 2014.

Society of England (1720), substitute of Isaac Newton at the Royal Society of Paris (1721), and election an honorary member of the Academy of Sciences of St Petersburg, Russia-1727 (Kidd and Modlin, 1999).

PROMINENT ACHIEVEMENTS

One of Professor Ruysch's great contributions to the anatomical knowledge was his comprehension of the flow pattern of lymph fluid while studying the lymphatic system (Ruysch, 1721; Ijpmma and van Gulik, 2013). Ruysch began his research on lymph vessels after being encouraged by Von Horne, his professor and the first to identify the human thoracic duct (Kooijmans, 2004). After the dissection and preservation of lymph vessels, Frederik Ruysch succeeded in visualizing and confirming the hypothesis of the existence of valves inside lymphatic vessels. The vivisection of just-fed animals, associated with innovative preparation techniques, enabled the creation of a vast collection of specimens with prepared lymph vessels. He also contributed to the understanding of the distribution of the lymphatic system distribution around the gastrointestinal tract (Ijpmma and van Gulik, 2013).

During his career, he made many others contributions to medical development in fields such as anatomy, physiology, and pathology. Ruysch was the first to describe a case of congenital megacolon disease (Ruysch, 1691), which later received the name of Hirschsprung Disease (Leenders and Sieber, 1970). Another important contribution was the pioneer construction of a detailed and clear representation of bronchial circulation (Mitzner and Wagner, 1992). In addition, he contributed to the understanding of the development of rectal carcinoma (Kidd and Modlin, 1999) and the discovery of the human vomeronasal organ; however, this structure was named after Ludwig Levin Jacobson, who discovered similar organs in non-human mammals (Bhatnagar and Smith, 2003). One of the first observations of Meckel's diverticulum was made by Ruysch in 1707, although it is eponymously by Johann Frederick Meckel, who described it more precisely in 1809 (Uppal et al., 2011).

The collection of specimens of Frederik Ruysch has been admired to the present for many reasons, including the quality of his dissection, an artistic component, and, perhaps the most important of them, his fixative solution (Fig. 2) (Ijpmma et al., 2013).

The quality of his dissection is justified by his knowledge of anatomy, as an honored professor in this field, and also with the contribution of new valuable information to many areas of anatomical systems. The artistic component is related to the cultural concepts in Netherlands during his lifetime, i.e., "*vanitas mundi*" (vanity of life in relation to the proximity of death) (Kidd and Modlin, 1999). Based



Fig. 1. A portrait of Frederik Ruysch (Kunstkamera Museum).

on this context, Ruysch developed his collections, presenting humans cadavers and fetal skeletons as dioramas in different positions and associated with several elements, for example, inscriptions of Latin proverbs: such as "*Vita humana lusus*" (Man's life is but a game), "*Volat irrevocabile tempus*" (Time flies and cannot be recalled), "*Vita quid est? Fumus fugiens et bulla caduca*" (What is life? A transient smoke and a fragile bubble), "*Nec parcat imbellis juventae poblitus*" (Death does not even spare even innocent youth), "*Memento mori*" (Remember that you are mortal) (Luyendijk-Elshout, 1970; Rifkin et al., 2011). Analyzing the context of the epoch and the selfsame image of the cadaveric pieces, it is effortless to infer that his opus was not only a display of a dissection, but also a picture of the mindset of his time.

Ruysch's fixative solution

The major innovation of Ruysch was his remarkable fixative solution, which enabled several discoveries in the anatomical field. The idea underlying the creation of a better embalming fluid was focused on the necessity to study accurately and for longer periods the anatomical pieces, because dissection at that time was only possible during the winter, due to the perishable status of the organs and tissues (Houtzager, 1982; Middelkoop, 2005). The process of its creation was based on a previous method elaborated by Jan Swammerdam, his



Fig. 2. An image of Ruysch's specimen, exhibiting a leg of a child, with a natural colour. Under its feet is found a piece of the skullcap deformed by caries. (Kunstkamera Museum)

former classmate (Mayor, 2000). Ruysch refined it by injecting a type of wax into blood vessels, and by replacing body fluids with his preservative formula; this was possible due to another invention of that time: a practical syringe, created by Renier de Graaf (Ruestow, 2004; Tarlow, 2013). After injection, Ruysch preserved the cadavers to avoid decomposition in containers filled with some compounds, including black pepper and *liquor balsamicus* (Kidd and Modlin, 1999; Rodrigues, 2010). The formula was kept a secret by him, but nowadays it is known that this embalming procedure used substances such as a mixture of wax, lavender oil, mercury sulfide (cinnabar), glycerol, resin, talcum, and colored pigments (Kidd and Modlin, 1999). This preservation technique appeared to be very useful since it made possible the observation of several anatomical systems, revealing new insights into these systems, such as the reproductive structures, the spleen, the vessels of the skin and bones, the vascularization of the brain and its meninges, the *lamina choriocapillaris* of the choroid or tunica ruyschiana, the periosteum of the *ossicula auditus*, the central arteries of the retina and the discovery that the placenta consisted of

blood vessels instead of glands, as it was considered at that time (Ruysch, 1744; Mirilas, 2006; Ijpmma et al., 2013). This special technique also led to other discoveries by different anatomists, for example, Abraham Vater (1684-1751), who used the injection of the liquid to observe and understand a tubercle of the pancreas where two ducts were fused, creating an elevation of the pancreatic mucosa, which was named later "Ampulla of Vater" (Hepatopancreatic ampulla) (Beger et al., 2009).

Frederik Ruysch maintained an exhibition of his prepared cadaveric pieces, which is still portrayed in the illustrated catalogue *Thesaurus Anatomicus* (Rifkin et al., 2011). The almost "life-like appearance" of the cadavers quickly drew the attention of renowned people all over the world. One of them was Tsar Peter the Great (1672-1725), who became close to Frederik in one of his visits to the Netherlands, and turned into an admirer of his art. In 1717, Peter the Great bought approximately 2000 pieces of the doctor's collection, at the price of 30.000 Dutch guilders (300.000 Euros nowadays) (Mirilas, 2006; Ijpmma et al., 2013). At present, almost half of this collection is still exhibited at the Kunstkamera Museum in St. Petersburg, and on seeing them one may not believe that these pieces exposed were prepared approximately 300 years ago. Ruysch also created a special collection for Jon Sobiesky, the king of Poland (Rifkin et al., 2011). This great doctor and even greater anatomist died at the age of 92 years old in Amsterdam (Ijpmma et al., 2013).

FINAL CONSIDERATIONS

The development of techniques to preserve human cadavers is a long and complex process throughout history. Mainly in the context of the Renaissance, many anatomical injection techniques were created, using a large variety of materials. The contribution of many great anatomists was essential to this process (Saeed et al., 2001). Professor Ruysch heralded a new era in the art of dissection, enabling the anatomists to perform it without the concern of the decaying flesh (Luyendijk-Elshout, 1970).

The singular characteristic that distinguishes Ruysch from many other great anatomists is his capacity to emphasize not only the scientific aspect of his dissections but also an artistic aesthetic. His anatomical preparations are captivating for their beauty and its "liveliness" constructions, and they offer a moral and ethical reflection to the public. Beside normal bodies, Ruysch exhibited fetuses, cadavers with anatomical malformations and pathologies, and placentas with an intention of in-

tegrating these singularities of nature into his anatomy (Clark et al., 1999).

At present, another artist, Gunther von Hagens, from the same country is following the perspective implemented by Ruysch using a different technique; the plastination, which he has developed at Heidelberg University. This new technique enabled a revolution in anatomical science similar to that of Ruysch in the 17th-18th century (Jones, 2002). Von Hagens has also another similarity with Professor Frederik: his artistic concern for cadaveric preparations, which we can perceive by his exposition *Body Worlds*, a presentation of the human body: "aesthetic and instructive presentation of the body's interior" (Von Hagens and Whalley, 2009). Frederik Ruysch must be recognized as important for bringing the study of anatomy to another level, and also for changing the way we view this subject, from an objective study to a living science. It explains why his lessons on anatomy, physiology, and pathology remain in our books and the impressive images of his preparations remain in our minds. "Perfect necropolis, all the inhabitants asleep and ready to speak as soon as they were awakened" (Rifkin et al., 2011).

ACKNOWLEDGEMENTS

The authors would like thank the Peter the Great Museum of Anthropology and Ethnography (Kunstkamera) for all its kindness for allowing the use of the images presented in this paper.

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