

Historical Review

The Andalusian surgeon al-Zahrawi (936-1013) and his method of treatment for infantile hydrocephalus in Muslim Spain

Ntakoulas G*, Mourellou E*, Tsoukalas G.

Department of the History of Medicine and Medical Deontology, School of Medicine, University of Crete, Heraklion, Greece. (equal contribution)*

Abstract

Hydrocephalus is a condition in which excess cerebrospinal fluid builds up within the fluid-containing cavities or ventricles of the brain, with its name deriving from the Greek words “hydro” (ὕδρω), meaning water, and “cephalus” (κέφαλος), meaning the head. Cases of hydrocephalus have been known to humankind since the era of Hippocrates, Galen and the medieval Arabian physicians. During the 10th century, Abul-Qasim Al-Zehrawi was the first physician to write detailed notes about hydrocephalus and the instruments he had used during treatment through trepanation. His contributions to medicine made him a pioneer in the field of operative surgery, while he is considered to be among the greatest surgeons of the Middle Ages.

Keywords: Abulcasis, Caliphate of Cordoba, Middle Ages, cerebrospinal fluid, cranium surgery.

Corresponding author: Gregory Tsoucalas, History of Medicine Department, School of Medicine, University of Crete. Voutes, 71003 PC, Heraklion Greece. Email: gregorytsoukalas@uoc.gr.

Introduction

Medieval Arab physicians undoubtedly played a significant role in the progress of medicine not only by helping maintain and safeguard the knowledge of antiquity during the relative stagnation of Europe in that period, but also by making their own notable additions, discoveries and corrections. One of the most prominent Arab figures was Abu al-Qasim al-Zahrawi, a gifted polymath physician and surgeon, who made some remarkable contributions in the development of neurosurgery and is credited as the first to describe a detailed surgical operation for the treatment of infantile hydrocephalus. This condition had a long history of being referenced in the medical and historical literature around the world, ever since the time of Hippocrates and Galen, who attributed its existence to an extracerebral accumulation of water [1]. Hippocrates first described hydrocephalus as “water over the head”, while Rhazes, the Persian physician stated that the cause of this condition was “water enclosed without exit, exiting upon death” [2]. It is believed that physicians were interested in hydrocephaly due to its odd appearance, while Hippocrates suggested decompression through trepanation as a treatment [3]. While hydrocephalus was first

described in 5th century B.C., it wasn’t until the 10th century A.D. that Abu al-Qasim Khalaf ibn al-Abbas Al-Zahrawi made a description for the treatment of hydrocephalic children with the surgical evacuation of superficial intracranial fluid for the first time [4].

This historical vignette presents al-Zahrawi’s most important live and medical moments to enlighten a part of his bequest on the field of surgery.

Biography

Abu al-Qasim Khalaf ibn Abbas al-Zahrawi, more commonly known in Western literature as Abulcasis [5] (Latin and later English transliteration of his name, which will be used for the rest of the article for reasons of simplicity) lived between 936 and 1013 A.D. in the Caliphate of Cordoba, the Islamic state occupying most of the Iberian Peninsula during the Middle Ages. He was born in Al-Zahra, a royal city near Cordova, as indicated by his name (“al-Zahrawi” meaning the one from Al-Zahra), the destruction of which later in history, during the Christian-Muslim conflicts of the Reconquista period [6], means that few details regarding his life aside from his published works have reached us to this day. It is known that he lived mostly in Cordoba, where he studied,

practiced and taught medicine and surgery [7]. He served as the personal court physician of Caliph Al-Hakam II, a renowned patron of arts and sciences whose position of power gave Abulcasis access to almost all of the medical knowledge available in that time, and dedicated his life in the advancing and improvement of medicine and surgery as scientific fields, as well as the practices and knowledge level of individual doctors. He wrote several pioneering and revolutionary works for a variety of medical topics, he was the first to describe or explain a number of diseases, however his defining and most important contribution was in surgery (neurosurgery in particular) through the development or improvement of techniques to deal with multiple diseases and injuries including infantile hydrocephalus. While Abulcasis was undoubtedly a bright physician, devoted to medicine, he was also a firm believer of the importance of child education and behavior and advised students to study medicine but have knowledge on grammar, language, mathematics, astronomy and philosophy as well [8].

Works and legacy

Not all of Abulcasis' extensive work has survived to this day. Perhaps the most important one though, his medical encyclopedia "Kitab al-Tasrif li-man Ajaza an al-Talif" or roughly translated as "The book [that] elucidates [medical problems] for him who cannot write [about the subject]", has and through it the incredible genius of him is known to us. Consisting of thirty books covering a particularly wide spectrum of his era's medical knowledge and with the last one completely dedicated to surgery, primarily neurosurgery, this encyclopedia was indicative of its writers' perceptions regarding medicine (according to him a doctor interested in practicing surgery had to acquire an expert knowledge of every aspect of medicine in general and of the conditions he could possibly encounter, before progressing into surgery proper) [9]. Abulcasis made his entrance into western European sources thanks to Gerardo of Cremona [10], who during his travel to Toledo (early 11th century) in search for translations of ancient Greek scrolls came into

contact with the works of various Muslim scholars (Abulcasis included) that have been transferred there after the pillaging of the libraries of Cordoba by the Castilian monarch Alfonso the VI (ca 1040-1109). He translated in Latin many of these books, one of which was the thirtieth book of Abulcasis "Kitab al-Tasrif", the one dedicated to surgery and the one where the surgical treatment of infantile hydrocephalus was described. Thanks to this translation, that was followed by many others, his work influenced several of the first pioneer surgeons of western Europe with the Italian surgeon Guiliermo di Saliceto (1210-1277) being most likely the first to be influenced by Abulcasis and Guy de Chauliac (ca 1300-1368) being the first of several great French surgeons that were influenced by him and utilized his work to further progress medicine.

Surgical method for infantile hydrocephalus

Infantile hydrocephalus is a medical condition characterized by the dramatic swelling of the infants' brain because of excess cerebrospinal fluid retention. It can be caused by a multitude of factors ranging from Aqueductal stenosis, a condition when the passageway that connects parts of the brains' ventricles, narrows down, thus preventing the free-flow of cerebrospinal fluid, to head injuries or infections of the central nervous system. Abulcasis described it on the first chapter of his thirtieth book as a condition in which the head of the infant was swollen by liquid the quantity of which increased daily and could be located either between the skin and cranial bones or between the latter and the meningeal coverings. Based on this, it appears that he used the term hydrocephalus both for subdural and subgaleal effusion. According to his writings the condition occurred more frequently on infants during birth due to either the violent application of pressure at the infant's head by the midwife or other unknown to him factors, which would appear to be the unknown during that time causes of congenital hydrocephalus [4, 11-12].

For surgically treating this condition Abulcasis [Figure 1] provided the following instructions: for

a concentration of liquid between the skin and the bones resulting in a small-sized tumor, a small transverse incision on the center of the head was performed and the liquid was allowed to flow freely towards outside. Should the quantity of the liquid be particularly great a similar procedure but with two cross-bodied incisions was advised. As for a concentration between bones and meningeal coverings, according to Abulcasis this would be indicated by the cranial sutures which would be open towards every direction, three incisions on the center of the head were made. Following the

incisions on either case, all the liquid should be removed. He also specifically stated on both cases that during the making of the incisions the surgeon should be cautious not to traumatize an artery for it would result in uncontrollable bleeding and potentially to the death of the patient. The tool that was used in treating infantile hydrocephalus, which resembled what is now known as a surgical scalpel, is described in detail in his textbook *al-Tasreed*, along with about 200 more drawings of surgical instruments [4, 11-12].

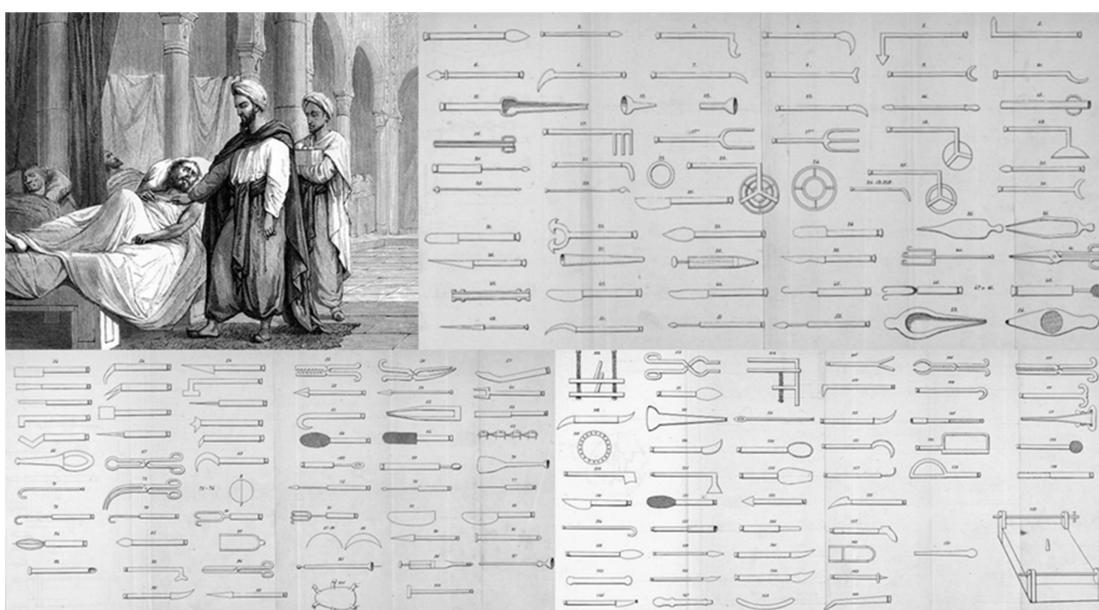


Figure 1. Abulcasis in the Bimaristan (hospital) at Cordoba attending to a patient, while an assistant carries a box of medicines, engraving from the 1883 edition of *Vies des Savants Illustres* (top left) & *Surgical instruments of Abulcasis* as printed in *La Chirurgie d'Abulcasis* (trans. Lucien Leclerc), 1861.

Postoperatively he advised for the wounds to be covered with bandages and ointments for the next five days. These first bandages would then be removed and the process would be repeated until a full healing. The instructions also stated that the patient should be sustained by foods with limited moisture for that time span [4-11-12].

Discussion

Taking all the above into consideration it is easy to understand why Abulcasis was considered such a remarkable pioneer. Not only did he

describe a technique for dealing with a fairly important and relatively frequent neurological condition without any of modern day's knowledge regarding the nervous system or advanced tools and machinery designed for such procedures, but he also did this in such detail that despite the lack of definitive proof regarding the conducting of such operations in historical archives, his technique is generally considered to have been truly utilized. The interest he took on ensuring a suitable postoperatively care for the patient as well as providing the future doctor reading his

work with all the necessary advices and information shows that he was not motivated by a simple lust for knowledge or the will to be remembered but by true dedication in improving medicine. This is further supported by the many reports of him personally conducting all kinds of trivial medical procedures, such as removal of teeth, wishing both to enhance his personal skills through experience, as well as to help people in need, and his repeated statements regarding the value of observation and its' superiority when compared to exclusively theoretical one, meaning he encouraged criticizing and questioning existing knowledge, including his own writings. He highlighted the significance of a good relationship between physicians and patients, which should be built on trust and not take into account the social status [4].

The work of Abulcasis on hydrocephalus continued to avail physicians throughout the world for centuries. The Turkish surgeon Serefeddin Sabuncuoglu (1385-1468 AD), who was a pioneer of pediatric neurosurgery, seems to have no important differences with Abulcasis in his textbook, since he described treatment by surgical incision for water accumulation in patients' intracranial cavity [8]. Modern-day research emphasizes the difference between hydrocephalus in children and hydrocephalus that develops later in life. It appears to be related to the restriction of the flow of cerebrospinal fluid (CSF) and most of the infants are treated with a ventricular shunt, after the full growth of the brain, with the time of the first intervention for treatment to be of great importance [13].

Epilogue

Hydrocephalus is a condition that has been known to the ancients since the time of Hippocrates and Galen, with Abulcasis being the first person to give specific details about the medical instruments used in decompression-trepanation as a treatment. In the centuries to follow a number of aspiring physicians were engaged in discovering further information regarding hydrocephalus, in an attempt to understand the causes and to provide a

treatment. It was in the 20th century that Harvey Cushing, the founder of modern neurosurgery, noted for the first time that the main source of the excess cerebrospinal fluid was the choroid plexus [14]. The significance of Abulcasis contribution to the understanding of hydrocephalus is undisputed. He was capable to provide detailed information from such an early era and be of help for many medical generations to come, in regards to a condition that might currently be routinely treated with great success, but used to have high mortality in the recent past. His innovations and clinical observation shaped European surgical practice, making Abulcasis one of the most influential physicians.

References

1. Aschoff A, Kremer P, Hashemi B, Kunze S. The scientific history of hydrocephalus and its treatment. *Neurosurgical review* 1999;22(2-3):67-95.
2. Santi R, Rizzolo P, Pietragalla M, Valentini V, Zelli V, Galassi FM, Ottini L, Nesi G. The antiquity of hydrocephalus: the first full palaeoneuropathological description. *Neurol Sci* 2019;40:1315-1322
3. Ring-Mrozik E, Angerpointner TA. Historical aspects of hydrocephalus. *Progress in pediatric surgery* 1986;20:158-187.
4. Turgut M. (2009). Surgical scalpel used in the treatment of "infantile hydrocephalus" by Al Zahrawi (936-1013 A.D.). *Child's nervous system: ChNS : official journal of the International Society for Pediatric Neurosurgery* 2009;25(9): 1043-1044.
5. Sami Khalaf H, Glenn S. A Pharmaceutical View of Abulcasis Al-Zahrāwī Moorish Spain: With a Special Reference to the "Adhān". Brill Archive. p. 15."Al-Zahrawi's ancestry then, one might infer, goes back to the Arabian Peninsula, to the inhabitants of "al-Madinah," the first city that accepted the message of Islam". Leiden: Brill, 1963.
6. Lowney C. *A Vanished World: Muslims, Christians, and Jews in Medieval Spain*. Oxford: Oxford University Press, 2006.
7. Pioreschi Pl. *A History of Medicine:*

Byzantine and Islamic medicine. Omaha: Horatius Press, 1996.

8. Turgut M. Pediatric neurosurgical techniques in the 15th century. *Journal of clinical neuroscience: official journal of the Neurosurgical Society of Australasia* 2008;15(10):1085-1090.

9. Al-Rodhan NR, Fox JL. Al-Zahrawi and Arabian neurosurgery, 936-1013 AD. *Surgical Neurology* 1986;26(1):92-95.

10. Ramen F. *Albucasis (Abu al-Qasim al-Zahrawi): Renowned Muslim Surgeon of the Tenth Century*. New York: The Rosen Publishing Group, 2006.

11. Abulcasis. *La Chirurgie d'Abulcasis* (trans. Lucien Leclerc). Paris: Ballière, 1861.

12. Hellier J. *The Brain, the Nervous System, and Their Diseases*. London: Bloomsbury, 2014.

13. ReKate HL. Hydrocephalus in infants: the unique biomechanics and why they matter. *Child's nervous system: ChNS: official journal of the International Society for Pediatric Neurosurgery* 2020;36(8):1713-1728.

14. Demerdash A, Singh R, Loukas M, Tubbs RS. A historical glimpse into treating childhood hydrocephalus. *Child's nervous system: ChNS: official journal of the International Society for Pediatric Neurosurgery* 2016;32(3):405-407.