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Tashrīh 'Ain (Eye Anatomy) from Greek to Arab Period: A Comprehensive Review

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Abstract

This comprehensive study delves into the development of eye anatomy from the Greek to the Arab period, highlighting key figures such as *Buqrāt (Hippocrates), Arastū (Aristotle), Herophilūs*, and *Jalinūs (Galen)*, whose pioneering contributions laid the foundation for the understanding of ocular structure and function. These scholars made significant strides in identifying the various components of the eye, including the cornea, retina, iris, and optic nerve, and proposed innovative treatments for ocular ailments. Their meticulous observations and detailed descriptions of eye anatomy in ancient medical texts underscore the early recognition of visual impairments and their clinical significance in early medical practices. The Arab period saw a flourishing of ophthalmological knowledge, with prominent figures such as *Abū Bakr Moḥammad Ibn Zakriyā Al-Rāzī, 'Alī Ibn Sahl Raban Al-Ṭabarī*, and *Ḥunayn Ibn Ishāq Al-ʻĀbādī* making significant contributions to the field. These scholars authored seminal works that provided detailed insights into common eye anatomy and various ocular diseases, paving the way for advancements in ophthalmic knowledge and treatment methods. Their comprehensive texts not only enriched the understanding of eye disorders but also contributed to the development of systematic textbooks on ophthalmology, furthering the dissemination of medical knowledge in the Arab world. The legacy of scholars such as *Ibn Sīnā, 'Alī Ibn 'Isā Al-Kaḥḥāl, Ibn Al-Haytham*, and *Ibn Rūshd* continued to shape the field of ophthalmology, with their ground-breaking research on vision, eye anatomy, and disease treatment setting the stage for modern practices. Their innovative approaches to studying the eye, introducing technical terminology, and proposing novel theories on ocular function have had a lasting impact on the field. Through their collective efforts, these scholars have enriched the understanding the Ocular anatomy and its applied aspect, paving the way for advancements in ophthalmic research and clinical practice.

Keywords: Al-Kahhāl, Ibn Al-Haytham, Saqba-e Anabia, Ocular Anatomy, Optic Nerve.

INTRODUCTION

This article reviews the major contributions of Arab and Muslim scientists and ophthalmologists from the 10th to the 13th century A.D. The Arabs based their principles of ophthalmology on Greek material but added their contributions [1]. An eye surgeon was referred to as "*Al-Kahhāl*" in Arabic, meaning an individual who applies "*Kuhl*," eye powder [1]. Muslim eye surgeons used to operate, dissect, discover, and write their findings in textbooks [2]. They made a valuable contribution to the anatomy of the eye, although their studies were limited to animal eyes because dissection of the human body was considered disrespectful. Their work produced the oldest pictures of the anatomy of the eye.

Numerous Unani scholars have extensively documented the anatomical layers of the eye, providing specific nomenclature for each layer in their respective treatises. The layers identified include the *Tabaqa sulbiyya*, which corresponds to the sclera; the *Tabaqa mashimiyya*, referring to the choroid; and the *Tabaqa shabakiyya*, known as the retina. Additionally, they recognize the *Tabaqa unkabootiya*, which denotes the capsule of the lens, the *Tabaqa 'Inabiyya*, representing the iris, the *Tabaqa qarniyya*, which is the cornea, and finally, the *Tabaqa multahima*, identified as the conjunctiva [3, 4]. These classifications reflect a

comprehensive understanding of ocular anatomy within the Unani medical tradition, illustrating the intricate structure of the eye. Each layer plays a crucial role in the overall function and health of the visual system, and the terminology used by these scholars highlights the depth of their knowledge in this field. The detailed descriptions provided in their writings continue to serve as a valuable resource for both historical and contemporary studies of eye anatomy.

From the period spanning 800 to 1400, the creation of manuscripts in Arabic notably exceeded that of Greek, Latin, and various other European languages. Before the city was ravaged by the Mongols, Baghdad was home to an impressive collection of 36 libraries. In the 12th century, Spain had 70 libraries, while the rest of Europe had none. Arab hospitals had eye wards, in which they used soporific drugs such as opium during painful eye operations. According to Professor Hirschberg, a 20th-century German professor of medicine, the Arabs wrote 30 textbooks of ophthalmology between 870 and 1370 A.D., of which 14 were preserved, 10 were written in Arabic, and 10 were written by ophthalmologists; some of these textbooks are discussed in this review article. The greatest Muslim contribution was in cataract treatment. Arabs called cataract "*al-Mā'*," meaning water or "*al-Mā' an-nāzil fī al a'in*" the water descending to the eye, which is used daily. They also introduced other common terms such as the conjunctiva, cornea, uvea, and retina [1, 2]

Ibn Al-Haitham (known as *Al-hazen* in Latin) was a scientist who played an important role in the middle age Islam world. He wrote many books and novels, but only 90 of them are known. His main book "*Kitāb al Manāzir*" was translated into Western languages in the late twelfth century, and in the early thirteenth century. In this book, he formulated many hypotheses on optical science. The book, which is also known as "Optic treasure" (opticae thesaurus), affected many famous Western scientists. He became an authority until the seventeenth century in the Eastern and Western countries [1, 2]. The development of the eye involves a series of inductive interactions between neighbouring tissues in the embryonic head. These are the neuro-ectoderm of forebrain (which form sensory retina and accessary pigmented structures), the surface of ectoderm (which forms the lens and the corneal epithelium), and the intervening neural crest mesenchyme (which contributes to the fibrous coats of the eye and to the tissue of anterior segment of eye) [5].

Alcmaeon, during the Pre Hippocratic era, conducted physiological studies on sense perception and the connection between the senses and brain function. He first mentioned the eyeball and the optic nerve, stating that external light and the liquid in the eyeball (vitreous humor) were essential for vision. *Alcmaeon* likely recognized the importance of light entering the eye for vision [6]. The eye is regarded as one of the most crucial structures within the living organism, as it accounts for approximately fifty percent of the sensory information relayed to the brain. In the historical context of medicine, particularly during the flourishing era of Greek Medicine, ophthalmology emerged as a distinct discipline. Notably, *'Alī Ibn 'Isā Al-Kaḥḥāl* gained recognition as a prominent ophthalmologist during this time. Furthermore, various Unani physicians and ophthalmologists, including figures such as *Al-Rāzī, Al-Zahrāwī, Al-Ṭabarī, Al-Majūsī, Jurjānī, and Ibn-Al-Haytham*, significantly advanced the field of ophthalmology, laying the groundwork for the development of contemporary practices in this area [6].

The eyeball, characterized by its oval shape, is primarily depicted through the iris and pupil, with the optic nerve playing a crucial role in transmitting visual impulses. The anatomical features of the eyeball, including the iris and pupil, are often overlooked, but their interplay is crucial for understanding the fundamental aspects of visual perception. Despite the limited representation, this simplified approach provides a clearer understanding of the eyeball's anatomy.

MATERIAL AND METHODS

This research focuses on the analysis and integration of knowledge on Tashrih Ain (Eye Anatomy) derived from historical Unani literature, including texts such as *Kitāb al-Hāwi, Kitāb al-tasrīf, Meezān e Tib, Firdaus-al-Hikmat, Kitāb-al-Mansoorī, Al-Qanoon fi'tib, Kitāb al-Kulliyāt, Al Moālijāt Buqrātia, Ghina Muna*, and *Kāmil-al-Sanā* etc.

Furthermore, the exploration extends beyond these traditional sources by incorporating perspectives from modern academic literature. This includes a thorough review of scholarly journals, research articles, and contemporary publications, thereby creating to establish a comprehensive framework that not only draws upon historical insights but also effectively connects them with contemporary academic discourse and emerging ideas. This dual approach not only enriches the analysis but also puts the Unani system of Medicine within the broader landscape of ophthalmology.

Objectives

This research paper aims to thoroughly explore and analyse the intricate anatomical structure of the eye, as articulated and described by a number of prominent scholars and influential philosophers from both Greek and Arab civilizations. By meticulously examining their invaluable contributions and insights, the study seeks to provide a comprehensive and detailed understanding of the historical perspectives on ocular anatomy that have shaped our current knowledge.

Ultimately, this study not only seeks to document the anatomical achievements of the past but also to inspire a renewed interest in the interdisciplinary nature of ocular studies, encouraging future scholars to build upon this rich intellectual heritage.

Literature Review

Buqrāt (Hippocrates), who lived from 460 to 377 BC, is noted in the Ebers papyrus of ancient Egypt for his observations on strabismus, a condition characterized by misalignment of the eyes [6-8]. His contributions to the understanding of this ocular disorder highlight the early recognition of visual impairments and their clinical significance in ancient medical texts.

Aristotle, known as Arast*ū* in some ethnicities and lively from 385 to 323 BC, made significant developments in the study of the optic nerve through his dissections of animals [5]. He identified three distinct pathways connecting the eye to the brain, with a particular focus on the optic nerve, thereby laying foundational knowledge for future anatomical studies of the visual system [6].

Herophilūs, who lived from 335 to 255 BC, is credited with the identification of three distinct layers of the eyeball. He described the outermost layer as a hard, protective covering, which includes the cornea and sclera, while the middle layer was characterized as smooth externally and textured internally, akin to grape skin, representing the iris and choroid. The innermost layer, likened to a casting net, is the retina, from which its name is derived. *Herophilūs* also proposed various treatments for eye ailments, utilizing unconventional ingredients such as crocodile dung and hyena bile, and provided detailed descriptions of the eye's anatomy, including the cornea, retina, choroid, iris, ciliary body, and vitreous humor [6, 7].

Jalinūs, known as Galen (129-200 AD), identified two distinct chambers within the eye, both contains a similar fluid. He explored the characteristics of the optic nerve, retina, and cornea, positing that the lens was the primary organ responsible for vision, located at the front of the eye. Although he was the first to mention the dissection of ocular muscles in animals, he did not provide a detailed account of his observations. *Jalinūs* firmly believed that the crystalline lens played a crucial role in the process of sight 6-9].

Yūḥanna Ibn Māsawayh (777-857 AD) made significant contributions to ophthalmology, notably through his technique for cataract removal using a hollow needle for suction. His works, including "*M'ārifat Mihnat Alkahhālīn*" (Knowing the Oculist Profession: Questions and Answers) and "*Daghal al 'Ain*" (The Defectiveness of the Eye), represent some of the earliest treatises in the field, laying foundational knowledge for future practitioners [7-11].

'Alī Ibn Sahl Raban Al-Ṭabarī (770-850 AD) authored "*Firdaus al Hikmat*" (The Paradise of Wisdom), which provides a concise overview of common eye anatomy and various ocular diseases. It presents a concise overview of prevalent eye anatomy and associated diseases, while dedicating a substantial portion to the various treatment modalities available for these conditions [7-12]. The text is particularly notable for its extensive discussion on treatment methods, reflecting the medical understanding of the time and contributing to the advancement of ophthalmic knowledge.

Ḥunayn Ibn Ishāq Al-'Ābādī (809 AD - 886 AD) authored "*Kitāb al-'Ashr maqālāt fī 'Ain*" (Ten Treatises on the Eye), which is recognized as the earliest systematic textbook on ophthalmology. In this seminal work, Hunain bin-Ishaq presented detailed illustrations of the anatomy and physiology of the eye for the first time. He accurately described the crystalline lens as being situated at the center of the eye, aligning with contemporary anatomical understanding [7-13].

Abū Bakr Moḥammad Ibn Zakriyā Al-Rāzī (850 AD - 923 AD) made significant contributions through his work "*Hāwi fi Al-Ṭib*" (Liber Continens/Magnus opus), particularly in the second volume, which focuses on the eye and is titled "*Kitāb fee Kaifiyātul Absār*" (A Book about the Mechanism of Vision). Additionally, "*Kitābul Mansoorī* " discusses the formation of the eye [14]. *Abū Al-Ḥasan Aḥmad Ibn Moḥammad Al-Ṭabarī* (D. 976 AD) furthered this discourse in his work "*Moalijāt al-Buqrātiā*" (The Hippocratic Treatments), completed in 850 AD, which includes ten dissertations, with the fourth specifically addressing ophthalmology. He notably described cataracts as a thick humidity affecting the crystalline lens, leading to opacity, and introduced the concept of biconvex lenses, referring to them as "burning pebbles." [15]. Lastly, *Abū 'Abdullāh Moḥammad Ibn Sa'īd Al-Tamīmī Al-Maqdesī* (D. 980 AD) authored a book on ophthalmology titled "Treatise on the Essence of Ophthalmia, Its Types, Causes, and Treatment", explaining how images formed on the retina are transmitted to the brain via the optic nerve [10].

Yūḥanna Ibn Ṣarabyūn (D.935AD) wrote "*Alkunāsh Alkabir* (Practica)" and eleven chapters of this book deals with ophthalmology [7]. *Abū Mansūr Al-Qumrī* (D. 990 AD) explained various causes of weak eye sight in his book entitled as Kitab al-Ghina Mana [16]. *'Alī Ibn Al-'Abbās Al-Majūsī* (930-994AD) He composed a book "*Kamil al-Sanā al-Tibbiya* (Complete Art of Medicine)". In the 13th chapter of the book he described 130 eye diseases in anatomical sequence, 143 simple drugs and names of beneficial herbs for the eye diseases [17]. There is description of eye diseases i.e. Ophthalmia, swelling, hardness in conjunctiva, itch, protuberance in the eyes, Pannus, blood spot, ulcers, pustules [18]. *'Ammār Ibn 'Alī Al-*

Mawṣilī (D.1000 A.D.) He composed a book on eye diseases "*Al Muntakhab fī al ilāj amrād al 'Ain*. Ammar used the word "*Saqba-e 'Inabia* (pupil) for the first time which was previously known as "hole of the iris." He was the inventor of the cataract operation by suction [7]. *Aḥmad Ibn 'Abdul-Raḥmān Ibn Mandawayh Al-Aṣfahānī* (D. 1019AD) He wrote two books on ophthalmology "*Risala fī Tarkīb Tabqātul 'Ain* (Treatise about the construction of the eye's coats)"and "*Risala fī Ilāj Inteshārul 'Ain* (Treatise about the treatment of Mydriasis) [7].

Abū Al-Qāsim Khalaf Ibn 'Abbās Al-Zahrāwī, commonly known as *Albūcasis*, lived from 936 to 1036 AD and authored the influential medical text titled " *Kitāb al-Tasrīf li-man 'ajiza 'an al-ta'lif fī al-tibb*," which is composed of thirty treatises. The final treatise of this comprehensive work focuses on surgical practices and is further subdivided into three distinct sections. Notably, within the second section, *Al-Zahrāwī* categorizes eye diseases into twelve specific classifications, reflecting his systematic approach to medical knowledge [19].

Ibn Sīnā, also known as Avicenna, who lived from 980 to 1037 AD, is renowned for his extensive medical encyclopaedia, "*Al Qanūn fī al-Tibb*" (The Canon of Medicine). In this ground-breaking work, Avicenna made significant contributions to the understanding of vision by identifying the lens as the primary organ responsible for sight, marking a pivotal moment in the history of ophthalmology. Furthermore, he was the first to describe the processes of pupil contraction and dilation, emphasizing their diagnostic relevance, and he provided insights into the functions of the lachrymal duct, categorizing the eye as one of the essential external senses [18].

'Alī Ibn 'Isā Al-Kaḥḥāl, who wrote in 1039 AD, is recognized for his contributions to ophthalmology through his work "*Tadhkirat al-Kahhālin*" (Memorandum Book for Ophthalmologists). This text is structured into three parts, with the initial section dedicated to the anatomy and physiology of the eye, while the subsequent sections address externally visible diseases and hidden conditions, respectively. Kahhal's work includes a detailed examination of the optic chiasm and the brain, and he notably discusses the condition of epiphora, attributing it to excessive cauterization of pterygium [7-20]. In cases of chronic epiphora, he recommended surgical intervention, showcasing his practical approach to ophthalmic conditions.

Ibn Al-Haytham, also known as *Al-Hazen* (965-1039 A.D.), made significant contributions to the field of optics through his extensive research on the eye, culminating in his seminal work titled "*Kitāb al-Manāzir*" (The Book of Optics). In this comprehensive text, he meticulously detailed the anatomy of the eye, identifying the region behind the iris as the uveal sphere. His exploration encompassed various components of the eye, including the conjunctiva, cornea, aqueous humour, iris, pupil, lens, optic nerve, and retina [6-8]. *Al-Haytham's* profound understanding of ocular structure was further enhanced by his self-created illustrations, which provided visual clarity to his findings.

In addition to his anatomical insights, *Al-Haytham* introduced a range of technical terminology that laid the groundwork for modern ophthalmology. He coined terms such as "*Saqba 'Inabia*" for the pupil, "*Al Qarnia*" for the cornea, "*Al A'asab Al Basariya*" for the optic nerve, "*Al Baiziya*" for the albugenous humour, "*Al Zujāajiya*" for the crystalline humour, and "*Al Jalīdiya*" for the vitreous humor [9-21]. His innovative approach not only enriched the vocabulary of the field but also facilitated a deeper understanding of ocular physiology. Notably, he was the first to elucidate the principle that vision occurs due to the refraction of light rays, thereby establishing a foundational concept in the study of optics.

Ibn Rūshd, also known as Averroes, lived from 1126 to 1198 AD and made significant contributions to the understanding of vision. In his seminal work "*Kitābul Kulliyāt*," he explored the photoreceptor properties of the retina and was the first to propose that the arachnoid membrane might serve as the principal organ of sight. Additionally, he provided a detailed anatomical description of the retina, referred to as "*Tabqa shibkiya*," thereby advancing the field of ophthalmology through his innovative insights [22].

'Alī Ibn Abī Al-Ḥazm Al-Qarashī (Ibn Al-Nafīs), who lived from 1210 to 1288 AD, made substantial contributions to the understanding of cataracts and glaucoma. He was among the first to articulate the phenomenon of incipient cataract-induced myopia, providing insights into the visual impairments associated with this condition [23, 24]. His work laid the groundwork for future research and treatment approaches in ophthalmology.

Furthermore, *Ibn Al-Nafīs* also explored the relationship between cataracts and glaucoma, describing cases where cataracts developed as a secondary condition to glaucoma [23, 24].

CONCLUSION

The contributions of Greek and Arab scholars throughout history to the discipline of ophthalmology demonstrate a gradual enhancement of knowledge concerning eye structure, visual disorders, and therapeutic approaches. This accumulation of insights has established a critical framework that continues to shape modern practices within the field. The collaborative efforts of these scholars underscore the

significance of their findings in the ongoing development of ophthalmic care.

The evolution of medical understanding related to ocular health is evident in the works of these scholars, who have meticulously documented their observations in the field of ophthalmology. Their research has not only expanded the comprehension of eye anatomy but has also highlighted the necessity of integrating both theoretical knowledge and practical applications. This dual focus has been instrumental in refining the methodologies employed in contemporary eye care.

Moreover, the historical trajectory of ophthalmology reflects a broader trend in medical science, where interdisciplinary collaboration and cumulative knowledge have led to significant advancements. The interplay between anatomical research and clinical practice has fostered innovations that enhance patient outcomes. As a result, the legacy of these early Greek and Arab scholars continues to advance the anatomy of eye, guiding current and future practitioners in their pursuit of excellence in eye health.

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