



Spine deformities and trauma in Avicenna's *Canon of Medicine*

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Abstract

Aim of the study The purpose of this historic review is to summarize the life and work of Avicenna (980–1037) and his contribution to the diagnosis and treatment of spinal deformities and trauma.

Method We conducted an extensive search in libraries as well as online in Pubmed and Google Scholar.

Results Avicenna in his work *Canon of Medicine* combines the knowledge of ancient Greek and Roman physicians and surgeons and he combines them with the extensive of Arabic medicine and pharmacology.

Conclusion Avicenna made an impact with his medical writings in which he summarized the works of ancient Greek and Roman physicians like Hippocrates and Galen with the influence of medieval authors and the knowledge of the Arabic medicine and pharmacology. His descriptions and comments in his work *Canon of Medicine* summarize and comment the work of his predecessors and it remained a work of reference until at least the sixteenth century.

Keywords Avicenna · *Canon of Medicine* · Spine trauma · Spine deformity · Arab medicine

Introduction

Ibn Sina or Avicenna (980–1037) (Fig. 1) was a Persian polymath and physician who lived during the era of the Islamic flourishing in the Middle Ages. He was particularly noted for his contributions in the fields of Aristotelian philosophy and medicine. He authored among others *The Book of the Cure*, a vast philosophical and scientific Encyclopedia, and the *Canon of Medicine* (Fig. 2), which is among the most famous and influential books in the history of medicine. It remained a work of reference in the Western world for the next 500 years [1, 2].

In this text, we present his life and work and his views and practice on spine deformities and trauma as presented in the *Canon of Medicine* and we compare them to the views of his predecessors and his successors for similarities and breakthroughs. Although other authors in the Arab world of the time, like Abulcasis (936–1013), made significant contributions to spine anatomy and surgery, the work of Avicenna was by far the most influential in the literature of the Middle Ages and the Renaissance so this historical review will focus on it.

Avicenna's biography

Avicenna was born in Afshana, a village in the outskirts of Bukhara, in 980. His father, originally from Balkh, was a state functionary, a governor of the nearby district Kharmaythan. He was in the employ of the Persian Samanid dynasty that ruled Transoxania and Khurasan with Bukhara as its capital (819–1005), where the family moved when Avicenna was still a boy. Avicenna grew up and was educated there and began his philosophical career as a member of the educated elite in political circles close to the Samanids [1, 3].

There he studied the Quran, Indian arithmetic and philosophy through his adolescence and he was considered a prodigy child. Eventually, he started studying medicine by the age of 16. The city, due to its position on the Silk Road, was a

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Fig. 1 Medieval portrait of Avicenna

cultural centre with a significant library and due to the influence of the Abbasid dynasty who supported the translation of ancient Greek texts to Arabic. Avicenna had access to that library and its manuscripts and he studied philosophy, logic, physics, mathematics and the practical sciences. There he wrote his first works, *Compendium on the Soul*, dedicated to the ruler in apparent gratitude for the permission to visit the library and works on philosophy and the practical sciences [1–3].

In 999, Avicenna had to leave Bukhara due to the Qarakhanids taking over the city and he moved to Gurganj in Khwarizm (999–1012) and later in Jurjan and then going on in Ray (1014–1015), in Hamadhan (1015–1024), and finally in Isfahan (1024–1037), in the court of alā -ad-Dawla [1–3].

Avicenna served the various local rulers in these cities certainly in his dual capacity as physician and political counselor. During the first period of the Islamic era, for a ruler in an Islamic state, it was a matter of prestige to have the patronage and service of top intellectuals, scientists, and physicians in his court. In the court of Alā -ad-Dawla in Isfahan where he spent his last 13 years or so, Avicenna enjoyed the appreciation that it was felt he deserved. His productivity never flagged, even during these years that were militarily and politically turbulent. He completed there his major work, *The Cure* and conducted a vigorous philosophical correspondence with students and followers in response to questions they raised about logic, physics, and metaphysics. He died in 1037 in Hamadhan and was buried there. A mausoleum in that city today is speculated to be his [1–3].

Avicenna on spinal trauma

The masterpiece of Avicenna as far as medicine is concerned is the *Canon of Medicine* which became a summary of all Hippocratic and Galenic medicine with comments and significant influences by the medieval Arabic and Byzantine medicine. It was translated and became widely known in Western Europe and, through it, medicine was taught until the sixteenth



Fig. 2 The *Canon of Medicine* by Avicenna (Arabic manuscript)

century. Avicenna referred to spine injuries and deformities in 8 chapters of the third volume of the *Canon of Medicine* [3, 4].

First of all Avicenna, in the tradition of Greek and Roman medicine, tried to base his clinical practice on the knowledge of the anatomy and physiology of the spine. As Galen did, he described the anatomy of the spine, the spinal cord and the spinal nerves with considerable accuracy based on the literature of the Alexandrine and Roman schools of medicine and anatomy. Like it is accepted nowadays, he classified the spine in five segments, the cervical, the thoracic, the lumbar, the sacral, and the coccygeal. He advocated, like Hippocrates that the main spinal movements are flexion, extension, and lateral bending and he even proposed the Hippocratic biomechanical model that the spine is like a chain formed by the vertebrae. He also suggested that the spinal cord is composed of motor, sensory, sympathetic, and parasympathetic nerves. Injuries in different kinds of nerves can evoke different clinical manifestations. He also described different clinical manifestations and symptoms based on the site of the injury and on these observations, he based his treatment proposals [4–7].

Avicenna’s main clinical observations, as far as spinal trauma is concerned, are the manifestations peripherally to the spinal trauma injured, on the contralateral part of the body except for head and neck, the devastating effect of a C1 injury

due to breath impingement, paralysis or paresis of muscles due to spinal nerve injuries and spinal shock. Avicenna observed that spinal trauma frequently leads to neurologic deficit and even death [4, 5].

As treatment options for spine trauma, he advocated food therapy, drug therapy, phlebotomy, physiotherapy and exercise, dry sauna, surgery, traction backbone, cupping, and massage. Most of those therapies already existed in previous literature. Nevertheless Avicenna was the one who made a detailed commentary on such treatments. Also, based on his knowledge of drugs, he refined previous drug therapies; he proposed the use of simple herbs to control inflammation both per os or with topical application like ointments [5, 6].

He, like Hippocrates, advocated the use of stretching or traction to reduce a dislocated vertebra with compression but he also follows the doctrine of Paul of Aegina, that surgical decompression should be attempted in cases that fractured vertebrae can compress and destroy spinal nerves or the spinal cord [8–11].

Avicenna on spinal deformities

Avicenna practiced Greek physician Hippocrates' treatment of spinal deformities with reduction techniques, an approach that had been refined by Greek physician and surgeon Paul of Aegina and through the work of early medieval authors had passed to the Arab world. Reduction involved the use of pressure and traction to straighten or otherwise correct bone and joint deformities such as curvature of the spine. The techniques were not used again until French surgeon Jean-François Calot reintroduced the practice in 1896 [8, 10].

As far as spinal deformities are concerned, Avicenna believed that “kyphosis and lateral bending of spine (scoliosis) are due to rotation and dislocation of the vertebra and usually involve more than one vertebra. He attributed spinal deformities to internal causes like tuberculosis or rheumatism and external like trauma. He also associated spine deformities and chest wall deformities to adverse effects on pulmonary functions [4, 8–10].

In addition, he described kyphosis or scoliosis, as conditions affecting the chest wall, and its development especially in young ages when a deformity can be lethal due to breath impingement. He describes the kyphotic deformities of children based on nutrition deficiencies such as in the case of rickets although this condition was described much later by Daniel Whistler in 1645 and Francis Glisson in 1650 [10, 11].

As treatment options for such deformities, he proposed the use of traction like Hippocrates (Fig. 3) with a patient tied with ropes on the Hippocratic ladder or the scamnum and the exertion of pressure against the deformity. He also proposed the use of diet therapy for deformities of the musculoskeletal system [4–6].



Fig. 3 Image illustrating the use of traction by Avicenna

Discussion

Before the time of Avicenna and his contribution, the treatment of spine deformities and injuries was based on reduction through traction in the tradition of Hippocrates and Galen and occasional surgery as Paul of Aegina suggested to decompress emergency injuries. The use of drugs was based on the use of simple pain killers and herbs of this era. In the Arab world, the methods of reduction were not so widely applied before his time, leaving spinal disorders and their comorbidities usually untreated [9, 11].

The description of Avicenna of spinal deformities and spinal trauma is heavily based on the writings of his predecessors from ancient Greece, the Alexandria school of medicine where dissections on human cadavers were executed, Hippocrates, Galen, and the Roman tradition of medicine and medieval physicians and surgeons like Paul of Aegina. His anatomic descriptions are heavily based on the Alexandrians and his whole medical concept is based on his famous predecessors. What he added was a detailed commentary and summary of the already existing knowledge based on the available literature [1–3, 11].

His main innovations are pharmaceutical in nature. He was well accustomed with the knowledge of herbs from the Arabic world and probably he was familiar with the work of Pedanius Dioscorides “De Materia Medica;” from those sources, he derived his ointments as well as his per os used herbs. He advocated the use of herbs with anti-inflammatory properties to treat spinal trauma and nerve compression and inflammation like *Ruscus aculeatus* or *Rhus coriaria* as well as opioids and other pain killers with possible muscle relaxant properties [2–4].

As far as physical treatment is concerned, he supported the use of the ladder or the scamnum according to the Hippocratic tradition for reduction and pressure for the alignment of the spine. According to the medieval tradition initiated by Paul of Aegina, Avicenna supported surgical treatment after injury to relief compression of the spinal cord from a vertebral fracture traumatizing the cord or any spinal nerve. From this point of view, he was an innovator; in the Hippocratic tradition and texts, the surgical treatment of a spine injury has devastating results [5, 8, 9, 11].

After Avicenna, the use of spine reduction was widely known in the Arab world and in Europe, after the translation

of his work in Latin, anti-inflammatory treatment began to spread for spine deformities and injuries. In addition in India, his work established a perpetual school of medicine named the Yunani medicine introducing both reduction and anti-inflammatory treatment in the work of his followers [1, 2]. The work of Avicenna provided an authoritative basis for the combination of Greek, Roman, and Arabic medicine treatment options in the field of spine trauma and deformities [1, 2].

Conclusion

In conclusion, the work of Avicenna *Canon of Medicine* is a summary of the existing knowledge on spine trauma and deformities. He was based on the Greek School of medicine as well as the Roman and he also derived knowledge from the pharmaceutical and other treatment of the Arabic world. Thus, his work was later introduced into the Western Europe and it remained a work of reference and essential teaching of medicine until at least the sixteenth century.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflicts of interest.

References

1. Zargaran A, Mehdizadeh A, Zarshenas MM, Mohagheghzadeh A (2012) Avicenna (980–1037 AD). *J Neurol* 259:389–390
2. Porter R (1999) *The greatest benefit to mankind: a medical history of humanity*. WW Norton, New York, NY
3. Kennedy MT (2004) *A Brief History of Disease, Science and Medicine*. Asklepiad Press, Mission Viejo, CA
4. Ghaffari F, Naseri M, Movahhed M, Zargaran A (2015) Spinal traumas and their treatments according to Avicenna's Canon of Medicine. *World Neurosurg* 84(1):173–177
5. Avicenna (2015) *Canon of Medicine complete five volume set*. Kazi Publications, Chicago
6. Aciduman A, Belen D, Simsek S (2006) Management of spinal disorders and trauma in Avicenna's Canon of Medicine. *Neurosurgery* 59(2):397–403
7. Naderi S, Acar F, Mertol T, Arda MN (2003) Functional anatomy of the spine by Avicenna in his eleventh century treatise *Al-Qanun fi al-Tibb* (the Canon of Medicine). *Neurosurgery* 52(6):1449–1453
8. Hippocrates (1959) *On joints*. Harvard University Press, Cambridge
9. Marketos SG, Skiadas P (1999) Hippocrates: the father of spine surgery. *Spine* 24:1381
10. Korres D, Markatos K, Chytas D, Andreakos A, Mavrogenis A (2017) Injuries of the spine and of the spinal cord in the Hippocratic Corpus of medicine. *Int Orthop* 41(12):2627–2629
11. Markatos K, Korres D, Kaseta MK, Karamanou M, Androutsos G (2018) Paul of Aegina (625–690): his work and his contribution to neurologic surgery: trephinations and laminectomies in the dark ages. *World Neurosurg* 109:338–341