History of Ancient Medicine in Iran

Concepts of Orthopedic Disorders in Avicenna's Canon of Medicine

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Abstract

This manuscript offers a brief review of the orthopedic subjects in the Canon of Medicine. Highlights include, but are not limited to, the anatomy of the musculoskeletal system, fractures and dislocations, nerve and tendon injuries, different types of wounds and ulcers, and bone infections. Some of the concepts regarding musculoskeletal disorders remain relevant to current orthopedic knowledge. Reviewing the orthopedic subjects in the Canon of Medicine reveals that Avicenna has made a significant contribution to the evolution of orthopedic knowledge.

Keywords: Avicenna, orthopedic history, The Canon of Medicine

Introduction

Canon is the masterpiece of Avicenna's medical books. It was prepared as an encyclopedia in five books and completed between 1020 – 1025 A.D.[1–4] Each book is divided into sections and chapters, and each chapter has been divided into different parts. The presented medical subjects were based on personal experience, inductive logic, and absorbed evidences from the Greek school of medicine.[4] A distinguished feature of the Canon is careful observations and precise description of the disorders. However, the recommended treatments might make no sense today.

Although some parts of the Canon were previously translated into Persian; however, a complete Persian translation of this old medical reference was not available until recently. The original Arabic Canon consisted of five books whereas the Persian translation of the Canon has eight volumes.[5] Book four of the Arabic Canon was translated into three volumes in Persian and volume eight was added for subject indexing. Since its first print in 1981, the Persian translation of the Canon has been reprinted several times.[5]

Avicenna probably had the same difficulties as the contemporary non-English authors who wish to publish their works in English, which is the *lingua franca* of today. Sharafkandi A., who accomplished the translation from Arabic to Persian found some Arabic vocabulary errors in the Canon and believed that Arabic was not Avicenna's native language (Vol. 7, p. 531, Persian translation). The Canon was written in Arabic simply, because Arabic was the formal language of the Islamic territories during those times.[3]

The aim of this manuscript is to briefly point out the orthopedic subjects dispersed through the different books of Avicenna's Canon of Medicine. The Persian translation of the Canon as published by Soursh Publication, Tehran, is the main reference of this manuscript.[5]

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Concepts of musculoskeletal disorders in the Canon of Medicine

Comparing the contemporary knowledge of medicine, some of the terminology used in the Canon might be found inexact. However, readers can deduce the meanings from the careful descriptions of the points in context.

Avicenna believed that learning anatomy is one of the cornerstones of medical education. Therefore, in the first volume of the Canon several chapters are devoted to human anatomy, including musculoskeletal anatomy (Vol. 1, pp. 45 – 117, Persian translation). Avicenna differentiated between cancellous and cortical bones. He defined the sesamoid bones and described their function as a fulcrum for the attachment of muscles and tendons. Cartilage is described as softer as and more flexible than bone, and its consistency ranges between bone and soft tissues. It is an intermediate tissue that prevents the soft tissues being injured by the bones. The cartilage also acts as a shock absorber. Regarding osteology and myology, Avicenna described the bones and muscles of the upper and lower limbs region by region. He divided the spine into cervical, thoracic, lumber, and sacral segments and described each segment of the spine separately.[5] Since human dissection was forbidden under Islamic law in those times[2] it is not clear whether Avicenna secretly performed human dissection or not, but he accomplished major contributions and wrote novel descriptions of human anatomy. In his anatomical descriptions he added biomechanical, functional, and applied clinical descriptions for each relevant section which was novel in the 11th century.[3,6]

Galen observed that small white nerves enter muscles and large white tendons leave muscles. He concluded that nerves and tendons have the same nature.[7] However, Avicenna was able to differentiate between nerves and tendons.[8] He described: "nerves originate from brain or spinal cord. They provide motor and sense to the limbs. Tendons originate from the muscles and connect the muscles to the limbs. The limb movement is provided by the excursion of the tendons. Ligaments are the same as tendons but they are located between bones and stabilize the joints." Avicenna is credited as a pioneer of repairing tendons[7–10] and nerves,[11] separately.

A chapter in the Canon was devoted to peripheral nerve injuries (Vol. 6, pp. 500 – 512, Persian translation). Avicenna

indicated: "an injured nerve swells and swelling has adverse effects. The swollen nerve is extremely painful and tender. The excruciating pain may even lead to convulsions. Medications are given to relieve pain and remove swelling. However, for the unsuccessful treatment the nerve ends should be ablated".[5] By the above descriptions Avicenna probably has introduced "neuroma" and "causalgia", which are common problems in neglected nerve injuries.

Avicenna advised suturing transverse nerve cuttings (Vol. 6, pp. 504, Persian translation). Although he did not explain the technique used for nerve repair, however, the concept of surgical repair of nerve injuries is first presented in the Canon.[11]

Avicenna mentioned: "open nerve injuries might be produced by piercing or cutting by sharp objects. Cutting wounds might be located along the longitudinal or transverse axis of the nerve. Longitudinal wounds are better than the transverse wounds because a majority of "capillaries" (the word probably stands for the nerve fibers) might remain undamaged. The wounds should have proper cleaning and it should not attempt to fuse the wound edges until the inflammation subsides. If the wound has a small opening and inflammatory substances accumulate in the wound, drainage of the wounds by enlarging the small opening is recommended. The nerves should not be exposed along their course and the exposed nerves should be covered by muscles" (Vol. 6, pp. 500 – 512, Persian translation).[5]

Avicenna described compression neuropathies as "crushing of the nerves due to falling down or receiving a blow to the nerves. The patient experiences numbness when the hardened and twisted nerves are compressed with a finger. The compressed nerves are treated by medications to kill pain" (Vol. 6, pp. 511, Persian translation). Today's readers might infer that the described physical finding is "the nerve compression test" and/or "Tinel's sign" and Avicenna was probably the first to explain it.[11]

Until the advent of antibiotics in the 20th century, osteomyelitis either killed or produced lifelong morbidity. Avicenna regarded osteomyelitis as "a bone disease that pus penetrates into the bone and absorbs and decays the bone piece by piece. An abscess might be a sign of a diseased bone. The bone under the abscess might feel soft. Excess mobility and slippage of the soft tissue on percussion denotes detachment of the delicate bone membrane (periosteum), which is a sign of beginning of bone decay (Avicenna described a subperiosteal abscess). If the overlaying decayed soft tissues are removed, the color of the bone is changed. Infection of the bone might be secondary to necrosis of the overlaying soft tissue. Treatment of the decayed bone is carving, cutting, and sawing. The destroyed bone should be removed to reach the intact bone. If a major portion of the bone is decayed the bone should be removed by sawing. Infected vertebrae or femoral head should not be ablated due to possibility of secondary damage to the spinal cord. If the decayed bone is close to a joint, remove the bone from the joint. Sometimes pieces of infected bone remain inside" (Vol. 6, pp. 512 – 516, Persian translation).[5] Avicenna advised against probing and manipulating the wound to remove the dead bone but reminded: "nature helps to extrude the bone and attempt to cure the wound after the extrusion of the dead bone" (Vol 6, pp. 515, Persian translation). It seems that Avicenna described chronic osteomyelitis and extrusion of the sequestrum. Avicenna advised to saw the bone, which is devoid of flesh and became bared, since the bone does not have the potential to grow flesh (Vol. 1, pp. 504, Persian translation).

Avicenna mentioned infections located at the distal phalanx of the fingers and felon (Vol. 5, pp. 454 – 457, Persian translation). Paronychia was described as: "a painful swelling around the nails which might be accompanied by fever and complicated by loosening and falling out of the nail. Infections in the pulp might be turned to recalcitrant wounds and decay the involved digit. If the painful substance accumulates in the pulp it should be drained by stabbing".[5]

Regarding spinal deformities, (Vol. 5, pp. 412, Persian translation) 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. The cause of the spinal deformities may be internal (spinal tuberculosis was the leading culprit) or external due to trauma". The association of the chest wall deformities and their adverse effects on pulmonary functions were also mentioned. Avicenna noted that spinal trauma might be complicated by neurological deficit and even death (Vol. 6, pp. 589, Persian translation).[12]

One section consisted of three chapters devoted to fractures and dislocations (Vol. 6, pp. 521 – 597, Persian translation). Signs of a dislocated joint were described as "pain, asymmetry of the contours compared to the intact other side, loss of movement, abnormal prominence, and abnormal dimpling." Generally dislocations were reduced by traction along the deformity. Avicenna introduced several techniques to reduce dislocated shoulders and his preferred technique was the Hippocratic technique (Vol. 6, pp. 528 – 532, Persian translation).

Avicenna devoted a chapter to discuss the general principles of fracture management and in the subsequent chapter described certain bone fractures (Vol. 6, pp. 546 – 559, Persian translation). He noticed that intra-articular fractures have a poor prognosis and result in loss of joint movement. Some intra-articular fractures may lead to dislocation of the joint.[5] In those days without radiography, fractures close to a joint might be considered as dislocations.

Avicenna described that patients tolerate valgus malunions better than varus malunions. Fractures associated with soft tissue injuries if left untreated, may lead to infection and loss of the limb. He recommended the use of gentle traction to reduce fractures. He was aware of adverse effects of edema and advised against tight bandaging. A tight bandage may occlude the vessels of the limb and prevent nutrients from reaching the fracture site. The tight bandage may produce infection and limb loss. He advised that "if severe pain developed after manipulation the treatment should not be continued, remove the bandage and let the patient get rid of the pain" (Vol. 6, pp. 550 – 552, Persian translation).

Richard von Volkman is credited for describing the compartment syndrome and its related contracture in 1881,[7] but in the early 11th century, Avicenna discussed some precautions to prevent the development of compartment syndrome (Vol. 6, pp. 550 – 556, Persian translation) (Vol. 6, pp. 558

– 560, Persian translation).[5]

For ominous wounds of open fractures, because of the fear of infection and limb loss, he gave priority to treat the wounds and advised open drainage for the wounds even if malunion ensues (Vol. 6, pp. 551, Persian translation).

Avicenna described the use of splints to treat femoral fractures (Vol. 6, pp. 594, Persian translation) and suggested using buddy taping to immobilize fractures located in the digits (Vol. 6, pp. 592, Persian translation). Avicenna advised people who wanted to treat fractures that "they should have different perforating drills for use. The bones might be cut by sawing or joining the side-by-side drilling holes" (Vol. 6, pp. 553 – 554, Persian translation).

He described osteoclasis (Vol. 6, pp. 565, Persian translation) for the treatment of malunions and gave the caution that in performing osteoclasis, if the union is hard enough, the bone might be broken in another area instead of the initial fracture site. In those days performing an osteoclasis was safer than open surgery. Today's reader should note that in Avicenna's time there was no anesthesia, no satisfactory pain control, no aseptic techniques for wound care, and no radiography. Therefore fracture management was far from a safe treatment. However his careful observation and description brought to light serious problems such as compartment syndrome, open fractures, malunion, and infections, which might be encountered even in contemporary practice.

In one section Avicenna mentioned snake bites (Vol. 7, pp. 43 – 72, Persian translation). He provided information with which to identify different poisonous snake species for treatment aid. Additionally, he advised the use of a tourniquet proximal to the bite site to obstruct entrance of the venom into the body, mouth suction of the snake bite to remove venom, amputation of the limb to protect the body and burning of the bite site.[5] He distinguished between human and animal bites, including dogs and wild animals (Vol. 7, pp. 73 – 88, Persian translation).

One section that consisted of four chapters was devoted to the management of different wounds and ulcers (Vol. 6, pp. 413 – 417, Persian translation). A particular discussion involved foreign bodies and arrow heads (Vol. 6, pp. 450 – 454, Persian translation).

Avicenna advised the stopping of bleeding from wounds by compression and elevation to prevent hematoma formation, which might become abscessed (Vol. 6, pp. 417, 440, 462 Persian translation). He mentioned that "sometimes arterial damages might produce aneurysms and develop thrilling and bruit on examination" (Vol. 6, p. 459, Persian translation). It is interesting to know that Avicenna recommended ligation of bleeding arteries to stop bleeding (Vol. 6, p. 463, Persian translation) five centuries before Ambroise Pare (1510 – 1590), the father of French surgery, reintroduced the ligation of vessels.[7] Avicenna logically concluded that reattachment of injured vessels is possible (Vol. 6, pp. 415 – 416, Persian translation).

Avicenna mentioned varicose veins and described: "some ulcers might develop because of circulatory insufficiency and some ulcers might develop because of blood pooling" (varicose ulcers) (Vol. 6, pp. 475, Persian translation). He believed that overgrowth and excessive size of the lower limb (elephantiasis) was produced because of excess blood pooling and incurable (Vol. 5, pp. 415 – 417, Persian translation).

Avicenna devoted a chapter to the description of limb pain (Vol. 5, pp. 419 – 458, Persian translation). He differentiated between low back pain and sciatica, and mentioned that low back pain might originate from genito-urinary problems. Sciatic pain originates from the buttock and radiates to the thigh, behind the knees, heels, and toes, which might lead to limb atrophy.

Avicenna mentioned different arthralgias, including gout (Vol. 5, pp. 422 – 424, Persian translation). He believed that gout was inherited from a father to his child. Avicenna believed that different arthralgias were under the influence of different temperaments of the individuals. He pointed out that sometimes flesh grows in the joints and produces deformities in the fingers. It seems that Avicenna was aware of synovial hypertrophy and pannus formation of rheumatoid diseases.[5]

Conclusions

Reviewing relevant sections of orthopedic disorders in the Canon of Medicine reminds us of our rich medical heritage. Some of the concepts pertaining to musculoskeletal disorders remain relevant to current orthopedic knowledge. Every aspect of science has a history of evolution based on previous experiences and works. The evolution of orthopedic surgery from surgery and medicine did not appear suddenly. The presented remarkable examples of orthopedic subjects in the Canon of Medicine tell us that the history of orthopedic surgery in Iran has its roots that date to at least a millennium.

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