Spinal Traumas and their Treatments According to Avicenna’s *Canon of Medicine*

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- Avicenna
- Persian medicine
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**INTRODUCTION**

In the past, spinal traumas had a high rate of incidence, and many patients are still affected by them today. Despite the development and expansion of medicine, a number of issues regarding the treatment of spinal traumas remain unsolved [12]. The first report of paraplegia caused by spinal injury is in an ancient Egyptian papyrus, the Edwin Smith surgical papyrus, dating back to 3000 BC [26]. In Homer’s *Iliad* (ca 8th century BC), brief but clear descriptions of neurologic complications attributable to spinal traumas are presented [6]. The first reported comprehensive scientific description of spinal trauma, and secondary complications and treatment approaches, such as traction methods (suction on a ladder), go back to Hippocrates (460–370 BC) [7]. After him, some other great scholars such as Aulus Cornelius Celsus (1st century AD), Galen (131–201 AD), as well as Paul of Aegina (625–690 AD), Rhazes (865–925 AD), and Haly Abbas (died 982–994) improved on that knowledge [1, 6, 7, 23].

Avicenna was another great scientist in the early 11th century who advanced neurologic concepts, including those regarding spinal trauma [22]. Although some of his contributions in describing and treating spinal traumas have been investigated recently [2], most of his findings and treatment approaches are still unclear. Here we attempt to clarify Avicenna’s points of view and descriptions of the spinal cord, spinal trauma, and also his treatment approaches, including food and drug therapy, as well as manipulation methods, such as surgery and exercise, in his large medical encyclopedia, *The Canon of Medicine*.

**AVICENNA AND THE CANNON OF MEDICINE**

Ibn Sina, who is known in western countries as Avicenna (Figure 1), was a great Persian medicine and philosophy scholar. He was born in Afshaneh, a village near Bokhara (a city in the north-east of old Persia) in 980 AD [22]. He finished learning Persian literature, as well as religious texts such as the Quran [24], when he was only 10 years old. Then, he began learning medicine and philosophy. Avicenna was a famous physician by the time he was just 18 years old. He had more than 200 records in the various science branches in Persia. His most valuable work in the field of medicine, The Canon of Medicine, is a large and comprehensive encyclopedia. In the 12th century AD, this manuscript was translated into Latin by Gerard of Cremona and was one of the main medical textbooks taught in western universities until the 16th century AD. The third volume of this book begins with neuroscience topics, including chapters regarding spinal traumas and its relevant treatment approaches (Figure 2) [4, 22].

**DESCRIBING VERTEBRAE AND SPINAL NERVES**

Eight chapters of The Canon of Medicine explore functional spinal neuroanatomy. Avicenna tried to find explanations for the anatomic features of the vertebrae and the spinal region. He emphasized that the shape and the size of any vertebra are determined by its regional function. Therefore, he classified the spine into the following segments, which is similar to the currently used classification system: cervical, thoracic, lumbar, sacral, and coccygeal. Then, he described the anatomic features of the vertebrae in each region. Avicenna described the biomechanical features of the vertebrae and the spine almost perfectly correct. He described the flexion, extension, and lateral bending aspects of the moving segments (Chapters 8 and 9), as well as the coupling phenomenon of the thoracolumbar spine [2, 9].
The most interesting of Avicenna’s points of view concerns the biomechanics of the craniovertebral junction. Avicenna described the different characteristics of the atlas and the axis vertebrae. He reported that the head-atlas moving segment is responsible for lateral bending, whereas the C1–C2 segment makes anteroposterior motion possible. One condyle elevates the head and the other bends it (5). Furthermore, Avicenna observed that “the odontoid process has two functions: it protects and prevents displacing the thinner first cervical vertebra. During the anteroposterior and lateral head movements C1 and C2 vertebrae act as a single bone and move together” (5). The similarities between some parts of Avicenna’s Canon and our current biomechanical knowledge are surprising. In addition, the chapters of the Canon mentioned previously reveal that an understanding of spinal biomechanics was a necessity, even 1000 years ago (17):

The neck includes seven vertebrae [C1–C7 in current classification]. Each cervical vertebra has one edge, two wings, four upward articular apophyses, four downward articular apophyses and each wing has two branches. In addition to these eleven apophyses, each vertebra has a common place with its adjacent vertebrae for nerves to exit the structure. The first and second vertebrae have some features that other vertebrae do not (5).

Avicenna described spinal-cervical, thoracic, lumbar, sacral, and coccygeal nerves, as well as the sensual and the motor functions of each aforementioned nerve system based on his recognized anatomy (5). Avicenna believed that the spinal cord contains 2 parts, in the same as the brain, although one cannot feel it (Figure 3) (5).

TRAUMATOLOGY OF SPINAL TRAUMAS

Avicenna produced a great amount of comprehensive information about spinal traumas and their treatments in The Canon under the title of “nerve [asab in original text] diseases, orthopedics and medicinal simple drugs.” He considered various parameters as signs and symptoms, including location, kind, and paroxysm of trauma. They will be discussed in the sections to follow.

Location of Trauma

If trauma is located where the spinal cord passes, Avicenna believes that the whole body, except the head and face, will be paralyzed. Also, he stated that “If one half
of the spinal cord is damaged, the same part of the body (whether left or right), except the head and face, will be affected by paralysis. If trauma is located vertically under the spinal cord passage, the nerve with the injured origin will be paralyzed." Regarding distinctive diagnosis of spinal trauma and apoplexy (stroke), Avicenna guessed the apoplexy involved the head and face (5).

Regarding the displacement of lumbar vertebrae, Avicenna reports that in case the C1 is injured, "it will become the cause of the patient’s death because this damages the respiratory nerves. If lumbar vertebrae are displaced towards the abdomen, a disorder will appear regarding excretion and urination, although if the same injury does not hurt the spinal cord severely, it might be treatable. If lumbar vertebrae are displaced backward, the damage will decrease but a disorder will appear in the vesica and anus muscles. If vertebrae are curved or broken towards the left or right, there will be more physical loss than if their bending is forward or backward, because spinal nerves grow towards the right or left" (5).

Kinds of Trauma
Avicenna stated that “If the nerve incision is longitudinal, it will not affect the senses and motions, but if it is transverse, it will. If paralysis happens suddenly, there will be no hope for successful treatment; although if paralysis happens gradually, it is probably due to neuritis and is treatable" (5).

Paroxysm of Trauma
Avicenna noted that “If a nerve does not grind severely, it might be treated but if paroxysm is high, treatment will be impossible” (5).

THERAPEUTIC INTERVENTIONS REGARDING SPINAL TRAUMAS
According to Avicenna, the resulted paralyses of vertebrae displacement are mostly treatable. He also reported that “the paralysis that result due to vertebrae displacement is mostly treatable and the paralysis caused by trauma will sometimes be treatable if the nerve was not damaged severely; otherwise, it cannot be treated" (5). To treat spinal trauma, Avicenna pointed to the following therapeutic interventions: food therapy, drug therapy, phlebotomy, physiotherapy and exercise, dry sauna, surgery, traction backbone, cupping, and massage.

Food Therapy
Avicenna believed that these patients were required to eat less food. Tolerating hunger was proven to be beneficial in the early days of the symptoms’ appearance. Among the appropriate foods, water in which barley is boiled and a special tonic of honey are useful for these patients. If the patient cannot ingest the aforementioned drinks, eating birds’ meat will be beneficial (5).

Drug Therapy
Generally speaking, Avicenna reported that treating spinal traumas is difficult but he believed that stasis and inflammation can be reduced by edible and local medicines. Regarding the spinal traumas, it is very important to localize the involved region and for the nerves to exit the region correctly. Furthermore, local medicine should be placed on the nerves exiting the region, or on the involved nerves. Avicenna presented various medicines to treat trauma, spinal traumas, and paralysis in section two of The Canon. Some of these medicines are listed in Table 1.

Phlebotomy
Phlebotomy was considered as a major treatment by Avicenna. He believed that if the nerve or spinal trauma is not too severe, its early treatment necessitates phlebotomy. This kind of treatment was applied to different body regions based on the kind of trauma. The regions at which phlebotomy was practiced included the cephalic and basilic veins in the hand, and saphena veins (magna and parva), and popliteal in the leg. Phlebotomy of the hand reduces the inflammation and bleeding of the traumatic region (5).

Physiotherapy and Exercise
According to Avicenna, when paralysis is treated and the recovery stage is initiated, it is necessary to make the patient exercise. Furthermore, “the patient’s muscles should be stretched and contracted to strengthen them and to allow the patient to recover completely” (5).

Dry Sauna
In Avicenna’s view, a dry sauna can be taken over a long duration and will cleanse surplus substances from the body (5).

Surgery
According to Avicenna, if a lumbar vertebra is broken, either the spinal peritonea will be contracted or the spinal cord will be pressed. In particular, if the broken vertebra is one of the cervical vertebrae,

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<th>Table 1. Simple Herbs and Natural Products Used by Avicenna for Trauma, Spinal Traumas, and Treatment of Paralysis</th>
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<tr>
<td><strong>Clinical uses</strong></td>
</tr>
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</tr>
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<td>Trauma</td>
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the condition will be very severe and the life of the patient will be threatened. If it is possible for a surgeon to take the risk and pull the broken bone out through surgery, it is a must. Then the surgeon should stitch up the region (5).

**Traction Backbone**

Avicenna had applied various methods of traction of the backbone when a displaced vertebra was present, which also applied pressure to the spinal nerves (5).

**Cupping**

Avicenna prescribed cupping to reduce the ecchymosis and phlegmasia in a traumatized region. One should follow the special rules to determine the proper body region for cupping (5).

**Massage**

Avicenna advised massaging the backbone with special oils to improve the senses of traumatized regions (5).

**DISCUSSION**

Avicenna discussed the anatomy of the backbone, spinal cord, and spinal nerves with considerable accuracy. As we know, the spine is classified into 5 segments: the thoracic, cervical, lumbar, sacral, and coccygeal sections. Avicenna used this classification about 1000 years ago. He explained the main spinal movements: the flexion, extension, and lateral bending (5). Furthermore, the spinal cord is composed of motor, sensory, sympathetic, and parasympathetic nerves. Different spinal cord injuries may impair its different functions with variant clinical presentations (14). Avicenna explained the spinal cord motor and sensory functions and the different types of spinal traumas, “longitudinal and transverse” as well as different clinical presentations regarding the different sites of injury (2, 5). Moreover, he illustrated the involvement of various spinal nerves, clinical symptoms, different food and drug therapies, and manipulation under the title of “paralysis.” From his recognition of the anatomy of peripheral and centripetal nerves, Avicenna had localized the traumas. He also based his treatment process on his etiologic diagnosis of such traumas. Avicenna presented various medicines for trauma, spinal traumas, and treatment for paralysis in section two of The Canon.

Many of Avicenna’s methods to treat or control spinal traumas are supported by current findings. As an example, in the current era, nonsurgical and acute treatments of spinal cord injuries are limited to controlling the inflammation with anti-inflammatory medicines, such as methylprednisolone and tilazad, within the first minutes and hours after the initial trauma. As nondrug medical procedures, bloodletting (phlebotomy), and food restriction are two methods mentioned by Avicenna for improving the patient’s condition and controlling the inflammation (5). According to the recent findings, it is shown that in patients infected with hepatitis C virus receiving glycerrhizin injections, phlebotomy improves the serum aminotransferase levels, even in those with the compensated cirrhosis (21). Furthermore, in patients with chronic hepatitis C, phlebotomy causes positive responses of hepatitis C virus—specific CD8⁺ T cells (11). In another research, it was proven that phlebotomy can decrease inflammatory infiltration in rats with acute renal injuries (10). These investigations can show that phlebotomy has some anti-inflammatory effects. Most likely, Avicenna observed positive experiments in the use of phlebotomy for spinal traumas because of its anti-inflammatory effect.

In contrast, Avicenna believed that food restriction or intermittent fasting is the basis of many disease treatments, such as spinal cord injuries (5). In this regard, new findings show that restriction of food intake may protect against strokes, which cause brain injury by inducing the expression of the anti-inflammatory cytokines (15). In addition, restriction of food intake can regulate autophagy in many organs (3), and autophagy has a major role against inflammation (13). Furthermore, according to The Canon, although restriction of food intake is a good method for managing trauma, its application depends on the patient’s energy levels. Avicenna denoted that if the patient’s energy is low, fasting or sometimes even food restriction is forbidden (5). He ordered some special ingredients to be included in the food regimen of patients with spinal cord injuries, such as a drink prepared from barley (Hordeum vulgare L.) called barley water (5). Barley has antioxidative and anti-inflammatory effects (9) and decreases the levels of interleukin-6 and tumor necrosis factor-α (19). Therefore, it can potentially help in reducing inflammation at the site of the injury.

In contrast, the same effect can be observed by the other medications suggested by Avicenna, such as Rubia tinctorum and Rheum palmatum (16, 18). These results show the probable positive effects of Avicenna’s methods of managing traumas. In contrast, no evidence is found for some of Avicenna’s other suggestions in treating trauma, but both groups are good candidates for further investigation to evaluate Avicenna’s suggestions in treating and managing spinal traumas. It can shed light on a part of history of neurosurgery and the level of human’s knowledge about spinal traumas and their management 1000 years ago in Persia.

**REFERENCES**


