

THE HISTORY OF VERTEBRAL FRACTURES

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ABSTRACT

In this review, the development of the history of vertebral fractures and biomechanics is presented.

Key words: Spinal injury, Vertebral fractures, History, Spinal biomechanics

ÖZET

VERTEBRA KIRIKLARININ TARİHÇESİ

Bu derlemede omurga kırıkları ve biyomekaniğinin tarihçesinin günümüze kadar olan gelişimi sunulmuştur.

Anahtar Kelimeler : Spinal travma, Vertebra kırıkları, Tarihçe, Spinal Biomekanik

The earliest accounts of spinal injury are contained in the papyrus from Egypt (2,3,4,6,14,15,22,23,27). Edwin Smith surgical papyrus originally written during the Egyptian Old Kingdom (2600 – 2200 BC). The exact author of the original papyrus is unknown, but it is possible that it was written by Imphoteb. He was a great physician – architect at the court of Pharaoh Zoser of the Third Dynasty (22,32).

The earliest account of treatment of spinal deformity is seen in the Srimad Bhagvat Mahapuranam, an ancient Indian epic written between 3500 and 1800 BC. A passage from the epic describes how Lord Krishna corrects the hunchback in one of his devotees, Kubja by applying axial traction (32).

Hippocrates (460 – 361 BC) has used traction table in the treatment of spinal deformities (4,14,16,21,28,30,32) (Figure 1). He understood some basic concepts of the spine such as undetailed anatomy and basic biomechanics of the vertebral column. He also treated some spinal injury cases with this traction technique also called "extension bed" (3,14,16,21,33). Hippocrates was the first to describe hyperextension applications on vertebral fractures and dislocations (3).

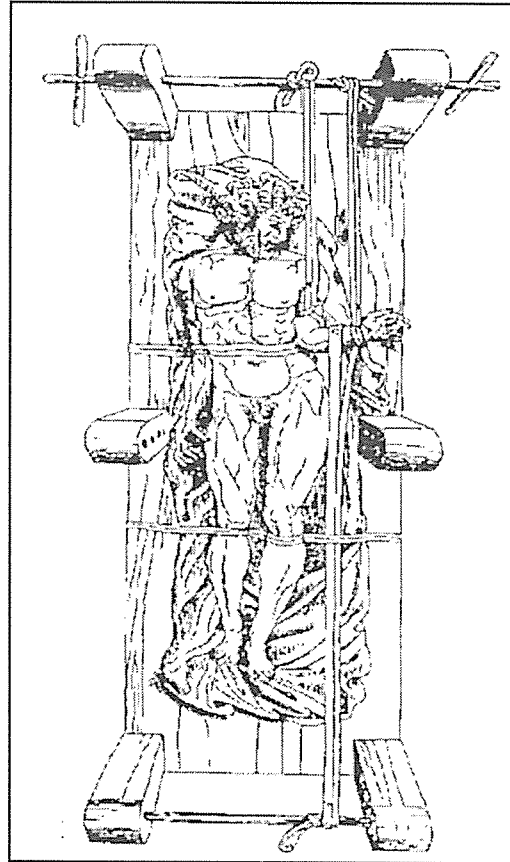


Figure 1. Traction Table of Hippocrates

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Hippocrates described the differences between vertebral fractures and dislocations, he made descriptions exceeding his era but some of these are in contradiction with current ones. He believed that the vertebral dislocations that are associated with paralysis are fatal. In the mid 1st century BC Apollonius of Chition modified the traction technique of Hippocrates, he tried to reduce fracture or dislocation by succession (3). Succession was a practice denounced by Hippocrates for being too rough.

Celcius, a Roman surgeon developed the Scamnum by working with the traction principles of Hippocrates (Figure 2) (16,28). Celcius also denoted that respiratory arrest, vomiting can be seen with cervical fractures and lower extremity paralysis and urinary incontinence are seen with lower level injuries (15).

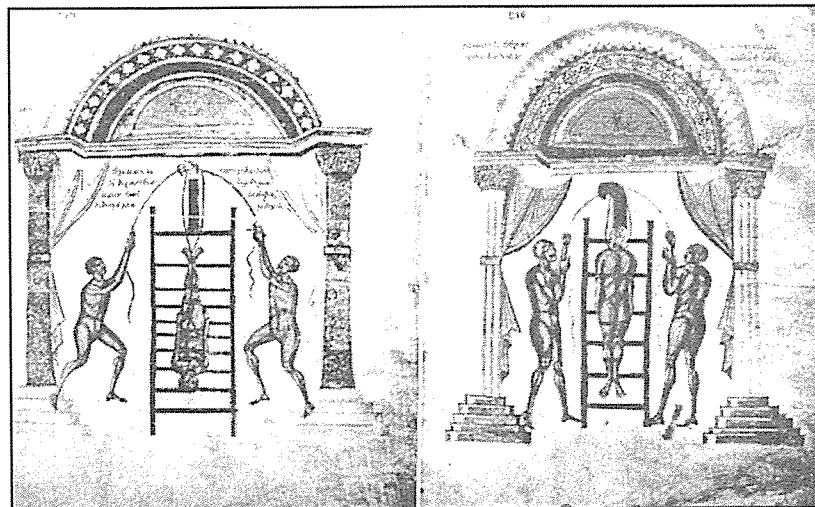


Figure 2. The reduction technique of Apollonius (Citium) for the treatment of fracture and dislocations.

By the middle ages, Galen (AD 131 – 201) was the first one to use the terms "kyphosis", "lordosis" and "scoliosis". He correctly described many anatomic features of the spinal column such as; the number of the vertebrae in each segment of the vertebral column (7 cervical, 12 thoracic, 5 lumbar). Galen described the effects of trauma on spinal cord (16,28), he described ligamentum flavum and he was also able to correlate neurological

findings with their spinal level.

Oribasius, in the 4th century AD used a rod lever to reduce a vertebral fracture (14). Sushruta Samhita, an Indian surgeon in the 4th century, has used a support and bandage technique in cervical fractures (14).

Aegean Paulus, in the 7th century AD did pay special attention to Galen's works and he was the first one to perform a procedure similar to laminectomy to a patient who had a spinal cord compression (16,28,36).

By the middle ages the European civilizations entered an unproductive period, meanwhile Eastern and Arabian surgeons were translating old Greek and Roman works. Especially Rhazes, Avicenna and Albucasis have performed the suggestions of Paulus (3). However Avicenna and Albucasis did not perform

any surgical applications (3). Avicenna has used his own reduction technique in vertebral dislocations (Figure 3) (3). In the 13th century Roland from Parma has described different reduction methods in vertebral dislocations (3). But the most important thing that get him in the history of vertebral fracture treatment is that his emphasis on the urgency of this treatment, he was the first one to express this (3).

The only knowledge about the treatment of vertebral fractures in



Figure 3. The reduction technique of Avicenna for the treatment of spinal dislocations.

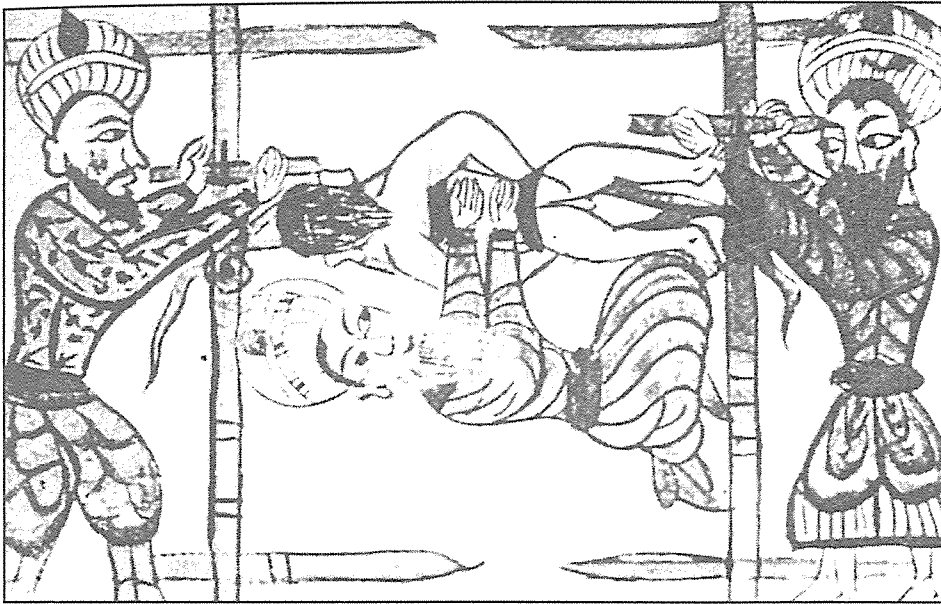


Figure 4. Treatment of spinal dislocations From Cerrahiyetü'l Hanniye Chapter 3 - sect. 30

Anatolia is "Cerrahiyetü'l – Hanniye" written by a Turkish physician Sabuncuoğlu (Şerafeddin Ali Bin İlyas) in the late 14th century and early 15th century (3,16,22,31,37,38). This work was about the treatment of vertebral dislocations, the method describes how to reduce gibbosity when traction is applied by an equipment similar to that of Hippocrates traction table (Figure 4).

By the 16th century many traction methods similar to that of Hippocrates traction table was used throughout the Europe in the treatment of vertebral fractures, dislocations and deformities (Fig.5) (29). Vidus Vidius in 16th century, has used a traction technique of Oribasius for the treatment of gibbus deformity (Figure 5) (28,29).

da Vinci was the first to accurately describe the spine with the correct curvatures, articulations and number of vertebrae. The anatomy of the entire spine was examined with such attention to detail and proportion unlike before (Figure 6).

Ambroise Pare, in the 16th century discussed about spinal injury (15,36). He used a reduction technique in cervical dislocations similar that of Roland (3). He was the first to classify the dislocations

as complete and incomplete (3).

He also pointed out that one must avoid to apply pressure on spinous processes when reducing vertebral dislocations (Figure 7) (3). He suggested reduction to be done with hands or with mechanical equipment in cervical or thoracal dislocations without fracture. Pare also applied a surgical technique similar to

laminectomy like Paulus Aegenita did 900 years before him (3,36). He demonstrated the fragments of

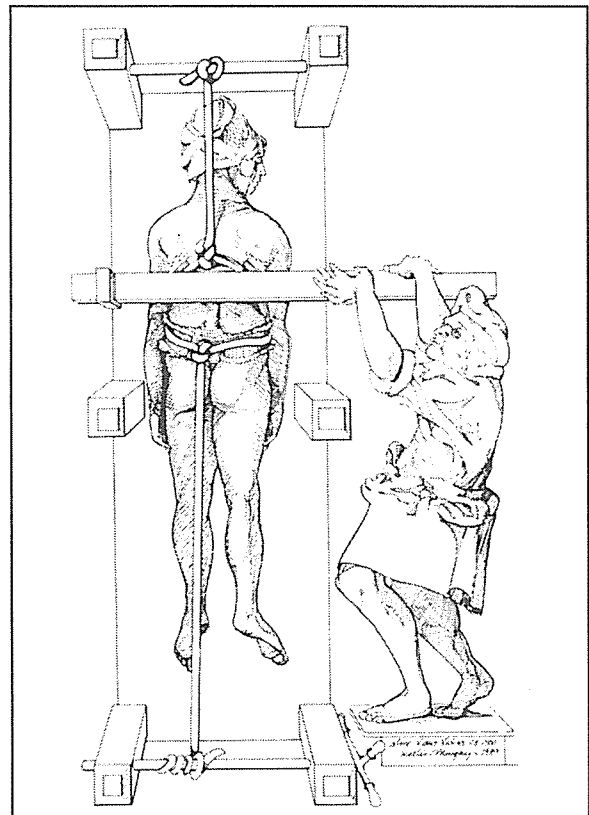


Figure 5. Traction techniques used in Europe in 16th century.

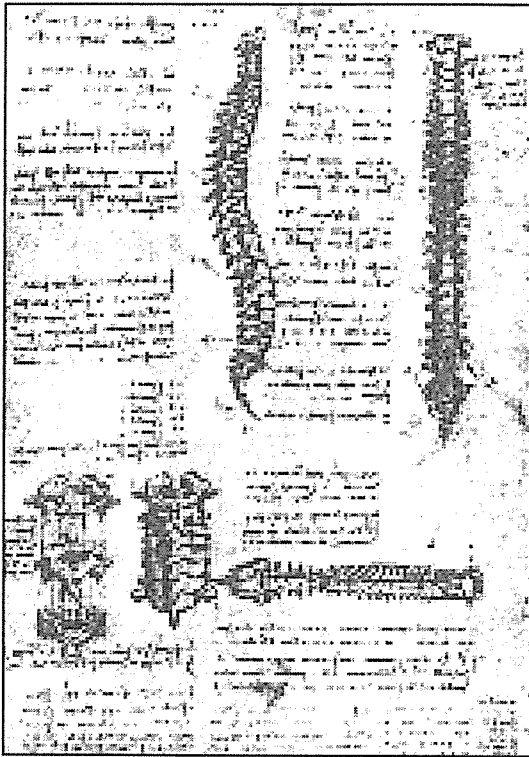


Figure 6. The Neuroanatomy of Leonardo da Vinci

laminae after a vertebral fracture compressing the spinal cord as an indication to laminectomy (15,36).

Jean Francis Calot (19th century) used the modification of this traction method in patients with and without paralysis (28,29).

Andreas Vesalius (1514 – 1564) described surgical correction of gibbosity after a vertebral fracture using

some equipment and plates made of iron (3). Because of his accurate descriptions of spinal anatomy he occupies a place in the history of spinal biomechanics. Although he followed da Vinci by a number of years, da Vinci's anatomic works remained unknown for centuries and so history has titled Vesalius the "Father of Anatomy".

Fabricius Hildanus, a German surgeon from late 16th century to early 17th century has pointed out that if reduction of the dislocation fails the surgical intervention is needed. He used two incisions in spinal surgery, one is over the spinous processes and the others were passing nearby bilaterally (3). He emphasized that bleeding was an important problem and he proposed the use of egg white powder against bleeding (3). He also described a silver needle traction system used in cervical dislocations (A silver pin was placed through or between the spinous processes and controlled traction was performed).

Surgeons like Vauguron, Le Clerc used surgical procedures in reduction of dislocations in 17th century (3).

Petit applied the hyperflexion maneuver in thoracal and lumbar vertebral dislocations in 18th century (3). He is followed by Hunczovsky from Germany who proposed and used the hyperextension maneuver in thoracal and lumbar dislocations (3).

Henry Clene was the first to perform laminectomy in the actual manner (1814) (14), after him Smith identified the principles to perform successful laminectomy (1829).

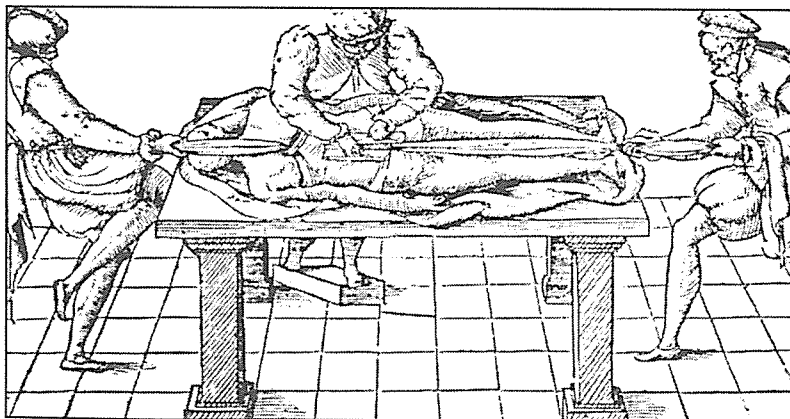


Figure 7. Pare's reduction technique of vertebral dislocations.

Malgaigne used hyperextension method successfully (1847) (14). Antonius Matysen used cast immobilization in vertebral fractures (1852) (16). Bonnet used his cast immobilization technique by applying the cast from head to pelvis, immobilizing the entire vertebral column (3).

Show claimed that spinal injury resulting from the injury of vertebral

column could not be treated with surgical decompression (1861) (16). Conversely Brown – Sequard claimed that it is essential to apply surgical treatment in vertebral fracture cases (4,16).

Wilkins had reduced a Th12 – L1 dislocation and applied pedicle cerclage technique with a wire (1887) (14).

Hadra used a "figure of 8" cerclage technique after reducing a C6 – C7 pathologic dislocation (3).

Modern approach to spinal injuries has accelerated by the developments in anaesthesia and radiology (15).

Jefferson has described the comminuted fracture of atlas (C1) in 1920 (14). Grove has described hyperextension injury (whiplash) in 1928 (14).

In 1920's and 1930's several techniques of hyperextension-postural reduction were used to maintain the correction of thoracolumbar fracture and dislocations (16,18,28). This technique was most used by Guttman (15). After him Davis (1929) and Rogers (1930) have applied reduction using a hanger and a hammock under anaesthesia (16,18,28). Watson Jones (1931) has described the "two table technique" in vertebral fractures and dislocations (4,16,18,28). Bohler (1932) has used the technique in which the patient is hanged from his or her feet upside down to take the advantage of body weight when applying traction (14,18).

Crutchfield (1933) has applied skull traction tongs cervical fractures and dislocations (14,18).

By the second world war new approaches described in the treatment of vertebral fracture and dislocations. Menno and Guttman from England have treated many cases with spinal chord injury by conservative management, they used cast immobilization and cervical collar for this purpose (29). Albee (1940) used open reduction and fusion without internal fixation in vertebral fracture-dislocations (29). The same year Wilson used plate fixation in treatment of vertebral fractures (29). This method is developed by Holdsworth and Hardy in 1953 and bolt nails which

were applied through the spinous processes were added to plate application Meurig-Williams plates were started to be used (29).

Nicoll has classified the vertebral fractures as stable and unstable depending on the integrity of the posterior interspinous ligament (17,18,29). Nicoll claimed that spinal stability depended on the integrity of the posterior interspinous ligament he said if the ligament was intact then the fracture was stable and no spinal reduction and immobilization needed (29). He proposed postural reduction and cast immobilization in case of interspinous ligament rupture (29).

Holdsworth and Hardy have used surgical procedures in the treatment of vertebral fracture-dislocations (1953), however they've described the concept of stability and instability with relation to the integrity of the posterior ligamentous complex (16,29). They thought that stable fractures are the ones which are compression fractures and burst fractures with intact posterior ligamentous complex (29), unstable injuries were complete dislocations, stress fractures and rotational fracture-dislocations (29).

Harrington (1958) used his own device in surgical treatment of vertebral fracture-dislocations. The system consisted of rods and hooks was applied to maintain distraction with fusion. This method had become popular throughout the world in a short period (29). The developments about spinal surgical techniques from this point to date is summarized on Table 1.

Table 1. The chronologic list of events

| Author | Time | Event |
|----------------------------|--------------------------------|---|
| Imphotep | 2600-2200 BC. | First writings on papyrus. |
| Srimad Bhagwat Marapuranam | 3500-1800 BC. | An ancient Indian epic, a passage from the epic describes how Lord Krishna corrects the hunchback in one of his devotees. |
| Hippocrates | 460-361 BC | Described the traction table. |
| Apollionus | Mid 1 st Century BC | Modified the traction table of Hippocrates. |
| Celcius | | Developed the Scamnum by working with the traction principles of Hippocrates. |
| Galen | 131-201 AD. | Used the terms "kyphosis", "lordosis" and "scoliosis". |
| Oribasius | 4 th Century AD. | Used a rod lever to reduce a vertebral fracture. |
| Aegean Paulus | 7 th Century AD. | Performed a procedure similar to laminectomy. |
| Avicenna | | Middle ages Used his own reduction technique in vertebral dislocations. |
| Roland | 13 th Century AD. | Described different reduction methods in vertebral dislocations. He pointed out the urgency of the treatment. |
| Şerafeddin Sabuncuoğlu | 14 th Century AD. | Cerrahiyetü'l Hanniye. |
| Vidus Vidius | 16 th Century AD. | Used the traction technique for the treatment of gibbus deformity. da Vinci Described the detailed anatomy of the spine. |
| Ambroise Pare | 16 th Century AD. | Used a reduction technique similar to Roland in cervical dislocations. Classified dislocations. Performed a surgical technique similar to laminectomy. |
| Andreas Vesalius | 1514-1564 | Described surgical correction of gibbus deformity after a vertebral fracture using iron plates. |
| Fabricius Hildanus | 16 th Century AD. | 16-17th Century Described surgical techniques. |
| Petit | 18 th Century AD. | Hyperextension maneuver. |
| Jean Francis Calot | 19 th Century AD. | Modified the traction technique. |
| Henry Clene | 1814 | Performed laminectomy in the actual manner. |
| Malgaigne | 1847 | Used hyperextension method. |
| Antonius Matysen | 1852 | Used cast immobilization. |
| Show | 1861 | Claimed "surgical decompression cannot treat the injury" |
| Wilkins | 1887 | Brown – Sequard claimed "surgical decompression is essential" |
| Hadra | "Figure of 8" | Pedicle cerclage technique. cerclage technique. |
| Jefferson | 1920 | Described comminuted fracture of atlas. |
| Grove | 1928 | Whiplash – hyperextension injury |
| Guttmann, Davis, Rogers | 1920's and 30's | Hyperextension – postural reduction technique. |
| Davis, Rogers | 1929-1930 | Reduction under anaesthesia. |
| Watson Jones | 1931 | Two table technique |
| Crutchfield | 1933 | Skull traction in cervical fractures and dislocations. |
| Albee | 1940 | Open reduction and fusion without internal fixation. |
| Wilson | 1940 | Plate fixation. |
| Holdsworth and Hardy | 1953 | Used Meurig – Williams plates. |
| Nicoll | | Classified vertebral fractures as stable and unstable. |
| Harrington | 1958 | Used his own device in the treatment of fracture-dislocations. |
| Boucher | 1959 | Pedicle screw fixation. |
| Roy – Camille | 1961 | Pedicle screw – plate fixation. |
| Spence | 1973 | Used methyl methacrylate for the stabilization of vertebral column. |
| Weiss | 1974 | Used his own spring device. |
| Jacobs | 1981 | Locking hook spinal rod. |
| Zielke – Slot | 1981 | Used anterior distraction system. |
| Luque | 1982 | Sublaminar segmental spinal instrumentational method. |
| Edwards | 1982 | Rod – sleeve method. |
| Denis | 1983 | Three column theory. |
| Cotrell & Dubousset | 1983 | CD instrument. |
| Rezaian, Kostiuik | 1983 | Developed their own spinal instruments. |
| Kaneda | 1984 | Developed his own spinal instrument. |
| Magerly | 1984 | ESSF System. |
| Drummond & Keene | 1987 | Spinal instrumentation based on wire fixation. |
| Dick | 1987 | Fixation interne |
| Black | 1988 | Developed his own spinal instrument. |
| Alici | 1989 | Alici spinal system |

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