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The Historical Development and Proof of Lumbar Traction Used in Physical Therapy

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Abstract: Lumbar traction is a physical modality that has been used in the treatment of mechanical spinal diseases. The present article focuses on the history of lumbar traction starting from early antiquity until today. The oldest existing reference available about axial traction belongs to an ancient Indian religious literature written between 3500 BC and 1800 BC. Hippocrates was the first physician to use an axial traction device to correct spinal deformities. Since Hippocrates' time, traction continued to be developed by the contribution of many famous physicians. After the clarification of "nuclear disc herniation" by Mixter and Barr, lumbar traction regained its popularity and in 1950s and 1960s based on James Cyriax's findings, lumbar traction became a preferred method for the treatment of LDH (lumbar disc herniation). Although mechanical efficiency of lumbar traction on LDH was clearly shown in 1980s; its clinical effectiveness remains to be controversial. Today, more standardized studies with standard traction techniques are needed to be done in order to reach a definitive conclusion about its clinical effectiveness.

Key words: Lumbar traction, lumbar disc herniation, history of medicine.

1. Introduction

Traction is the process of applying force through body weight, weights, and/or pulleys in order to stretch a given part or to separate two parts. Although it has been used as a medical intervention to correct spinal deformities since early antiquity, it was in only 1950s and 1960s that lumbar traction became a popular treatment method for LDH (lumbar disc herniation) with contribution of James Cyriax [1]. The aim of this article is to discuss the history of lumbar traction including antiquity and modern time as well as the proofs of its clinical effectiveness for LDH.

2. Ancient History of Traction

The oldest existing reference available about axial traction was described in "Srimad Bhagwat Mahapuranam", an ancient Indian religious literature written between 3500 BC and 1800 BC [2, 3]. It was a mythological epic about Lord Krishna who corrected the hunchback of one of his devotees, Kubja, by applying axial traction.

Much later, Hippocrates (469-377 BC), who is known as the founder of scientific medicine, was the first physician to use an axial traction device to correct spinal deformities [2, 4]. One of the methods he used was "Succussion" method, in which the patient was tied to a ladder (the Hippocratic ladder) and inverted (Fig. 1). The second method he used was a table (the Hippocratic board) with various straps, wheels, and axles to enable the traction (Fig. 2) [5]. In the third method, a board (the Hippocratic scamnum) which was placed into a hole in the wall at one end and pressed down at the other end by applying direct force to it in order to correct the spinal deformity [6].

Claudius Galen (131-201 BC), a noted Greek surgeon, adopted "Hippocrates" work, Hippocratic board and scamnum, and advanced them one step

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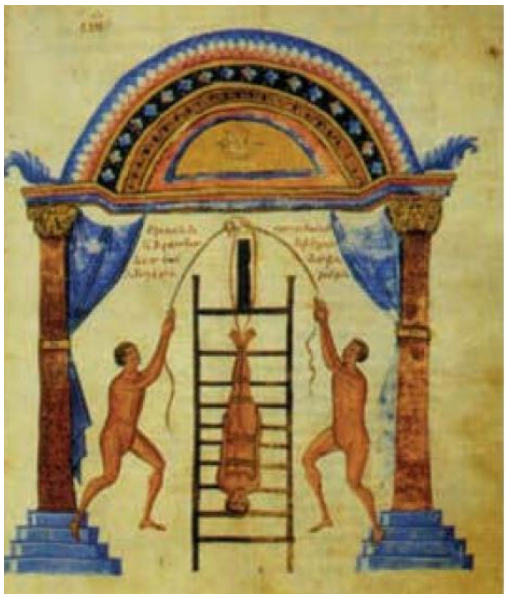

Fig. 1 The Hippocratic ladder for correction of spinal deformities with the head pointing downwards (From the illustrated comments of Apollonius of Kitium on the Hipoccratic treatise On Articulations. Bibliotheca Medica Laurenziana, Florence) [6].

Fig. 2 An illustration of Hippocratic board by Apollonius of Kitium showing the correction of a spinal deformity (From Bibliotheca Medica Laurenziana, Florence) [6].

further by combining axial traction with direct pressure applied by a manipulator (Fig. 3) [2, 7, 8].

Oribasius (325-400 AD), a Byzantine physician, improved the Hippocratic board further by adding a bar and used it for treatment of spinal trauma and deformities [6].

Fig. 3 A drawing showing Galen's method of correction of spinal deformity on a device similar to the Hippocratic scamnum by applying pressure with the use of a board attached in the wall [6].

3. Traction in the Middle Ages

Caelius Aurelianus (5th century), a Roman physician, gave a detailed description of the type of traction and physical therapy he used to treat sciatica, in his work "ardarum sive chronicarum passionum", which was about acute and chronic illnesses [9].

Later, Paulus of Aegina (625-90 AD), a Byzantine Grek Physician, who was the first to propose a surgical intervention in a living patient, used traction devices and red hot iron during spinal interventions [10].

At the beginning of the tenth century, a Byzantine physician Niketas (Nicetas) made a collection of surgical manuscripts which is known as the earliest surviving illustrated surgical codex. It contained illustrations of Hippocratic treatments including traction methods in addition to illustrations representing Byzantine practice [11].

A famous Turkish physician of the Middle East Ibn-i Sina (Avicenna, 980-1037 AD) also used spinal traction to correct spinal deformities under the influence of Hippocrates and Galen. He also explained his own methods for traction in his book named Al Kanun fit

Tibb (The Canons of Medicine) (Fig. 4) [12].

In 1210, Roland of Parma, a surgeon from Salerno, discarded the use of Hippocrates' methods and recommended a new traction mechanism with bands fastened over the trunk, neck and hips for the treatment of spinal cord injuries, in his famous book "Chirurgica" [13].

Serefeddin Sabuncuoglu (1385-1470), a famous Turkish surgeon from Central Anatolia, was the author of the first illustrated surgical textbook in the Turkish-Islamic literature, namely, "Cerrahiyyetu'l Haniyye". He was thought to be the first to use copper plate after traction which was thought to be a precursor of thermal therapy and to practice wheels in traction. Unlike the traditional positioning (suspending position) he also suggested "prone position" during the traction (Figs. 5 and 6) [14, 15].

4. Traction from Renaissance to Early Modern Period

In the early period of Renaissance, Ambroise Paré (1510-1590), the famous French royal surgeon, who served many kings of France, advocated the cure of spinal fractures and dislocations by traction. The use of spinal traction, as well as medieval Turkish manipulation during traction, was recorded in the leading textbooks of the Renaissance, Dix Livres de Chirurgie (Ten Books of Surgery) [16, 17]. Ambroise Pare wrote about "vertebral dislocations" thus: "When the vertebrae are dislocated outwards, forming a prominence, the patient should be tied down prone to a board with ropes under the armpits, the waist, and the thighs. He is then pulled and stretched as much as possible from above and from below, but not violently. If traction is not applied, cure is not to be expected. The operator then places his hand on the kyphosis and presses the prominent vertebra in" (Fig. 7) [18].

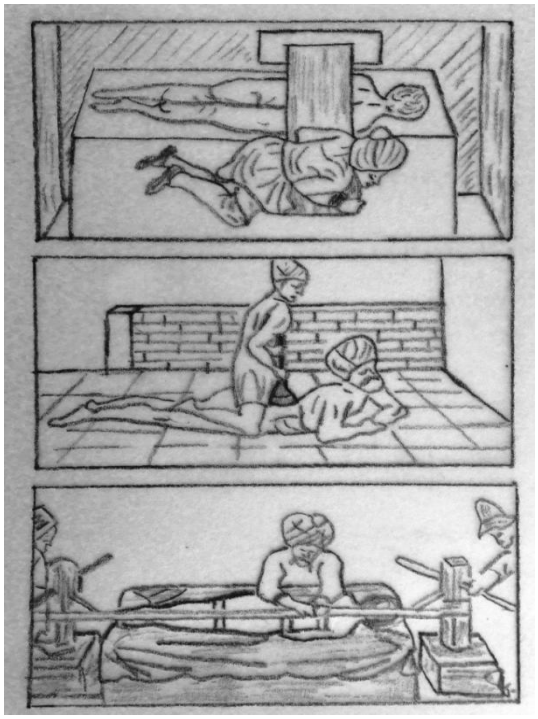

Fig. 4 Ibn-i Sina's methods of correction of spinal deformities. Redrawn from Kumar [6].

Fig. 5 Illustration showing the axial traction system of Serefeddin Sabuncuoglu for replacement of dislocated vertebrae (Reprinted with permission from Uzel [15]).

Fig. 6 Lumbar traction and manipulation technique of Serefeddin Sabuncuoglu displayed with models (From Selimiye Health Museum, Edirne).

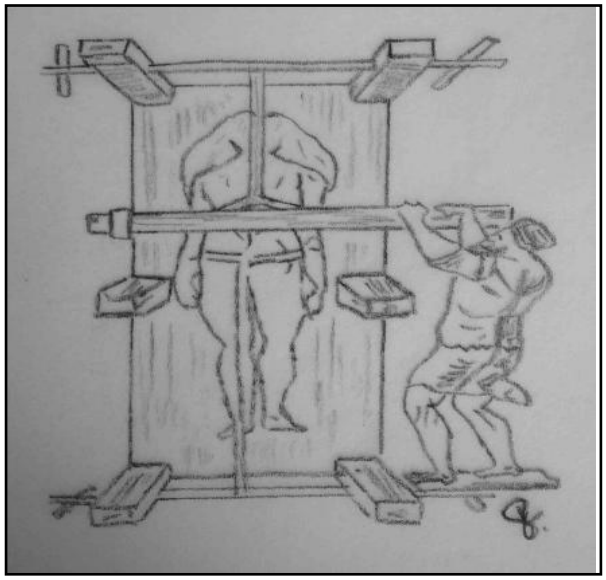

Fig. 7 Ambroise Pare's method of traction: combined suspension and pressure on lumbar spine. Redraw from J.W. Basmajan [18].

In the same century, Jean Andrea Venel (1740-1791), a Swiss surgeon who founded the world's first orthopedic hospital, introduced a different method for the treatment of scoliosis. He performed the traction in two planes: spinal traction along the axial plane together with traction in the transverse plane at the region of deviation [19, 20].

5. Traction in the Nineteenth Century

Beginning with the German physician Schreger in 1810, many physicians designed different modern looking spinal traction beds. French physicians Maisonabe, Lafond, Duval, Delpech, Pravaz and English physician Shaw were some of them. It was reported that although all these devices were surprisingly modern-looking and more complicated than those of the twentieth century, they did not become popular (Fig. 8) [20].

6. Traction in the Twentieth Century

In the nineteenth century, the main indications for spinal traction were scoliosis, spinal deformities, rickets and backache of different origins and at various locations [20]. Although disc diseases including prolapse were also recognized in the

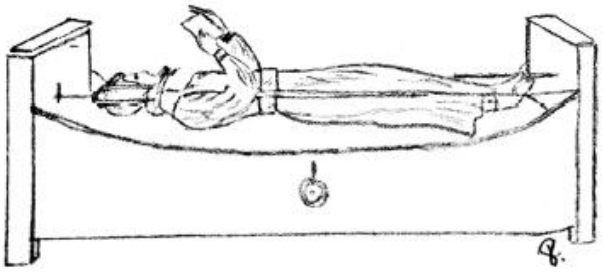

Fig. 8 The French spinal traction device of CA Maisonabe. Redrawn from Maisonabe, 1825 [20].

nineteenth century, it was in 1934 after the well-known definition by Mixter and Barr that the topic of "nuclear disc herniation" became very popular (Fig. 9) [9]. Lumbar traction re-gained its popularity in the 1950s and 1960s based on James Cyriax's findings on the efficiency of spinal traction for the treatment of discogenic back and leg pain [4].

The mechanical effects of traction on the lumbar spine are well documented in the literature. The earliest study that examined the mechanical effects of lumbar traction belongs to Judovich and Nobel (1957), who measured the frictional force between the body and the couch during the traction. They found that the mean frictional force between the disarticulated lower body segment of a cadaver (below L3/L4) and the couch was about 27% of the total body weight. So, in order to eliminate the frictional force, they recommended the use of a split table, which is now being used commonly in clinical practice [21].

Cyriax described the beneficial effects of traction as distraction in order to increase the intervertebral space, tensing of the posterior longitudinal ligament to exert centripetal force at the back of the joint and suction to draw the protrusion toward the center of the joint [4]. Several studies have used diagnostic imaging to document these effects.

In 1968, Mathews used lateral vertebral radiography to study the effects of lumbar traction in 11 patients with sciatica who were administered epidural injection of contrast medium. Lateral radiographs showed the reduction of disc prolapse, vertebral separation, and flow of contrast material into the disc spaces [22].

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RUPTURE OF THE INTERVERTEBRAL DISC WITH INVOLVEMENT OF THE SPINAL CANAL*

BY WILLIAM JASON MIXTER, M.D.,† AND JOSEPH S. BARR, M.D.†

DURING the last few years there has been a good deal written and a large amount of clinical work done stimulated by Schmorl's[1] investigation of the condition of the intervertebral disc as found at autopsy. His work will stand as the most complete, painstaking and authoritative that has ever been done in this condition. This work, however, is purely pathological and it now remains for the clinician to correlate it with the clinical findings and apply it for the relief of those patients who are disabled by the lesion.

FIG. 1. A normal intervertebral disc. Note cartilage plate, anterior and posterior longitudinal ligament, annulus fibrosus, and the semifluid nucleus pulposus which bears the superincumbent body weight and is retained in place under pressure by the annulus.

In the routine examination of spines from autopsy material he discovered that the intervertebral disc is often involved in pathological changes, the most common one being prolapse of the nucleus pulposus into an adjacent vertebral body. He found one or more such prolapses (Knorpel-knochen) in about thirty-eight per cent of the spines examined. He also discovered that in about fifteen per cent of the spines there were small posterior prolapses beneath the posterior longitudinal ligament, but concluded that they rarely, if ever, produced clinical symptoms. He attributed their presence to weakening of the annulus fibrosus by degenerative changes, with mild trauma as a second factor, producing fissures in the annulus and escape of the semifluid nuclear material.

On the other hand, for a number of years clinicians have been reporting cases of spinal cord pressure from intervertebral disc lesions.

*Read at the Annual Meeting of the New England Surgical Society, September 30, 1933, at Boston.

†Mixter, William Jason—Visiting Surgeon, Massachusetts General Hospital. Barr, Joseph S.—Orthopedic Surgeon to Out-Patients, Massachusetts General Hospital. For records and addresses of authors see "This Week's Issue," page 224.

In 1911 Goldthwait[2] reported a case of sciatica and paraplegia which he attributed to a posterior displacement of the intervertebral disc at the lumbosacral junction and suggested that such displacements might be the cause of many cases of lumbago, sciatica, etc. Middleton and Teacher[3] report a similar case confirmed at autopsy. Elsberg[4] in 1916 mentions chondroma of the vertebrae as causing compression of the cauda equina and states that Oppenheim has described a similar case. Mixter[5] in 1921 mentions a similar case and numerous other re-

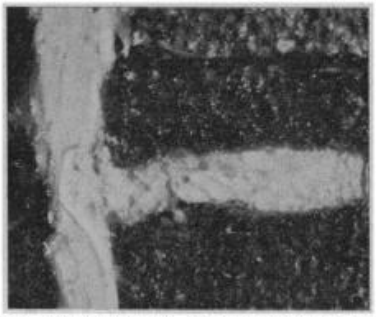
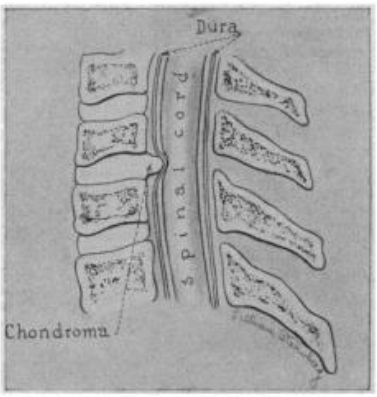


FIG. 2. Autopsy specimen. CASE 8. Note small posterior prolapse such as Schmorl describes.



(FIG. 17. Showing the usual location of a ventral vertebral disc chondroma. [Legend in *Surgery, Gynecology and Obstetrics*].)

FIG. 3. Illustration taken from article by Elsberg, showing "chondroma" arising from intervertebral disc. (Elsberg: S. G. & O.; 46: 10: 1928.

Fig. 9 Mixter and Barr's paper, New England Journal of Medicine, 1934.

In another radiographic study designed to investigate the vertebral separation, Colachis and Strohm [23] found that lumbar traction generally caused decreases in anterior disc heights and increases in posterior disc heights with the patient in Fowler's position (i.e. supine with the hips and knees flexed, and the lower legs supported on a stool). The greatest increase in posterior vertebral separation was observed at the L4-5 level.

Ten years later, Gupta and Ramarao [24] studied the effects of 10-15 days of continuous traction on prolapsed discs by using epidurography. Marked clinical improvement with no radiographic evidence of defects were present in 10 of the 14 cases.

In 1989, Onel et al. [25] used CT (computed tomography) to study the effects of static horizontal traction on disc herniations. Thirty patients with LDH were included in the study. The herniated nuclear material retracted in 78.5% of median, 66.6% of posterolateral and 57.1% of lateral disc herniations during the traction. Widening of the disc spaces, separation of the apophyseal joints, increase in neural foramina and thinning of the ligamentum flavum were reported as the other mechanical findings after the traction. Retraction of the herniated nuclear material during the traction was attributed to the suction effect of negative intradiscal pressure and pushing effect of the posterior longitudinal ligament. All the patients included in the study showed clinical improvement except for two patients; one with a large herniation filling the spinal canal, and the other with a calcified disc protrusion.

In 2005, the effect of motorized horizontal lumbar spinal traction on spinal structures and herniated area were evaluated in detail and quantitatively for the first time. Thirty-two patients with acute LDH were included in the study. CT results of the subjects before and during the traction showed significant changes. During the traction, the area of protruded disc decreased 24.5%, the thickness of psoas muscle decreased 5.7%, the area of the spinal canal increased 21.6% and the width of the neural foramen increased 26.7%. The anterior intervertebral disc height remained unchanged with traction however the posterior intervertebral disc height was significantly expanded (Figs.10 and 11) [26].

Despite substantial evidence to support mechanical effects, the clinical effectiveness of lumbar traction is still controversial. The literature results about the efficiency of traction as a part of physical therapy in the treatment of low back pain is conflicting. Differences in the type of traction, treatment techniques, treatment durations, diagnostic categories and outcome measures make it difficult to compare the studies and reach a definitive conclusion about its clinical effectiveness [1].

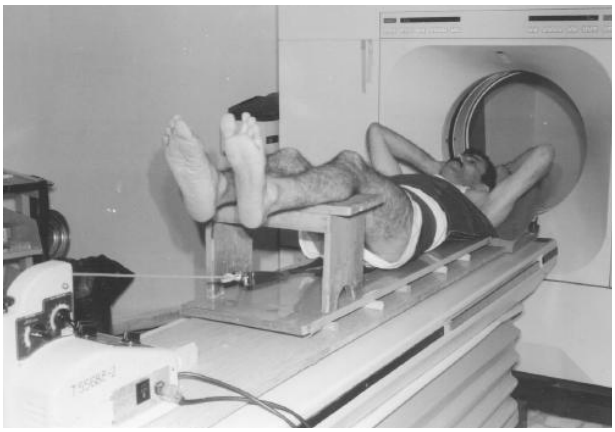
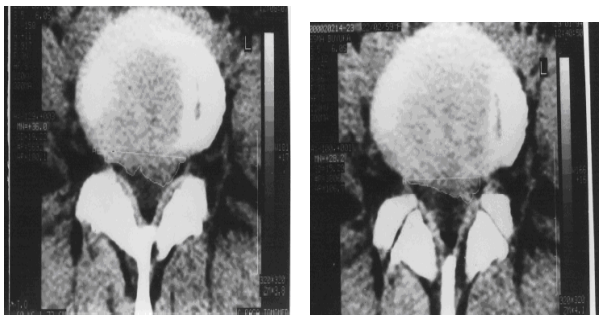


Fig. 10 Positioning of the patient on the traction boards (Cerrahpasa Experimental Lumbar Traction Model) (Reprinted with permission [26]).



(a) (b)

Fig. 11 (a) CT-scan before traction, showing the median disc herniation at L4-L5. Herniated nuclear material invades the spinal canal and left neural foramina and, compresses the dural sack and L5 nerve root. Spinal canal area and neural foramina are narrowed; (b) CT-scan during traction using 45 kg of force. Regression of the nuclear material from the discal space and neural foramina can be seen. Neural foraminal diameter and spinal canal area are increased (Reprinted with permission [26]).

To overcome the drawbacks of traditional traction methods, motorized spinal decompression systems have been developed. VAX-D (Vertebral axial spinal decompression) was the first non-surgical spinal decompression system that was introduced in 1991 by Dr. Allan Dyer. The original device was controlled by a pneumatic system, which was replaced with more precise electrically driven components. After the VAX-D (Vat-Tech, Inc., Palm Harbor, FL, USA, approved by the FDA in 1996), the Accu-Spina System (North American Medical Corporation, Avetura, FL, USA, approved by the FDA in 2000) and

Fig. 12 Modern lumbar traction device; motorized spinal decompression system.

the DRX-9000 (Axiom Worldwide, Tapma, FL, USA, approved by the FDA in 2003) have been developed (Fig. 12). Although some nonrandomized studies of motorized spinal decompression reported pain reduction [27-30], a systematic literature review of randomized trials suggests that published data are too limited and whether vertebral axial decompression provides benefit to individuals with LDH is difficult to be determined [31].

7. Conclusions

Lumbar traction is a physical modality that has been used in the treatment of mechanical spinal diseases since ancient times. Although it has been mostly used for the treatment of spinal deformities and fractures of the extremities, after the clarification of the topic of "nuclear disc herniation" in 1934, the questions of "retraction of disc material back" have arisen. Later in 1950, Cyriax became the first physician to advice the use of lumbar traction in the treatment of LDH. However, evidence to support its mechanical effects, remained controversial for many years. In 1989, Onel et al. [25] showed that the herniated nuclear material can retract during the traction under the guidance of CT. In 1995 and 2005, with the help of an experimental lumbar traction-CT model, the mechanical efficiency of lumbar traction on spinal structures and the herniated area was also shown quantitatively and in detail. Today in modern medicine motorized spinal decompression systems are actively being used for the treatment of LDH. This proves that a mechanical treatment modality that was used in ancient times can be turned into a modern system if combined with electrics, motorized devices and computer after the investigation of its efficiency with scientific methods. Therefore, it is important to give a special attention to empiric treatment methods of old medicine and try to improve them based on the scientific research and the developments of today's modern medicine.

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