

Vertebral Axial Decompression

a report by

Frank Tilaro, MD

Doctor of Internal Medicine, Utah

Reduction of a nuclear protrusion by spinal distraction was practiced even before the intervertebral disc was recognized. A 14th-century translation of Albucasis's *Surgery* illustrates lumbar manipulation during spinal traction.¹ Apollonius of Kitium describes a form of distraction 2,000 years ago. Guidi (1544) illustrates a traction table in his *Chirurgia*, and one of his tables can be found in the Wellcome Historical Museum of London. In their book on manipulation past and present, Cyriax and Schotz² illustrate the employment of traction by Hippocrates (400BCE), Galen (131–202CE), and the Spanish-Arabian physician Abu'L Qasim (1013–1106CE).

Today, two methods of performing traction are practiced: the sustained manner, preferred by Cyriax, and various forms of intermittent traction. Intermittent traction can be performed electronically, manually (by a

lumbar distraction. With the split table, designed by Dr Allan Dyer, it is estimated that 25% of the traction force is required for distraction to occur.⁸

The effects of distraction include tautening of the posterior longitudinal ligament, which exerts a centripetal force at the back of the joint. This maneuver may be of therapeutic value, particularly if the protrusion is located anterior to and remains in close contact with the ligament. On the basis of biomechanical calculations, significant intradiscal negative pressure may be achieved during sustained traction.⁹ One study has shown that a traction load of 30kg caused the intradiscal pressure to drop from 30 to 10kp in the L3 intervertebral disc.¹⁰ Improvement in nutrition, deposition of reparative collagen, and healing of annular tears and fissures have all been suggested as benefits of axial distraction.

Dr Allan Dyer, former Deputy Minister of Health from Ontario, Canada, and a pioneer in the development of the external cardiac defibrillator, designed the vertebral axial decompression (VAX-D) therapeutic table to apply distraction tension to the patient's lumbar spine without eliciting reflex paravertebral muscle contractions. A patented harness is attached to a tensiometer during separation of the movable part of the table. The distraction-relaxation cycles are automated or variably timed. Distraction tensions and rates are continuously monitored and measured by the tensiometer, and the output is shown on a digital gauge and captured on a pen-write printout.

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therapist), or by the patient (autotraction). The effects of sustained traction have been investigated. An increase in body length of 10–30mm was demonstrated in healthy males when a sustained force of 60kg was applied for one hour, and was lost at 4mm/hr.³ In the excised spine the greatest separation was in those subjects with wide disc spaces, and the least in those with evidence of disc degeneration. Other investigators confirmed an increase in stature over and above that known to occur when the load is taken off the spine by lying down.⁴ The findings suggest that most of the vertebral separation takes place within the first 30 minutes. During normal traction, the enlargement between two consecutive lumbar end-plates is between 1 and 1.5mm. Other studies have demonstrated a widening of the lumbar intervertebral space of between 3 and 8mm, measured radiographically during gravitational traction.^{5,6} Anderson et al.⁷ have shown an increase in intradiscal pressure with certain traction techniques.

The heavy lumbar paravertebral muscles exert resistance to distraction. At least 30–35kg of force is required to influence the lumbar spine.⁵ Other studies have shown that a force of at least 25% of bodyweight is necessary to achieve

Procedure

The VAX-D table utilizes pneumatic cylinders coupled with hydraulic damping as the drive-damping mechanism for the pre-tension and therapeutic program. The technology applies and maintains a baseline tension of 20–24lb (the pre-tension) to the patient's pelvis throughout the treatment session (even during the rest periods), and the distraction cycles then move from pre-tension range up to a pre-selected therapeutic tension. The above parameters are absolutely critical to the success of the treatment. The pneumatic hydraulic cylinders separate the lower table section from the upper section and apply the tensions to the patient's pelvis. The pneumatic hydraulic drive mechanism allows precise control of the amount of tension and is able to apply tensions in a logarithmic time/force curve. The pneumatic hydraulic drive mechanism is applied in both the distraction and retraction movements of the VAX-D table and provides a smooth, controlled operation with gradual return of the patient to the starting position each time. To achieve optimum control of the application of distractive tensions, it was found essential to develop a harness that would attach directly to an electronic tensiometer, which continuously monitors and provides feedback of the tensions being applied to the spinal column. The harness design also facilitates proper placement, which is necessary to attain reproducible results.

Patients with discogenic low-back pain—with or without radiculopathy—who have failed conventional therapy become candidates for VAX-D therapy after six to eight weeks.¹¹ Patients with neurological deficits are also candidates since outcome studies have shown no difference with surgical or medical management.¹² Patients with fusion or failed back surgery syndrome are also candidates.

Contraindications for VAX-D therapy include infection, neoplasm, osteoporosis, bilateral pars defect, unstable grade 2 spondylolisthesis, fractures, and the presence of surgical hardware in the spine.¹¹ The patient should be evaluated by a therapist or physician prior to initiating therapy and routine spine films are necessary to rule out any contraindications. A computed tomography (CT) or magnetic resonance imaging (MRI) scan is not a pre-requisite before therapy, but most patients have undergone neuroimaging. A trained VAX-D technician administers the daily therapy for approximately 20 sessions. An occasional patient may require a short maintenance period in which two to three treatments a week are given for two to four weeks following initial therapy. The average patient has required 20–25 sessions. Each session is 15 cycles, each cycle being one minute in distraction and one minute in relaxation.

Patients are instructed to wear loose clothing for each treatment. The patient is placed prone on the table so that the superior border of the pelvic harness is at the level of the split. The patient then grasps the adjustable handgrips, which are positioned to ensure the arms remain straight without bending the elbows. A roll is placed under the patient's ankles—a chin or forehead roll is optional. Patients who have difficulty

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lying prone can use a pillow placed under the abdomen. Patients with shoulder pathology may employ a roll under the axilla. The patients are instructed to hold tightly to the handgrips, since motion artifact can be seen on the graph printout if the patients are pulling with their arms. This maneuver inhibits decompression. Patients are allowed to release their grip during the relaxation phase.

A pre-tension level of 20lb is set and maintained throughout the resting phase. Ramos¹³ demonstrated that 50lb of tension was the threshold tension necessary to develop negative intradiscal pressures. Women start with 50lb and work up to 70lb. Men usually start at 60lb and work up to 80lb. Tension increments are in the order of 5lb every three to four days, although some patients need to proceed more slowly. Tension should remain constant for each treatment cycle (see *Figure 1*).

If the centralization phenomenon—the movement of pain pattern from a distal to a more proximal location—occurs in the early treatment stages, the patient will most likely respond to physical therapy and not require further

VAX-D. Centralization may appear at a later stage of treatment or shortly after completing a full VAX-D course. In patients with an intact annulus, no researcher has yet reported the results of CT discography prior to treatment and following the onset of centralization.¹⁴ Pain during distraction that

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lessens with relaxation is probably due to stretching shortened tissue. If pain persists for more than 30 minutes after treatment, the tension should be reduced for the next few sessions. The tension should be lowered or the treatment cycle stopped for pain that increases with each two-minute cycle. Some patients require a two- to three-day hiatus from therapy if they have too much discomfort. The daily response to treatment and any changes made are recorded in the patient's chart and reviewed by the physician and technician every few days.

Patients are encouraged to remain active, but should not engage in strenuous activities while undergoing therapy. They should not be receiving any other treatment modalities while receiving VAX-D therapy. Patients may wear a back support after therapy, but it should be removed within one to two hours. Once the VAX-D course is completed, patients are encouraged to enter some form of rehabilitation program and learn proper biomechanics.

Discussion

Ramos and Mart¹³ studied intradiscal pressures during VAX-D treatment. Five cases with subligamentous disc herniation at L4–5—confirmed by MRI and scheduled for percutaneous discectomy—were chosen. Using lateral and anteroposterior (AP) fluoroscopy, a cannula was inserted into the nucleus pulposus of the L4–5 intervertebral disc. The pressure measurements were recorded by an Ohmeda pressure transducer connected to a Hewlett-Packard pressure monitor via a saline bridge and a Camino fiber optic intracranial transducer, adapted for intradiscal measurements. Since the pressure transducers were designed to measure changes in the positive range, calibration was necessary. The pressure transducer and monitor for each patient were individually calibrated, and a correction curve was plotted showing the transducer readings versus actual pressures to correct for the nonlinearity of the instrumentation in the range of the negative pressures achieved. A pneumatic calibration analyzer was employed.

Distraction tensions ranging from 50 to 100lb were monitored on a digital read-out and recorded on a continuous graph tracing by a chart printer incorporated in the control console. Intradiscal pressure changes were observed as a digital read-out on the pressure monitor. Intradiscal pressures were significantly reduced to negative levels, ranging from a negative 100mmHg to a negative 160mmHg. Changes in intradiscal pressure were minimal until a threshold distraction tension was reached. The relationship

Spinal Decompression

between percentage maximum tension and time was a logarithmic function. If one plots the percentage of the maximum tension reached in 60 seconds versus time, it takes 17–20 seconds to reach 50%, 25–28 seconds to reach 70%, and 42–45 seconds to attain 90% of the maximum. The retraction phase followed a linear time/tension relationship and returned to baseline in 25–30 seconds.

The first large-scale retrospective study¹⁵ involved over 700 patients with low back pain—with and without radicular symptoms. Over 70% achieved a positive outcome. Even though the study was not a randomized blinded trial, the majority of patients were suffering beyond the period where natural resolution would be expected. All had failed treatment with other modalities and demonstrated a positive response during treatment and/or immediately thereafter.

Sherry et al.¹⁶ conducted a prospective, randomized controlled trial of VAX-D versus transcutaneous electrical neural stimulation (TENS). All

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patients had chronic symptoms (with the average duration of pain being 7.3 years). TENS was regarded as a placebo. The data revealed an attributable success rate of 68.4% for VAX-D, significantly superior compared with TENS ($p < 0.001$).

A study by Ramos¹³ compared the effects of a subtherapeutic treatment versus the protocol treatment. All patients had symptoms of sciatica and were referred to a neurosurgeon after failing conventional therapy. Imaging studies and the clinical examination were concordant. The protocol group showed significantly superior results compared with the subtherapeutic treatment group. Two similar studies evaluating the effect of VAX-D on sensory nerve dysfunction in cases of low back pain came to similar conclusions.^{17,18} Either a current perception threshold neurometer or

Figure 1: Vertebral Axial Decompression Chart Record—Typical Sample of 15 Cycles

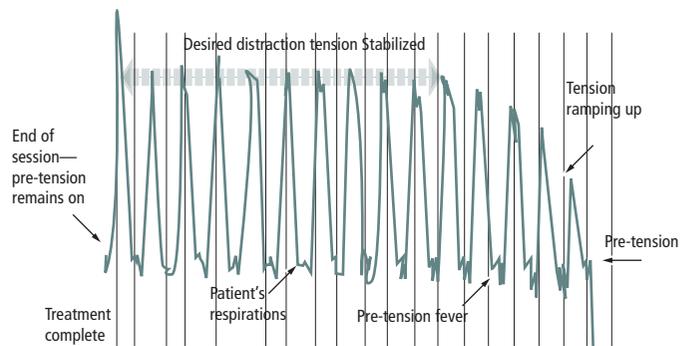


Chart speed set at 0.1mm/second. Note phases of pre-tension, tension ramping up, and desired tension stabilized on chart recording during treatment cycle.

dermatomal somatosensory-evoked potentials protocol was employed. Both studies demonstrated that VAX-D was capable of positively influencing sensory nerve dysfunction associated with compressive radiculopathy. Although compression is a frequent finding in sciatica, compression does not explain all the observed symptomatology. Other factors include the force and rapidity of compression, the effect on arterial and venous circulation, and the release of pain, vascular, and neural modulators—nitrous oxide, phospholipase A2, the prostaglandins, and leukotrienes.^{19–22}

Summary

VAX-D should not be considered as traction in the traditional sense, but as decompression: it is the only non-invasive treatment that has only been proved to decompress the disc. With other traction devices, there has been indirect proof. The patented therapeutic curve demonstrates that, when time is plotted against force, one observes a logarithmic function. Conventional traction devices have a linear time–force relationship. Nonsteroidal anti-inflammatory drugs, steroids, and doxycycline have been given in conjunction with VAX-D therapy to study possible diffusion into the disc and any beneficial effects. Other concepts for the future include investigation of immunomodulators, transplanting live fibroblast and chondrocytes, and minimally invasive surgical techniques in conjunction with VAX-D. The current focus may shift from treating back pain to repair and healing of the damaged disc. ■

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