# Intermittent Pelvic Traction in the Treatment of the Ruptured Intervertebral Disk

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THE PATIENT with a low-back problem is among the most frequently seen by the physical therapist in a nonspecialized clinic. In an analysis at the Mayo Clinic of 2,000 cases of back trouble, one half were diagnosed as degenerative disk disease (osteoarthritis) and intervertebral disk rupture.[1] Key reported that the most common cause of low-back pain with or without sciatica is the intervertebral disk lesion and that 90 per cent considered as idiopathic low-back pain are of this type.[2] Herniation of the fibrous ring has been reported by Friberg to be common soon after puberty from sixteen to twenty years of age while rupture through to the periphery of the ring is seen in the thirty to fifty age bracket, the most frequently involved areas being in the two lowermost spaces.[3] The purpose of this paper is to describe one method of conservative treatment for the ruptured intervertebral disk syndrome and to present an hypothesis to explain its success or failure.

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## REVIEW OF ANATOMY[4]

The intervertebral disks separate the vertebrae and make up one-quarter of the length of the spinal column. This column is held together in part by long ligaments in front and in back. The anterior longitudinal ligament is securely attached, fusing with the bone of the vertebral bodies and with the annulus fibrosus of the disk. The posterior longitudinal ligament lying within the vertebral canal fuses with the annulus fibrosus of the disk but attaches loosely to the vertebral bodies (Fig. 1). The disks and the facet joints on either side give support to each vertebra like a three-legged stool.

Projecting posteriorly from both sides of the vertebral bodies are the pedicles and laminae which together form the vertebral arch. The ligamentum flavum lies between two adjacent laminae. This ligament extends laterally to the capsule of the joint between the facets. Here it borders the posterior portion of the intervertebral foramen through which the spinal nerve emerges from the spinal cord (Fig. 1). The rest of the foramen consists of the bony notches in the pedicles with the vertebral bodies and the intervertebral disks lying anteriorly.

The intervertebral foramen is smaller in the lower lumbar than in the upper lumbar area. The size of the foramen increases with flexion and diminishes with extension.[5]

The intervertebral disk consists of three parts —the annulus fibrosus, the nucleus pulposus, and the cartilaginous plates. These plates cover the superior and inferior surfaces of the vertebral bodies. The nucleus pulposus, a semifluid substance which is 80 per cent water, is confined within the slightly elastic annulus fibrosus and the cartilaginous plates above and below. Since the nucleus obeys the laws governing a fluid, the pressure exerted upon it is transmitted to all parts of the surrounding fibrous ring.

The annulus fibrosus has concentric fibers spiraling from one vertebral body to the next. There is no nerve supply in the disk except possibly in the most superficial layers of the annulus. There is also no blood supply after the age of twenty. The disks are nourished by the exchange of metabolites across the cartilaginous plates by osmosis from the vascular spongiosa of the vertebral body. A change in permeability of the plate takes place with maturation and accounts, in part, for the water loss in the disk and subsequent shrinkage. As the disk shrinks, the disk space narrows. The annulus fibrosus can bulge laterally and with this a proliferation of collagenous tissue makes possible subsequent ossification of the lips of the vertebral bodies.[6] Therefore, the hypertrophic arthritis seen on the radiographic film could be secondary to disk disease.[1] The posterior portion of the ring is thinner behind than in front—a possible cause of the greater frequency of a posterior prolapse.

### Pathomechanics and Treatment

In 1934, Mixter and Barr presented an important paper which established intervertebral disk pathology as a possible cause of low-back disability with radiating pain.[7] They found the ruptured disk not uncommon (Fig. 2) and said it had frequently been taken for a cartilaginous neoplasm. Since then, many papers have appeared which attempted to explain the mechanics of pain while others have evaluated various treatments.

A paper by John E. A. O'Connell in 1942 presented the hypothesis that stretching of the

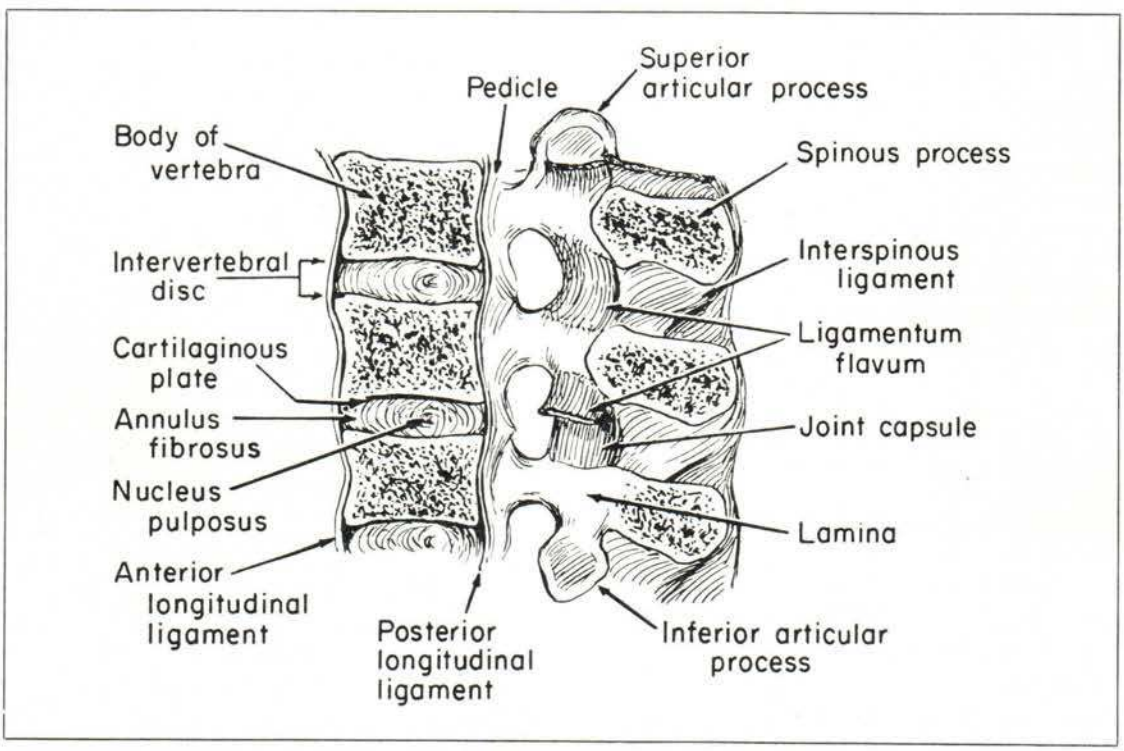


*Fig. 1. Median view of the intervertebral disk and ligaments.*

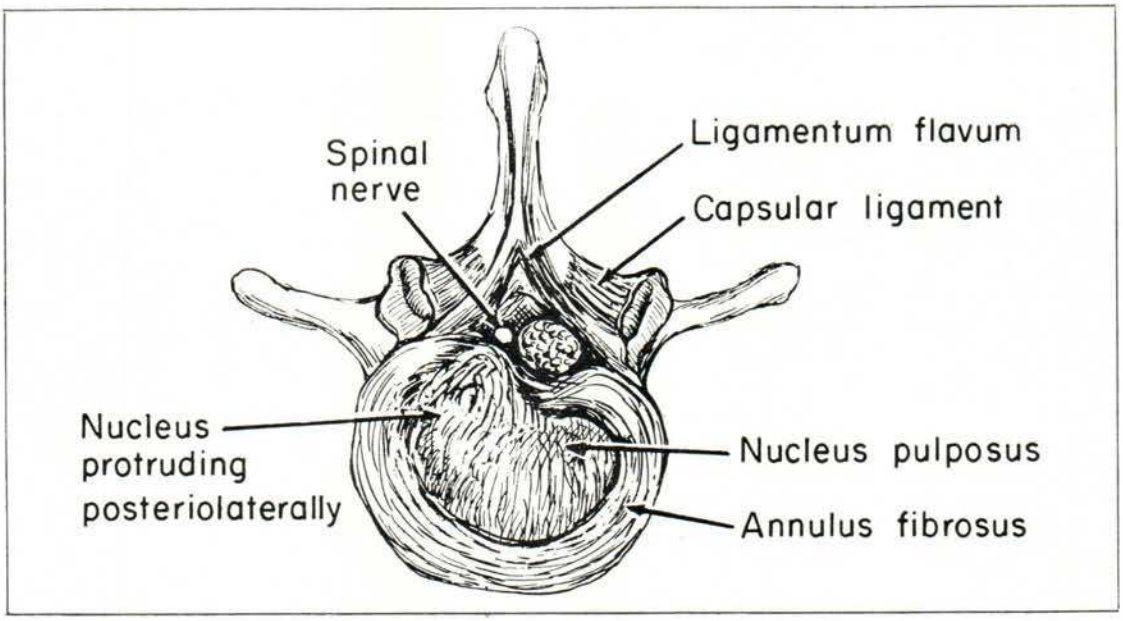


*Fig. 2. Cross-section of an intervertebral disk protrusion.*

extradural portion of an intraspinal nerve accounts for the symptoms resulting from intervertebral disk protrusions. The evidence is based on embryological, morphological, and clinical considerations.[8] O'Connell pointed out that the extradural portion does not have the mobility of the intradural portion of the intraspinal nerve. There is a greater amount of fibrous tissue around the extradural nerve and its position is relatively fixed. He stated that a small protrusion in the spinal canal would be unlikely to affect the mobile intradural nerve while an extradural nerve stretched over a small protrusion outside the canal could cause the symptoms. He further stated that the tension caused by the stretching of the nerve could also account for the increased pain experienced with those postures and movements which produce further tension on the nerve.

A different conclusion was reached by Smyth and Wright concerning the mechanism of this pain.[9] They conducted three series of experiments to prove that pressure on the lower lumbar nerve root caused sciatica. In the first series, during surgery, a loop of nylon thread was passed around the involved nerve root. The thread was then brought out to the body surface so that when pulled upon, it would come against the same spot where the disk had pressed. The procedure in the second series was the same but, in addition, a second loop was brought through the dura mater or placed around additional uninvolved nerve roots. In the last series, the loops were put through the ligamentum flavum, interspinous ligament, and the annulus fibrosus. In no instance was traction exerted on the nerve root. There was just enough pull on the thread to cause it to touch the nerve root. In all cases the patients had been completely relieved of their symptoms by the operation. This postoperative experiment of touching the nerve root by pulling on the nylon loop simulated the preoperative pain. The patients were virtually insensitive to stimulation or pull on the dura mater, the ligamentum flavum, the interspinous ligament, and the annulus fibrosus. Therefore, it was concluded that pain had been caused from irritation of the nerve root by the herniated disk. Nerves not involved in the disk syndrome were also stimulated. It was found that nerves subjected to prolonged irritation by a disk protrusion were much more sensitive than the unaffected ones. These authors suggested that irritation of this hypersensitive nerve by postsurgical fibrosis might account for the return of sciatica in some cases.

### Traction

Various conservative treatments of the ruptured intervertebral disk syndrome can be found in the literature but little has been written

concerning intermittent pelvic traction. Medical traction was known to have been used before the birth of Christ. Several clear and interesting drawings illustrating the traction methods and apparatus used by Hippocrates can be seen in Guido Guidi's (Vidus Vidius) *Chirurgia* containing translations of Hippocrates, Galen, and Oreibasius from Greek to Latin (Fig. 3).[10] Prior to the twentieth century, traction was used primarily in the treatment of dislocations, fractures, and spinal deformities. Only in the past two to three decades has strong traction been attempted for the relief of back problems with accompanying neurological signs.

Many of the traction tables were simple in design. These tables were used with the patients in the prone, supine, or sidelying positions, and the traction force to the lumbar spine was accomplished through straps attached to the legs or corsets fitted around the pelvis. When it became obvious that traction from the pelvis or legs alone was not enough, counterforce to keep the body from sliding was given by raising the foot of the table or having the patient hold onto a bar, and later by a thoracic belt.

The great amount of friction produced between the body and table top had to be overcome before the force was sufficient to produce an appreciable effect on the lower spine. Judovich claimed that almost half of the body weight lies in the lower segment through L3–L4 and that a pull of over half of this is required to overcome the surface traction–resistance in bed.[11] Therefore, he believed that hanging weights of 30 pounds from the legs or pelvis would not produce traction to the lower spine. Rothenberg, at surgery, observed no change in the disk or no separation between vertebrae with weights of 25 pounds on one or both legs (Buck's traction).[12] Since any pull less than 25 per cent of the body weight was not effective Judovich, to eliminate friction, used a split traction table, the lower half being movable. Although many methods described during the 1950's did not allow for friction factors, the split table had already been developed by De-Sèze and Levernieux.[13] The advantages of the split table were cited also by Crisp.[14]

Experimental lumbar traction was done also in the standing position. Lehmann and Brunner used healthy physical therapy students in a study of vertical traction with forces of 100,

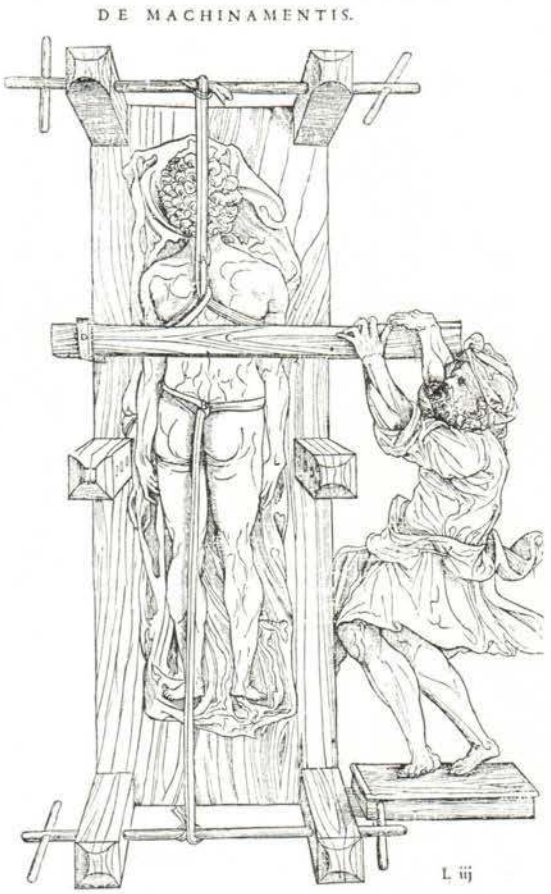


*Fig. 3. Traction for a gibbus. From Guido Guidi's* Chirurgia, *p. 529, Paris 1544.*

200, and 300 pounds.[15] A hydraulic overhead hoist pulled through a thoracic belt and counterforce was accomplished by a pelvic belt attached below to the frame. Roentgenograms showed a significant widening at 200 to 300 pounds of traction but most of the subjects felt an "uncomfortable stretch" at 300 pounds or more.

Neuwirth and colleagues described a table for vertebral elongation, the traction force being produced by handwheels.[16] Traction was gradually increased to maximum, held for eight to ten minutes then followed by a rest period of thirty to sixty minutes. These authors claimed a separation of 1.5 millimeters between two lumbar vertebrae with a pull of 100 kilograms (220 pounds). Not all traction was done at a constant pull. Judovich, in presenting a new method of motorized intermittent traction, said,

The necessary force to relieve pain cannot

be tolerated by the average patient when it is administered as a constant pull. If administered intermittently, adequate and much greater traction load can be tolerated without the discomfort which would normally accompany such force.[17]

Scott devised a traction frame with a canvas hammock which allowed for changes in patient positioning.[18] He applied pelvic traction in either the supine or sidelying positions with the spine in flexion and the hips and knees moderately flexed. Previously, most traction tables required the patient to lie with the pelvis in a neutral position and the legs extended. Scott believed that since most injuries occurred with the lumbar spine in flexion, treatment should be given in the same position. It also seems reasonable that placing the patient in the flexed position would eliminate a loss of force which otherwise would be dissipated in straightening the lumbar spine. Lawson and Godfrey in a study on spinal traction used the Scott traction frame.[19] Since their patients were lying on the canvas hammock with their legs on a pillow, the lumbar spine was slightly flexed. Traction was given with weights up to 150 pounds for varying amounts of time but no significant separation of the vertebrae was noted.

Cyriax used vertebral traction as early as 1950 and again stressed its importance in 1964.[20, 21] He suggested that sustained traction is a way of achieving in a very short time the same effect as rest in bed for some weeks. His traction consisted of bands attached tightly around the thorax and pelvis with the patient backlying. The pull varied according to the patient's tolerance but the desired traction ranged from 200 to 300 pounds for two or three periods of twenty minutes with five minutes rest between periods. The treatments were given daily for one to two weeks. Cyriax stated that traction has two effects. First, it creates an increased space between the vertebrae permitting the return of the prolapsed material. Secondly, the tightened ligaments help to squeeze the protrusion back into place.[20] However, even if this replacement were possible, the release of the traction would allow the return of the disk material to its original prolapsed state.

Of significance to this paper is a study done by Chrisman and associates.[22] The thirty-nine patients reported had low-back pain with sciatic radiation of pain, and a positive sciatic nerve stretch test, and one or more of the following: a diminished or absent tendon reflex, a loss in muscular mass or strength as seen by leg circumference measurement or manual muscle test and sensory impairment. A routine myelogram of the lumbar and lower thoracic spine was performed. This was followed by manipulation under anesthesia except in the case of a very large disk protrusion nearly blocking the canal. A modified Pitkin's maneuver was used. Fifty-one per cent had good or excellent results after manipulation. Those patients who showed most benefit had no myelographic evidence of disk protrusion. About one-half with positive myelograms also improved, although the myelograms showed no change after manipulation. They suggested that those who did not improve had a disk herniation so placed that it pressed continuously on and deformed the nerve. In fact, the patients who underwent surgery in this series did have a disk so placed. Rotatory manipulations were tried during the operations and there was no motion observed in either the disk protrusion or the nerve root, but the laminae moved apart by as much as 5 millimeters, stretching the lower fibers of the ligamentum flavum and the superior lateral joint capsule. They reasoned that this stretching of the ligaments around the vertebral foramen increased the space for the nerve root and could have accounted for the relief of symptoms. The results of the manipulation were compared to those of a control group of twenty-two patients who received the same conservative treatment that the manipulation group had initially. This control group did poorly with 73 per cent failure. Sixteen of these patients were operated on, ten in less than a week after the myelogram was done.

## METHOD

### Survey Population

This survey included forty patients selected consecutively from the physical therapy department files (1959–1960). They ranged in age from twenty-two to sixty-three years, the mean age being 39.5 years. There were twelve women and twenty-eight men with varied backgrounds and occupations (Table 1). The information in the table was obtained from the records in the physical therapy department, from the physicians' offices, from the hosiptal record room, and by questionnaire. These patients with diagnoses of ruptured intervertebral disks had both leg and back pain except for one who had muscular atrophy and weakness, and sensory deficit. All except two had a positive straight-leg-rais-

TABLE 1
PATIENT SURVEY DATA

| Patient | Age | Sex | Operation | SLR | Neurological | Pain | Roentgenogram |
|---|---|---|---|---|---|---|---|
| Excellent Results: | | | | | | | |
| 1. Teacher | 55 | F | No | — | Dermatome numbness | B & L | |
| 2. Salesman | 43 | M | No | + | Muscle tone ↓ | B & L | Disk space narrowing L5, S1 |
| 3. Florist | 34 | M | No | + | AJ 0, S1 numbness, muscle weakness | B & L | |
| 4. Industrial director | 46 | M | No | + | Sciatic cough pain | B & L | |
| 5. Sales clerk | 31 | F | No | + | List, numbness, muscle weakness | B & L | Negative examination |
| 6. Housewife | 29 | F | No | + | AJ ↓ | B & L | Negative examination |
| Good Results: | | | | | | | |
| 7. Housewife | 45 | F | No | + | L5 numbness, muscle weakness | B & L | Disk degeneration lumbosacral joint |
| 8. Industrial worker | 51 | F | No | + | AJ absent | B & L | Normal LS spine |
| 9. Teacher | 36 | M | No | + | AJ ↓, muscle tone ↓ | B & L | Negative examination |
| 10. Printing company owner | 45 | M | No | + | AJ ↓, sensory deficit S1 | B & L | |
| 11. Floor sander | 58 | M | No | + | Toe extensors weak | B & L | Narrowing of lumbosacral space |
| 12. Office clerk | 63 | F | No | — | Negative | B & L | Degenerative changes, slight disk space narrowing |
| 13. Hospital attendant | 39 | M | No | + | Numbness, list, muscle tone ↓ | B & L | Scoliosis slight, lumbar spine |
| 14. Instructor | 26 | M | No | + | Muscle atrophy, muscle weakness, L5 numbness | Back only | Narrowness L5–S1 space, degenerative changes in disk area |
| 15. Office clerk | 45 | M | No | + | AJ ↓, sensory deficit, muscle weakness | B & L | |
| 16. Highway engineer | 37 | M | No | + | Atrophy calf | B & L | Disk space narrowing |
| 17. Mill worker | 27 | M | No | + | Toe extensors weak | B & L | Slight scoliosis apex at L5 |
| 18. Housewife | 40 | F | No | + | Negative | B & L | Normal LS spine |
| 19. Mill worker | 22 | M | No | + | Muscle weakness | B & L | + myelogram, L4–5 |
| 20. Cook | 49 | F | No | + | AJ ↓ | B & L | Minimal osteoarthritis |
| 21. Machinist | 44 | M | No | + | AJ 0, muscle weakness, sensory deficit | B & L | |
| Poor Results: | | | | | | | |
| 22. Professor | 46 | M | No | + | AJ ↓ | B & L | Normal LS spine |
| 23. Maid | 59 | F | Yes | + | AJ 0 | B & L | + myelogram |
| 24. Orderly | 57 | M | Yes | + | AJ 0, muscle weakness | B & L | + myelogram |
| 25. Engineer | 33 | M | Yes | + | AJ ↓ | B & L | + myelogram |
| 26. Builder | 22 | M | Yes | + | AJ ↓, muscle weakness | B & L | + myelogram |
| 27. Housewife | 40 | F | Yes | + | Reflex difference | B & L | + myelogram |
| 28. Store clerk | 40 | M | Yes | + | Sensory deficit | B & L | + myelogram |
| 29. Housewife | 43 | F | Yes | + | Negative neurological | B & L | + myelogram |
| 30. Housewife | 37 | F | Yes | + | AJ ↓, sensory deficit | B & L | + myelogram |
| 31. Laborer | 32 | M | Yes | + | Muscle weakness | B & L | + myelogram |

Pain: B=back
L=leg
SLR: Straight-leg-raising test
AJ: Ankle jerk

TABLE 1 (Continued)
PATIENT SURVEY DATA

| Patient | Age | Sex | Operation | SLR | Neurological | Pain | Roentgenogram |
|---|---|---|---|---|---|---|---|
| 32. Orderly | 24 | M | Yes | + | — neurological | B & L | + myelogram |
| 33. Carpenter | 33 | M | Yes | + | Calf atrophy, muscle weakness | B & L | + myelogram |
| 34. Mill worker | 35 | M | Yes | + | AJ ↓, sensory deficit, muscle weakness | B & L | + myelogram |
| 35. Plumbing inspector | 45 | M | Yes | + | + neurological | B & L | + myelogram |
| 36. Mill worker | 34 | M | Yes | + | + neurological | B & L | + myelogram |
| 37. Clerk, frozen foods | 39 | M | Yes | + | AJ ↓, list | B & L | + myelogram |
| 38. Mill worker | 37 | M | Yes | + | Sensory deficit | B & L | + myelogram |
| 39. Construction worker | 36 | M | Yes | + | Muscle weakness | B & L | + myelogram |
| 40. Salesman | 34 | M | Yes | + | AJ ↓ | B & L | + myelogram |

ing sign and these had positive neurological or roentgenographic findings.

### Treatment Procedures

The treatment consisted of some form of heat, usually hydrocollator packs or ultrasound, followed by intermittent pelvic traction. The patient was placed on a traction table * with the lower legs resting on a padded footstool to provide flexion of knees and hips, thus flattening the lumbar spine (Fig. 4). A canvas traction belt was fitted around the pelvis so that its top edge came just above the anterior superior spines of the ilia. A strap from the bottom edge of the posterior portion of this belt was attached by a metal ring to an intermittent motorized traction machine. A thoracic corset or belt was placed firmly around the rib cage and secured by straps attached to the metal framework at the top of the table. Since it was absolutely essential that sliding of the entire body be prevented, the thoracic belt had to be applied very tightly. It was necessary in some cases to insert pieces of sponge rubber under the thoracic belt particularly along the rib margin.

A split table was used. The lower half of the table was movable but could be locked while the patient was being prepared for treatment.

* "Tru-Trac" table by Tru-Eze, Burbank, California.

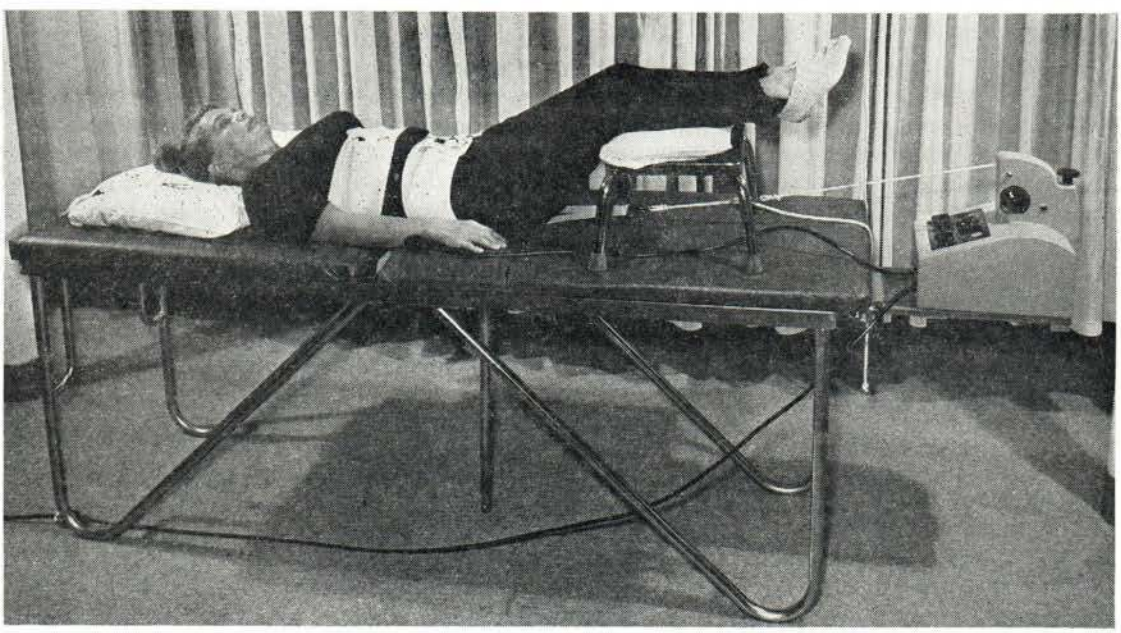

*Fig. 4. Patient ready for treatment.*

Before unlocking the table, the machine was allowed to pull a few times to take up any slack in the traction belts. The table was then released and observed for proper functioning. The traction for a period of twenty minutes was given daily except on weekends. The traction force was most frequently set at 65 to 70 pounds although the initial treatments were sometimes given at 55 pounds. In the event of increased pain, the pull was decreased slightly.

## RESULTS

The results of the survey were placed in classifications as follows:

Excellent: asymptomatic, employed full time.

Good: symptoms greatly improved, occasional minor backache and fatigue.

Poor: symptoms the same or worse.

Twenty-one patients had good or excellent results. The excellent group consisted of six patients who were free from pain and had returned to their full-time occupations. The duration of their pain prior to treatment had been from two days to several years. This group had three to ten treatments, with an average of seven treatments. Of the fifteen patients in the good group, four complained of occasional minor backache, and one of tiring more easily. The reported duration of their back problem before treatment ranged from one day to twelve years, with an average of one year and six months. They were treated from five to twenty-seven times, with a mean of nine treatments. The nineteen patients with poor results were given from one to sixteen treatments. They had no change in symptoms or were discontinued because of increased pain. Eighteen had myelographic examinations and were treated surgically. This group reported that pain prior to treatment had existed from three weeks to six years.

The survey was done on an average of approximately a year and a half following treatment, the range being from one year to two years and seven months. Therefore, the criteria for determining the distribution of the classifications were not based solely on the evaluations immediately following the treatment but took a more realistic view of how the patient continued to function in his daily living.

The results upon the completion of treatment compared with the survey results are given in Table 2.

Two patients with excellent results from treatment were placed in the good group following the survey, as one tired more easily and the other had occasional pain. Two patients who felt better after the pelvic traction treatments had a recurrance of symptoms and were operated on prior to the survey time. Twenty-one (or 52.5 per cent) of these forty patients diagnosed as having ruptured intervertebral disks showed improvement after pelvic traction. Of the other nineteen patients who were the same or worse, eighteen had surgery. It is interesting to note that of these eighteen patients, sixteen had disk protrusions which were lying below or medial to the nerve root. No disk protrusion was found in one patient, but the dura and the anterior longitudinal ligament were fused in the midline. On the other operative patient, the surgeon's report gave no specific location of the ruptured disk.

## DISCUSSION

Low-back pain appears most frequently in middle age when the degeneration process in the intervertebral disk is under way. If the patient has neurological symptoms or pain radiating down into the lower limb, there is the probability of disk encroachment into the intervertebral foramen.

Two views on the mechanics of pain are reviewed. O'Connell suggested that the stretching of that portion of the spinal nerve outside the spinal canal accounted for the symptoms ac-

TABLE 2
RESULTS UPON CESSATION OF TREATMENT AND AFTER AN INTERVAL OF TIME

| | Immediately After Treatment | | | One Year or More Later | | |
|---|---|---|---|---|---|---|
| Excellent | 8 | (20%) | | 6 | (15%) | |
| Good | 15 | (37.5%) | | 15 | (37.5%) | |
| | | | (57.5%) | | | (52.5%) |
| Poor | 17 | (42.5%) | | 19 | (47.5%) | |

companying an intervertebral disk protrusion. Smyth and Wright concluded from experimental evidence that pressure on a spinal nerve from a herniated intervertebral disk irritated the nerve, causing it to become hypersensitive. In either instance, there is an encroachment on the nerve by the prolapsed material.

Clearly, in reviewing the literature, little separation between the vertebral bodies is accomplished with a traction force which can be tolerated by the patient. Even if this were possible, a lasting separation could not be expected. Therefore, treatment aimed at restoring the disk to its normal status is unrealtistic. A possibility for the relief of the crowded nerve in the intervertebral foramen is to increase the space available. Chrisman and associates demonstrated at surgery a separation of the laminae by manipulation, stretching the ligamentum flavum and the joint capsule. They reasoned that the stretch on these ligaments provided more room for the spinal nerve and accounted for the relief of symptoms in 51 per cent of the patients manipulated. They speculated that those who did not improve had a disk herniation so placed that it pressed continuously on the nerve root. This was confirmed at surgery. A control group of patients given the same conservative treatment as the manipulation group had initially, did poorly with a 73 per cent failure.

In the present survey of patients with a ruptured intervertebral disk, 52.5 per cent improved with intermittent pelvic traction. Here again, the stretching of the ligaments of the posterior intervertebral foramen could provide enough additional space for the nerve to relieve it of pressure from the encroaching disk material. However, when the prolapsed substance lies medial to the nerve root or below the axilla formed as the nerve emerges diagonally downward from the spinal cord, then traction is likely to increase nerve pressure and pain. These patients will occasionally show a lateral trunk list toward the same side as the referred pain or neurological symptoms. The patient who leans away from the affected side most likely has nerve root pressure from above and in this case better results would be expected from traction. Of the nineteen failures in this survey, eighteen had surgery. The surgeons' reports revealed sixteen cases with disks that were lying in the nerve root axilla, one with adhesions, and one report was not specific as to the disk location.

The results of the manipulation study and the intermittent pelvic traction survey appear quite similar, with good results of 51 per cent and 52.5 per cent respectively. Certainly, on the basis of these figures, one can say that traction is as good as manipulation but without the problems of anesthesia.

A decision to operate on a suspected ruptured intervertebral disk has never been clear cut. Failure of improvement in a trial of intermittent pelvic traction is helpful in reaching a decision to advise surgery.

## CONCLUSION

The present survey indicates that intermittent pelvic traction is of value in treating the patient with a ruptured intervertebral disk. We suggest that the major benefit from this treatment is the stretching of the posterior ligaments of the intervertebral foramen, thereby increasing the space available for the nerve root. The patient with a nerve root compression from above and list away from the affected side would be expected to have the best results.

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