Computed Tomographic Investigation of the Effect of Traction on Lumbar Disc Herniations

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The aim of this study was to evaluate the effect of static horizontal traction on disc herniations by computed tomographic investigation. Changes occurring under the effect of a traction load of 45 kg have been evaluated in 30 patients with lumbar disc herniation. The herniated nuclear material (HNM) has retracted in 11 (78.5%) of median, six (66.6%) of posterolateral, and four (57.1%) of lateral herniations. Clinical response of these cases to conservative treatment varied with the amount and location of HNM, the retraction of HNM, and calcification of protruded disc. Static lumbar traction showed variable effects on lumbar disc herniations, especially in relation with the amount and location of HNM. [Key words: lumbar traction, computed tomography (CT), herniated nuclear material (HNM)]

TRACTION is one of the physical modalities frequently used for the treatment of lumbar disc herniations. The literature shows that traction causes a flattening of lumbar lordosis[1] accompanied by a distraction of vertebral bodies and an increase in disc height, a stretching of lumbar spinal muscles and ligaments,[3] and a widening of intervertebral foraminae and apophyseal joint spaces.[5] It is striking to note the disagreement among authors about the effect of traction. Matthews[3] and Gupta and Ramarad,[2] in radiographic studies, demonstrated the regression of the disc herniation during traction, but no objective *in vivo* study to visualize these changes has been heretofore available. The aim of this current study was to investigate the effect of static traction on the herniated nuclear material (HNM) and the other anatomic structures mentioned with computed tomography (CT) investigation.

MATERIAL AND METHODS

Thirty patients who were diagnosed as having lumbar disc herniation have been included in this study. The level and location of HNM have been defined by CT on a Somatom 2 CT scanner (Siemens, Erlangen, West Germany). Computed tomography investigation was performed at the time of the first diagnosis, before any medical and physical (including traction) treatment was applied.

A special traction table was designed as narrow as possible, to fit the gantry of CT. The borders were reinforced to resist the traction forces, and the material was transluscent to x-rays. A Tru-Trac (Tru-Eze Manufacturing Co., Inc., Temecula, CA) TT 92 B has been adapted to one end of this special table. The patient was supine on the table with the legs in semiflexion, and centralization was made in the gantry (Figure 1).

A lateral topogram with linear annotations indicating the location and angle of each cut was obtained from the lumbosacral spine. The gantry angle and the disc space were arranged parallel to one another and 2 mm spaced sectional tomograms were taken from the lower border of the pedicle of a vertebra to the upper border of the pedicle of the one below. Traction then was applied while the patient was still in the gantry, using a traction load of 45 kg, and 15 minutes later, a second lateral topogram was taken, followed by sectional tomograms of the same disc spaces, with continuing traction. The whole duration of traction application was 40 minutes. Reformatting with coronal and sagittal reconstructions was used in each case, and topogramic evaluation and reformatting proved that the sections before and during traction were taken from the same sections and angles.

The sectional and reconstructive images obtained before and during traction have been compared. Changes occurring in the amount and location of HNM, disc spaces, apophyseal joints, neural foramens, lumbar lordosis, flaval ligament, epidural fatty tissues, and interspinous distances were researched.

The patients were hospitalized following this CT investigation, and received physical treatment including traction as a modality for a month. Physical and neurologic findings before and after treatment were compared. Pain related to posture and activity, the finger-floor distance in centimeters during anteflexion of the lumbar spine, straight leg raising test, sensory impairment, and dorsiflexion capacity of the great toe were chosen as criteria. All patients were reevaluated at the end of 20 sessions of physical treatment; ten cases whose neurologic impairments were resistant to conservative treatment were followed up to 6 months by monthly examinations. The findings were evaluated statistically by Student *t* test and Fisher's test.

Of the 30 patients, 18 were men and 12 were women. Their ages ranged from 20 to 40 years, most of them being in the third and fourth decades of life. Body weight ranged from 55 to 68 kg, and averaged 59 kg. The level and location of HNM are shown in Table 1.

FINDINGS

Changes Occurring on CT Evaluation During Traction

The changes, diagnosed by CT, during traction were as follows:

From 14 Cases of Median Herniation. Four cases showed widening of disc space, separation of apophyseal joint facets, reduction of HNM, and increase of interspinous distances, while the epidural fatty tissues became prominent, and the flaval ligament thinner. (Figures 2-6). Seven cases showed a widening of disc space and reduction of the HNM (Figures 7,8). Two cases showed an increase in the amount of HNM, and there were large migrated disc herniations totally extruding in the spinal canal. The pain in the low-back and leg was worse in both cases during traction. One case showed no change in any anatomic structure. Thus, in 11 of 14 median herniation cases (78.5%), the HNM regressed during traction.

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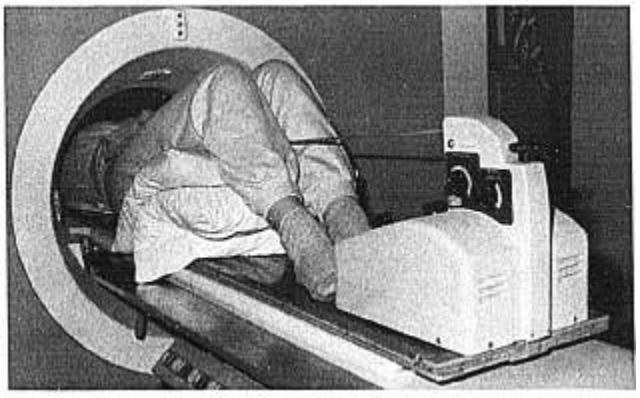


Fig 1. The position of the lumbar disc herniation patient in the gantry, during the CT investigation; traction device, pelvic bands, flexion of hips and knees to ensure the Williams position is visible.

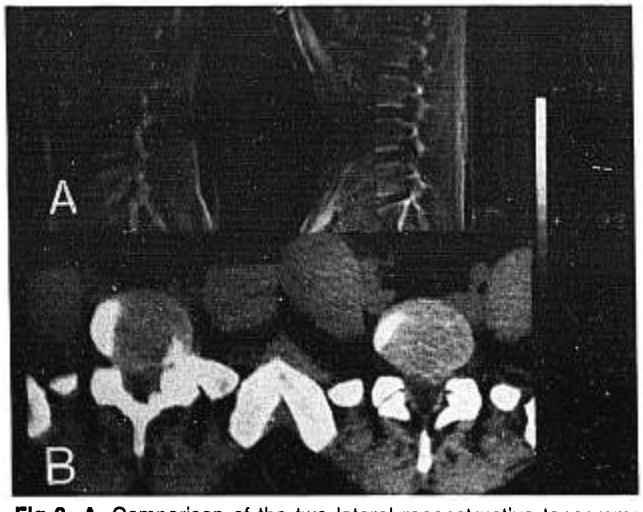


Fig 2. A, Comparison of the two lateral reconstructive topograms (LRT): During traction, decrease of the lumbar lordosis, narrowing of the lumbosacral angle, and expansion of the intervertebral spaces upto L2. **B,** Comparison of two axial segments, during traction, regression of the herniated disc material (HNM), stretching of flaval ligaments, widening of neural foramens, and prominence of the facet joint space is visible. (Traction CT is on the right)

Table 1. Level and Location of Disc Herniation Cases

Location	*Median*	*Posterolateral*	*Lateral*
L4-L5	11	6	5
L5-S1	3	3	2
Total	14	9	7

From Nine Cases of Posterolateral Herniation. Three cases showed an increase of disc space, widening of neural foramens, regression of HNM, and the fatty epidural tissues became prominent and the flaval ligament thinner (Figure 9). One case showed separation of apophyseal joint facets and regression of HNM. One case showed increase of disc space and regression of HNM. Two cases showed no change of disc space and apophyseal joint space, but the HNM has regressed. One case showed separation of apophyseal joint space with no other related change occurring. Two cases showed no anatomic changes of the spinal canal. Thus, in six of nine posterolateral herniation cases (66.6%), the HNM has regressed during traction.

From Seven Cases of Lateral Herniation. One case showed widening of disc space, separation of apophyseal joint facets, increase of neural foramens, increase of interspinous distance, and regression of HNM (Figure 10). Two cases showed increase of disc space and regression of HNM. One case showed increase of apophyseal joint space and regression of HNM. One case showed widening of disc space. One case showed widening of apophyseal joint space. One case showed no anatomic structure change. Thus, in four of seven lateral herniation cases (57.1%), regression of HNM occurred as a result of traction.

CLINICAL EVALUATION AFTER ONE MONTH OF CONSERVATIVE TREATMENT

Pain in Relation to Posture and Activity. In 13 cases of 14 median, in eight of nine posterolateral, and in all of seven lateral herniation cases, pain was reduced. Computed tomography proved for this nonimproving case of median herniation that the HNM was large enough to fill the whole spinal canal, and that in the posterolateral herniation case, the HNM was calcified.

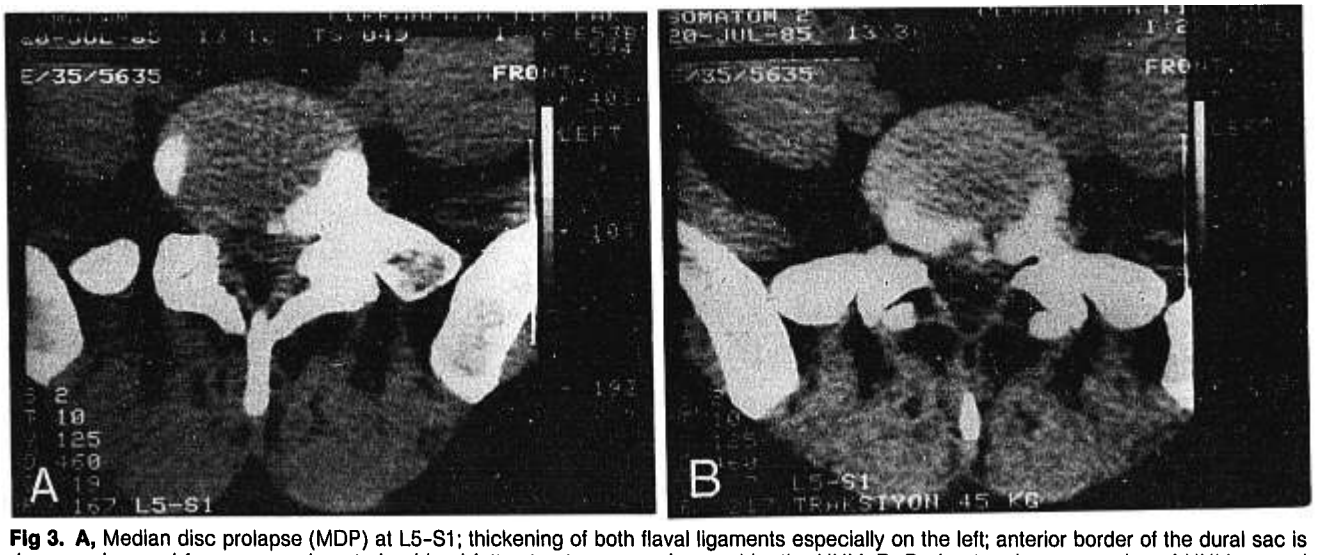


Fig 3. A, Median disc prolapse (MDP) at L5-S1; thickening of both flaval ligaments especially on the left; anterior border of the dural sac is depressed; neural foramens and ventral epidural fatty structures are obscured by the HNM. **B,** During traction; regression of HNM, normal contour of the dural sac, withdrawal of HNM from neural foramens, clearly visible ventral epidural fatty structures, and thinner flaval ligaments are detectable.

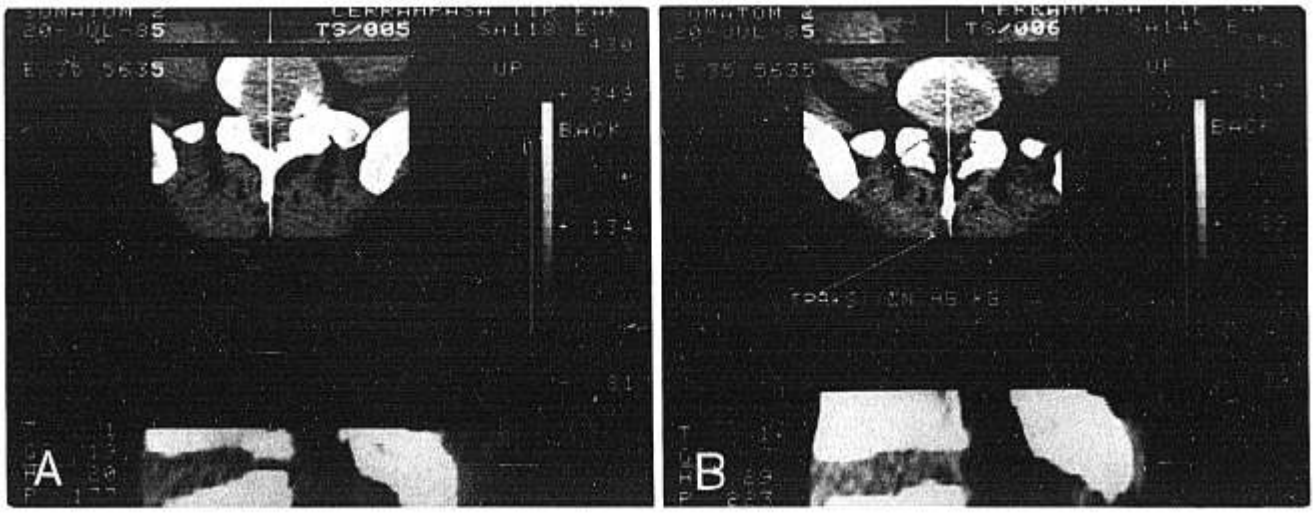


Fig 4. A, Above: MDP at L5-S1, occlusion of neural foramens especially on the left, pressure of the HNM on the dural sac. Below: On the LRT, narrowing of the discal space, particularly at the dorsal site, and MDP within the spinal canal. **B,** During traction. Above: withdrawal of HNM, widening and prominence of the facet joint interspace. Below: Widening of the dorsal discal interspace, regression of HNM.

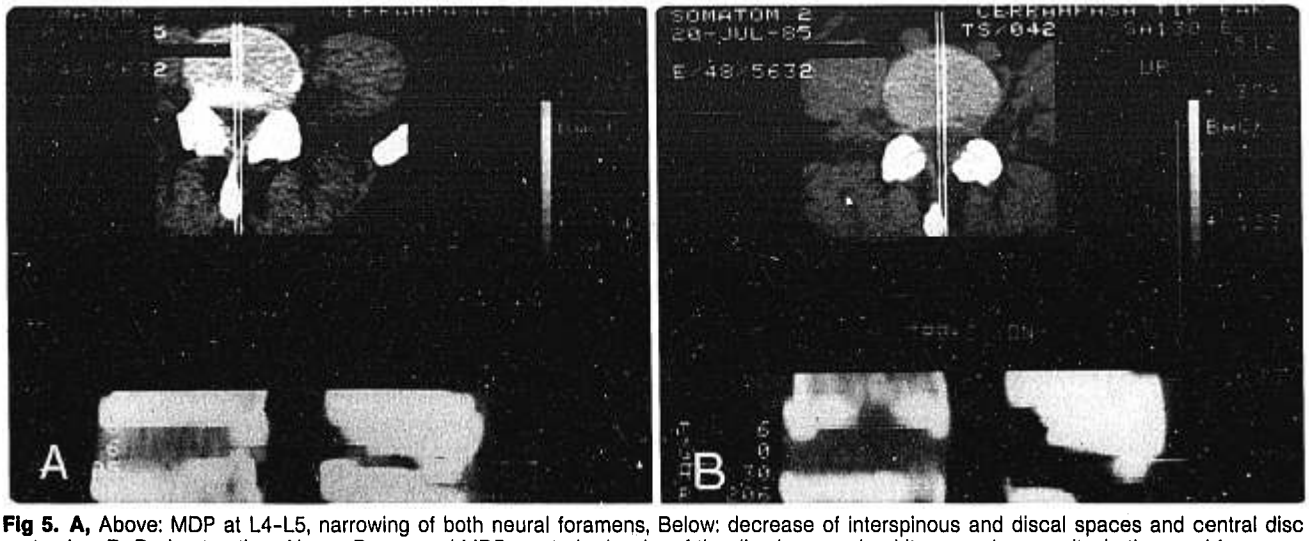


Fig 5. A, Above: MDP at L4-L5, narrowing of both neural foramens, Below: decrease of interspinous and discal spaces and central disc protrusion. **B,** During traction. Above: Decreased MDP, posterior border of the disc has regained its normal concavity, both neural foramens are enlarged. Below: LRT, decrease of MDP, increase of interspinous and intervertebral spaces.

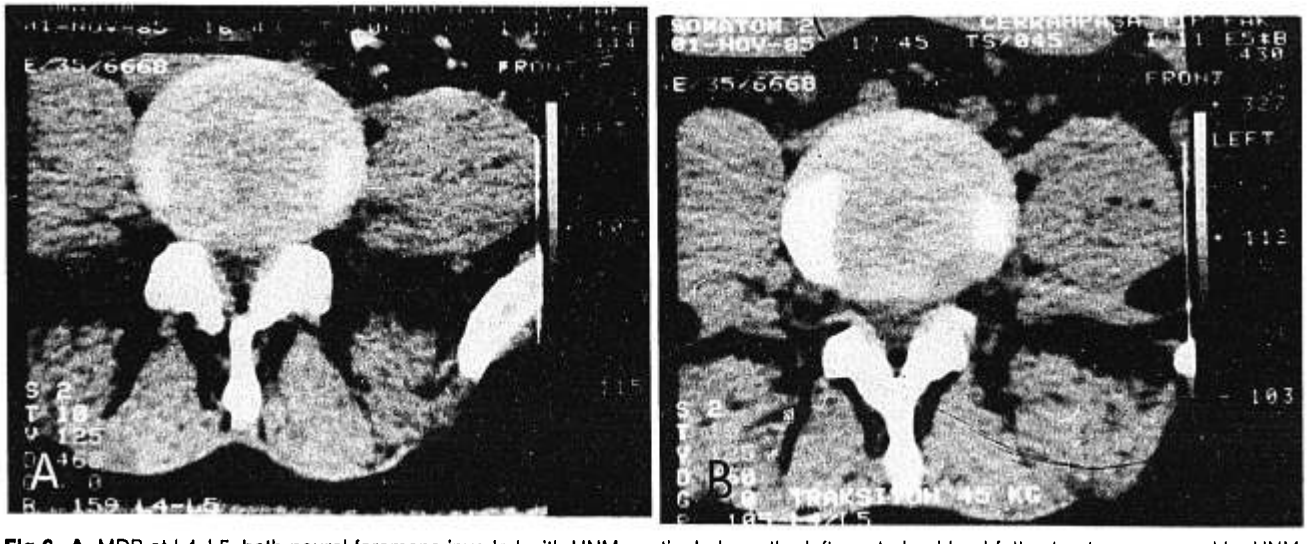


Fig 6. A, MDP at L4-L5, both neural foramens invaded with HNM, particularly on the left, ventral epidural fatty structures covered by HNM. **B,** During traction, withdrawal of HNM from neural foramens, and prominence of fatty structures is detectable.

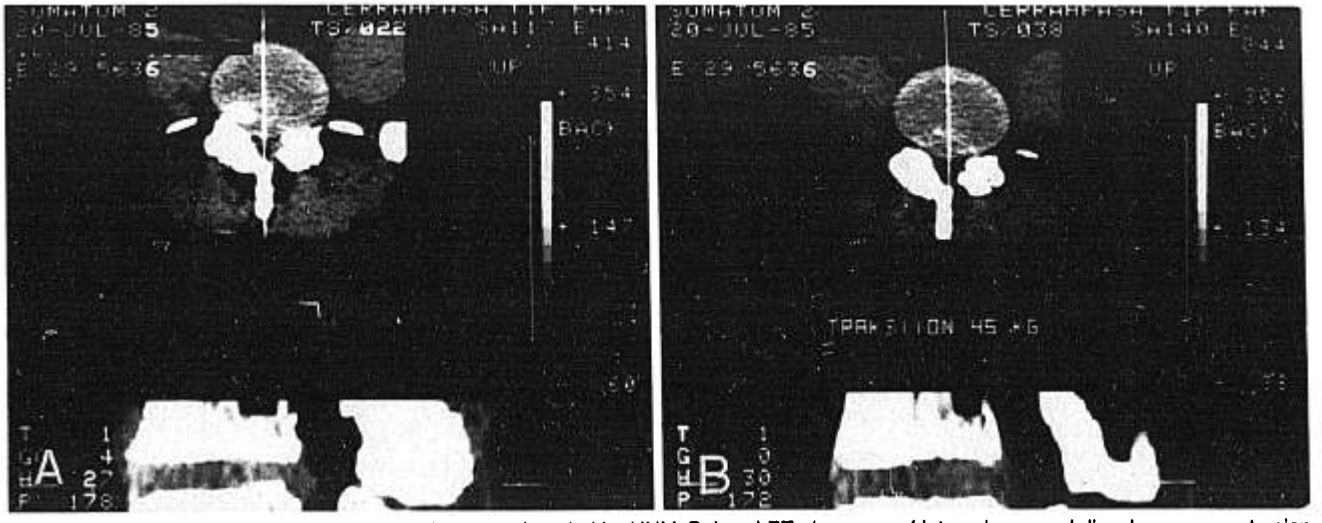


Fig 7. A, Above: MDP at L4-L5, both neural foramens invaded by HNM. Below: LRT, decrease of interspinous and discal spaces, protrusion of HNM within the spinal canal. **B,** During traction, Above: Regression of HNM, withdrawal of HNM from neural foramens, Below: Expansion of discal space peticularly at the dorsal site, regression of HNM, and increased interspinous distance.

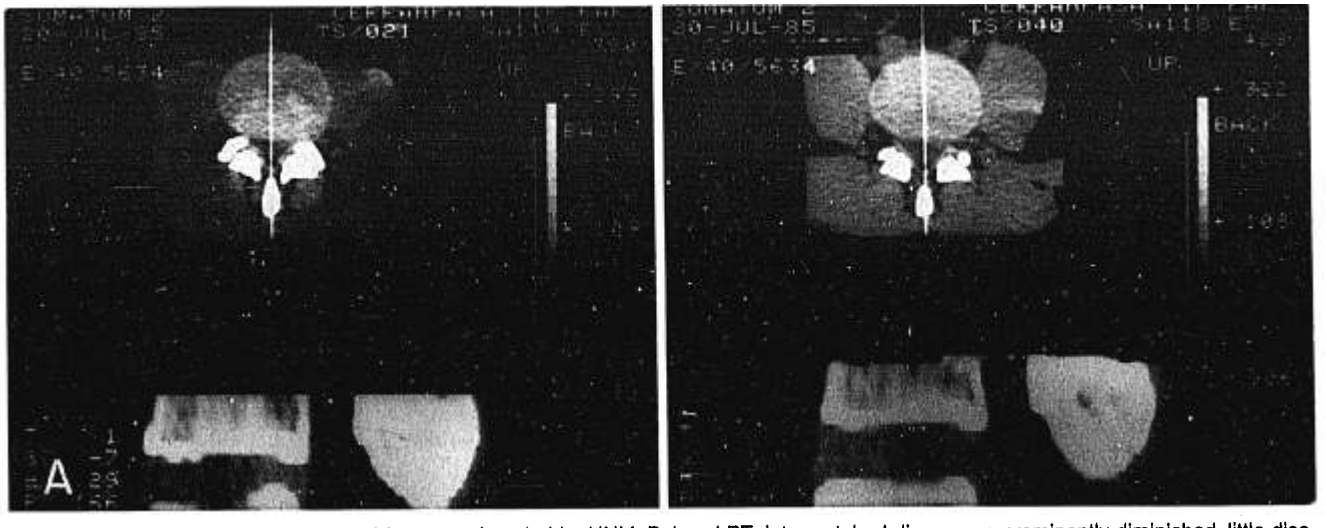


Fig 8. A, Above: MDP at L4-L5, neural foramens invaded by HNM, Below: LRT, intervertebral disc space prominently diminished, little disc protrusion. **B,** During traction. Above: decrease of MDP, neural foramens invaded by HNM: Below: intervertebral disc space increased and disc protrusion regressed.

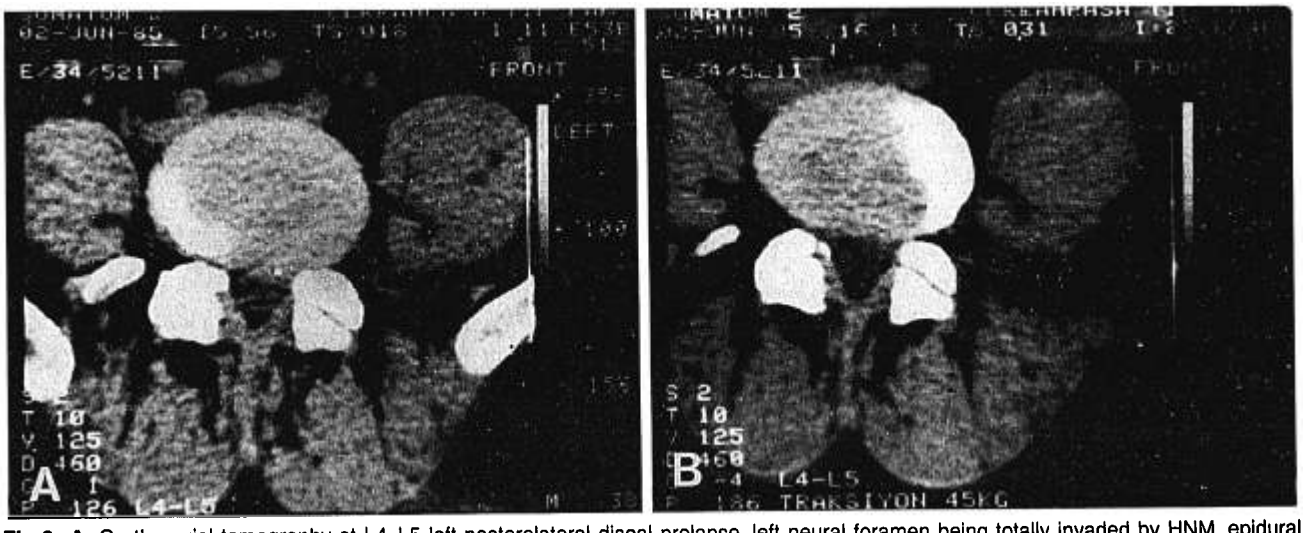


Fig 9. A, On the axial tomography at L4-L5 left posterolateral discal prolapse, left neural foramen being totally invaded by HNM, epidural fatty tissues surrounding the L5 root displaced caudally. **B,** During traction. Regression of the HNM, withdrawal of HNM from neural foramen, and prominent left facet joint interspace. The flaval ligaments are thinner and ventral and dorsal epidural fatty tissues are prominently visible.

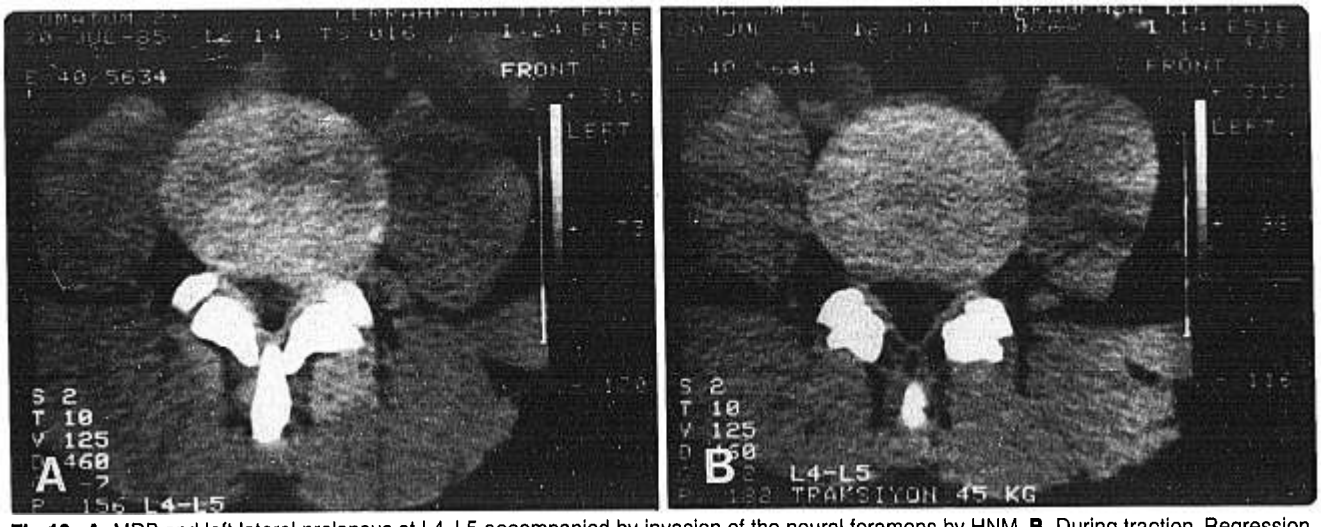


Fig 10. A, MDP and left lateral prolapsus at L4-L5 accompanied by invasion of the neural foramens by HNM. **B,** During traction. Regression of HNM from the discal space and withdrawal of HNM from neural foramens.

The Finger-Floor Distance During Anteflexion. While the range of anteflexion of the median and posterolateral herniation cases was improved significantly, no significant change was observed in lateral herniation cases.

Straight Leg Raising Test. As for anteflexion range, in cases of median and posterolateral herniations, the straight leg raising test was better after conservative treatment, but no significant improvement was noted for lateral herniation cases.

Deep Tendon Reflexes. Four of nine cases with deep tendon reflex impairment improved after treatment. No relation between location of herniation and degree of improvement has been stated.

Sensory Impairment. Three from eight median herniation cases (37.5%) associated with sensory impairment such as hypesthesia or paresthesia improved with conservative treatment. The rate was found to be seven out of nine posterolateral (42.8%) and one out of four lateral herniation cases (25%). No relation was deduced between improvement of sensory impairment and location of HNM ($P < 0.05$).

Muscle Weakness. In four of six median herniation cases (66.6%) associated with muscle weakness in dorsiflexion of the great toe, significant improvement occurred. The rate was four out of six cases of posterolateral herniation (66.6%) and two out of four cases of lateral herniation (50%). No significant relation between muscle weakness improvement and location of herniation was stated ($P < 0.05$).

Global Clinical Evaluation. Clinical findings in 28 out of 30 cases of lumbar disc herniation (93.3%) were found to improve ($P < 0.001$).

In one of the resistant cases, a "large" disc herniation filling the spinal canal, and in the other, a calcified disc, were diagnosed by CT investigation. As no long-term change was obtained by conservative treatment, they both have been operated, and the operation findings confirmed CT evaluation. At 6 months follow-up, six out of 12 cases (50%) with persistent sensory impairment, five out of six cases (83%) with residual muscle weakness, and one out of five cases (20%) with deep reflex impairment group had posterolateral herniation, three median and one lateral. In the patients in whom the neurologic impairment was permanent, the functional capacity was within normal limits and the patients were able to perform daily activity free from pain. (Tables 2-4)

DISCUSSION

Static lumbar traction applied with a traction load of 45 kg is found to be effective on discal space, apophyseal joint space, HNM, and all anatomic structures of the lumbar spine.

The widening of discal space under the effect of traction probably causes a decrease in intradiscal pressure. As a matter of fact, Nachemson[4] has proved that intradiscal pressure is reduced from 30 to 10 kg in L3 intervertebral disc, under the effect of a traction load of 30 kg. Since the traction load was 45 kg in the current study, that is to say greater than the one used by Nachemson, the intradiscal pressure would be lower and probably create a negative intradiscal pressure that "sucks back" the HNM.

The distraction of the vertebrae and the following widening of the intervertebral disc space reflects a stretching of the anterior and posterior longitudinal ligaments as well. The HNM of the median and posterolateral herniations are located in front of the posterior longitudinal ligament, whereas the HNM of lateral herniations are located away from this ligament. The stretching of the posterior longitudinal ligament suggests that it may "push back" the HNM towards the disc space. The fact that the retraction rate of median and posterolateral herniations is greater than lateral herniations, as stated in this study, seems to support this theory. Furthermore, the clinical improvement in cases of median and posterolateral herniations was far better than lateral herniations in response to conservative treatment. Referring to these facts, the effect of traction on herniation seems to be due partly to the suction effect of the negative intradiscal pressure, and partly to the pushing effect of the posterior longitudinal ligament.

The increase of the amount of HNM of the two cases of large median extrusions may be explained by the fact that these were fragmented discs, so they probably were out of reach of the sucking effect of the traction and were not able to retract. In the case of the calcified disc, no change has been expected or obtained during traction because a calcified nuclear material cannot be retracted by a traction effect.

The fatty epidural tissues were freed from the HNM, and this finding suggests that traction decreases the pressure of HNM on the spinal nerve root and dural sac during traction. As a matter

Table 2. Physical Examination Findings, Clinical and CT Results of Median Disc Herniation Cases

Case no.	Age (yrs)	Sex	Trauma	Duration	Pain score		Anteflexion (cm)		Lasegue		Numbness (dermatome)		Weakness (Big toe)		Reflex (achille patella)		CT findings	Therapy	Follow-up	
					Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post			1 month	6 months
1	35	M	+	6 mos (attack 1 mo)	2	1	26	22	60°	N	N	N	N	N	N	N	L4-L5 median HNP (large)	Conservative	Better	N
2	34	M	+	3 days	3	1	53	22	45	N	N	N	N	N	N	N	L4-L5 median HNP	Conservative	Better	N
3	31	M	−	25 days	3	1	31	0	25	N	N	N	RightDF 4/5	N	Right achille	Right achille	L5-S1 median HNP Cranial migration	Conservative	Better	N
4	33	F	−	10 mos (attack 15 days)	2	1	31	27	70	70	N	N	N	N	N	N	L4-L5 median HNP (little)	Conservative	Better	N
5	38	M	+	8 mos	2	1	27	10	80	N	N	N	N	N	N	N	L4-L5 median HNP (little)	Conservative	Better	N
6	42	F	+	2 yrs	3	1	42	11	40	80	Right L4,L5 S1	Right L5	RightDF 3/5	N	N	N	L4-L5 median HNP (large)	Conservative	Better	N
7	32	F	−	1 yr (attack 18 days)	3	3	35	30	45	45	Right L5,S1	Right L5,S1	RightDF 4/5	RightDF 4/5	Right achille	Right achille	L4-L5 median HNP (large, caudal migration)	Operation (median global HNP)	Same	Better (right achille)*
8	35	M	+	3 mos	3	1	35	16	60	N	Left L4,L5 S1	N	N	N	N	N	L4-L5 median HNP	Conservative	Better	N
9	22	F	−	5 mos	3	1	42	15	20	70	Left L5,S1	Left L5,S1	LeftDF 4/5	N	Left achille†	N	L4-L5 median HNP (large)	Conservative	Better	N
10	35	M	−	3 yrs (attack 1 month)	3	1	51	30	30	45	Left S1	N	N	N	Left achille†	N	L4-L5 median HNP	Conservative	Better	N
11	38	M	+	15 days	3	1	42	24	40	70	Left L5	N	N	N	N	N	L4-L5 median HNP	Conservative	Better	N
12	28	M	+	1 month	3	2	48	36	35	60	Left L5,S1	Left L5	LeftDF 4/5	N	Left achille*	Left achille*	L5-S1 median HNP (large, cranial migration)	Conservative	Better	Better (left achille)*
13	22	M	+	10 days	3	1	36	17	45	80	N	N	N	N	N	N	L4-L5 median HNP	Conservative	Better	N
14	34	F	+	5 days	3	1	45	30	30	60	Right L5,S1	Right S1	Right PF3/5	Right PF3/5	Right achille†	Right achille*	L5-S1 median HNP (large)	Conservative	Better	Better (right achille)*

M = male; F = female; DF = dorsiflexion; PF = plantar flexion of the great toe; HNP = herniated nucleus pulposus.
*Absence of reflex.
†Hyporeflexia.

Table 3. Physical Examination Findings, Clinical and CT Results of Posterolateral Disc Herniation Cases

Case no.	Age (yrs)	Sex	Trauma	Duration	Pain score		Anteflexion (cm)		Laseque		Numbness (dermatome)		Weakness		Reflex		CT findings	Therapy	Follow-up	
					Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post			1 mo	6 mos
1	40	M	+	15 days	3	0	42	15	40	80	Left L5	N	N	N	N	N	L4-L5 left PL HNP	Conservative	Better	N
2	39	F	+	1,5 mos	3	1	38	24	60	80	Right L5,S1	Right L5,S1	RightPF 3/5	N	Right achille*	Right achille*	L5-S1 Right PL HNP	Conservative	Better	Better (right achille)*
3	36	F	+	1 day	3	2	45	35	25	50	Right L4,L5	Right L5,S1	Right DF 3/5	Right DF 3/5	Right achille†	Right achille†	L4-L5 Right PL HNP	Conservative	Better	Better (right L5,S1 numbness)
4	20	M	+	1 mo	3	1	30	25	80	80	Right L4,L5	Right L5	RightDF 4/5	N	Right achille†	N	L4-L5 Right PL HNP	Conservative	Better	N
5	34	M	+	6 mos (attack 20 days)	3	1	26	23	45	80	N	N	RightDF 3/5	Right DF4/5	N	N	L4-L5 Right PL HNP	Conservative	Better	N
6	40	M	−	15 days	3	1	56	32	60	70	N	N	RightDF 4/5	N	Right achille*	Right achille*	L5-S1 Right PL HNP	Conservative	Better	Better (right achille)*
7	41	F	−	3 mos	3	1	20	0	N	N	Right L5	N	N	N	N	N	L4-L5 Right PL HNP	Conservative	Better	N
8	32	F	+	2 yrs (attack 15 days)	3	1	24	10	70	N	Right L5	Right L5	RightDF 4/5	N	N	N	L4-L5 Right PL HNP	Conservative	Better	N
9	42	M	+	5 yrs	3	3	53	45	40	60	Left S1	N	N	N	Left achille*	Left achille*	L5-S1 Left PL HNP (calcified)	Operation (calcified disc)	Same	Better (left achille)*

M = male; F = female; DF = dorsiflexion; PF = plantar flexion of the great toe; PL = posterolateral; HNP = herniated nucleus pulposus.
*Absence of reflex.
†Hyporeflexia.

Table 4. Physical Examination Findings, Clinical and CT Results of Lateral Disc Herniation Cases

Case no.	Age (yrs)	Sex	Trauma	Duration	Pain score		Anteflexion (cm)		Laseque		Numbness (dermatome)		Weakness		Reflex		CT findings	Therapy	Follow-up	
					Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post			1 mo	6 mos
1	34	M	+	15 days	3	2	52	41	30	45	Left L5	Left L5	Left DF 3/5	Left DF 4/5	N	N	L4-L5 Left lateral HNP (large)	Conservative	Better	Better (Left DF weakness)
2	34	M	−	5 wks	3	1	54	38	20	60	Right L4,L5 S1	Right L4,L5 S1	Right DF 4/5	N	N	N	L4-L5 Right lateral HNP	Conservative	Better	Better (right L5,S1 numbness)
3	35	M	+	10 mos	3	2	25	22	45	60	Left L5,S1	N	N	N	Left achille*	Left achille*	L5-S1 Left lateral HNP	Conservative	Better	Better (left achille)*
4	38	F	+	15 days	3	1	41	13	70	N	N	N	N	N	Left achille*	N	L4-L5 Left lateral HNP	Conservative	Better	N
5	34	F	+	8 mos	3	2	32	30	60	70	N	N	N	N	N	N	L4-L5 Left lateral HNP	Conservative	Better	N
6	28	F	+	2 mos	3	1	41	20	45	70	Left S1	Left S1	Left PF 4/5	Left PF 4/5	Left achille*	Left achille*	L5-S1 Left lateral HNP	Conservative	Better	Better left achille)*
7	38	M	+	3 mos	3	1	32	20	70	70	N	N	Left DF 4/5	N	Left patella†	Left patella†	L4-L5 Left lateral HNP (cranial migration)	Conservative	Better	N

M = male; F = female; DF = dorsiflexion; PF = plantar flexion of the great toe; HNP = herniated nucleus pulposus.
*Absence of reflex.
†Hyporeflexia.

of fact, the low-back and leg pain of all cases decreased parallel to the effect of traction, except for the two cases where traction increased the amount of HNM and the pain.

The increase of interspinous distances during traction leads to the idea that traction is not only affecting the anterior components of the lumbar spine, but also the posterior components, including the interspinous ligament. As the flaval ligament gets thinner under the effect of traction, we may deduce that apophyseal joint facets are separated, causing a stretching of the ligament.

The clinical responses of the herniation cases to conservative treatment and the location of HNM seems to be related. Traction is more effective on median and posterolateral herniation cases, and clinical improvement is evident in these cases, but traction is not very effective on lateral herniations.

Neurologic impairments were found to improve in time, as proved by long-term follow-up.

REFERENCES

1. Caillet R: Low Back Pain Syndromes. Third edition. Philadelphia, F.A. Davis Co. 1981, pp 90-94
2. Gupta RC, Ramarad SV: Epidurography in reduction of lumbar disc prolapse by traction. Arch Phys Med 59(7):322-327, 1978
3. Mathews J: The effects of spinal traction. Physiotherapy 58(2):64-66, 1972
4. Nachemson A, Elfstrom G: Intradiscal dynamic pressure measurements in lumbar discs. Scand J Rehabil Med (Suppl) 1:1-40, 1970
5. Rogoff JB: Manipulation, Traction and Massage. Baltimore, Williams and Wilkins Co, 1980

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