Inversion therapy: a study of physiological effects

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Inversion traction therapy has received only modest scientific investigation. No study to date, has investigated a complete range of physiological parameters pertinent to inversion therapy. In this study, a set of physiological parameters including cardiovascular, biomechanical and radiographic were studied in a normal population using the Inverchair. Our results demonstrated a significant increase of forward trunk flexion, a general reduction of paraspinal EMG activity, a significant level of distraction of the L4-5 and L5-S1 disc spaces, as well as a lack of change in heart rate and blood pressure. These findings establish the physiological basis for the clinical effects of Inverchair Therapy and for its appropriate clinical utilization.

KEY WORDS: inversion, traction, chiropractic, manipulation

La thérapie par traction inversée n'a été que très modestement étudiée par les milieux scientifiques. Jusqu'à ce jour, aucune étude n'a établi une gamme complète de paramètres physiologiques se rapportant à la thérapie par inversion. Dans la présente étude, un ensemble de données physiologiques comprenant les paramètres cardiovasculaires, biomécaniques, et radiographiques a été étudié dans une population normale en utilisant l''Inverchaise''. Nos résultats ont démontré qu'il se produisait une augmentation significative de la flexibilité du tronc vers l'avant, une réduction générale de l'activité paraspinale EMG, une baisse significative de la pression exercée sur les espaces interdiscaux L4-5 et L5-S1, ainsi qu'une absence de changement au niveau du rythme cardiaque et de la tension artérielle. Ces résultats établissent les bases physiologiques pour les effets cliniques de la Thérapie Inverchaise et pour son utilisation clinique appropriée.

MOTS CLÉS: inversion, traction, chiropractie, manipulation

Introduction

The efficacy of a particular conservative therapy is, in large measure, due to its potential to be used over a broad base of patients and a wide range of diagnostic entities. As well, such a therapy must be reasonably simple and economical. It must produce a very low iatrogenesis and have very few side effects. At the same time, the known effects of such a therapy must attain to a high enough degree of physiological benefit and thereby clinical utility. To the extent that any particular therapy maximizes each of these points, then it will attain a status of high efficacy and applicability.

Many such therapeutic modalities in the treatment of low back pain are in use today. Prominent among these has been spinal traction. The most recent development in the delivery of spinal traction has been the use of gravity-assisted inverted traction or Inversion Therapy (I.T.). Sheffield[1] was the first to describe the use of the inverted position for the application of spinal traction, reporting that of 175 incapacitated patients he treated in the inverted position, 155 were able to return to full-time work after an average of eight treatments. Gray[2] combined body-weight traction on a polished inclined plane with manipulation, and showed that effective relief of varying degrees was produced in seventeen of twenty-six cases. Gray[2] was also able to show radiographic proof of significant degrees of distraction of the lumbar disc spaces during use of an inverted traction board. Nosse[3] showed that the inverted position increased the spinal length and reduced EMG activity of the para-spinal lumbar musculature in healthy male subjects. It was also shown that a minimum inversion time of seventy seconds was needed to achieve maximal effect of the inverted position on the lumbar musculature. Most recently Klatz[4] has shown in 20 subjects that three minutes of vertical inversion in Gravity Inversion Boots produces significant elevation of blood pressure, heart rate, central retinal arteral pressure and intraocular pressure.

The most recent development in this area is a device known as the Inverchair, which appears to offer several refinements and benefits over the existing inversion devices (see Figure 1). The most important of these benefits are the following:

1 The sitting posture produces 90° flexion of the knees and hips, a posture which is known to reduce the lumbar curvature.
2 The traction is centered on the pelvis as in more traditional horizontal modes, thus focusing the immediate and full effect of traction on the lumbo-sacral spine.
3 The legs are left comfortable and unencumbered.
4 The patient is fully and comfortably supported by the back cushion.

No study, to date, has thoroughly investigated a wide range of physiological parameters involved in inversion therapy. It is the purpose of this study to investigate the effect of inversion traction on the normal subject both in terms of immediate effects during treatment and those which occur as immediate outcomes of I.T.

Methods and materials

Two different study samples were investigated. The first involved 40 subjects, 29 males and 11 females, with a mean age of 22.5 yrs. In this group, the parameters shown in Table I were assessed. Subjects received an initial orientation and were screened for any current low back symptomatology and any current or past pathology or condition of the heart and cranium.

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Table 1: STUDY 1: A DESCRIPTION OF THE TEST PARAMETERS AND METHODS

Parameter	Method
Forward and lateral trunk flexion	Tape measure – centimeters fingers-floor
Straight leg-raising	Goniometer
Pulse rate	Manual Measurement
Blood Pressure	Manual Measurement
Paraspinal Muscle Activity	EMG

The initial recordings of standing forward trunk flexion, lateral trunk flexion, and supine straight leg raising were taken. Trunk flexions were recorded by tape measure in centimeters of finger-floor distance; the SLR was measured by goniometer in degrees. The subject was then secured in the Inverchair.

Electromyographic readings were taken on a Narco Biosystems Physiograph using the EMG and integrated couplers. Surface electrodes were attached to the paraspinal area, bilaterally at the third lumbar vertebra, with a ground lead on the forehead. EMG measurements were recorded on Narco MK-IV-P Physiograph. The skin was prepared by cleansing it with alcohol, followed by mild sanding and then cleansing with alcohol again. Beckman Ag/Ag cl surface electrodes were attached to the skin and connected through a lead wire to the universal coupler type 7189. The signals were checked for resistance and sensitivity and their placement and/or skin preparation corrected where required.

The initial EMG reading was taken in the sitting position. As well, the initial blood pressure and heart rate readings were taken in the seated position. The subject was then moved to the horizontal position and remained there for 30 seconds. Second readings of EMG, pulse and blood pressure were taken. The subject was then inverted fully (see Figure 2) and readings of EMG, pulse and blood pressure were taken at intervals of one minute for three minutes. The subject was returned to the horizontal for 30 seconds, and then to the erect sitting position. The final recording of trunk flexions and SLR was then taken, ending the study sequence.

A second sample of 16 subjects was investigated for disc space separation. All subjects were males with a mean age of 27. In this study, radiographs of the lumbar spine (lateral views) were taken at the horizontal baseline and 3 minute inversion times. The X-ray tube was centered on the lumbo-sacral junction at a focus-film distance of 150 cms. A moving buckey was used to reduce X-ray scatter and thereby enhance the film clarity. All of the radiographs were taken with the subjects and the Inverchair in the same position.

The disc space heights were measured by calipers in millimetres. Measurements were taken at the anterior and posterior, inferior and superior margins of the disc space resulting in two test measurements – the anterior and posterior disc space heights. A distortion factor of 1.3 has been calculated when a 150 cm focus-film distance is used[5]. This factor was used to adjust the

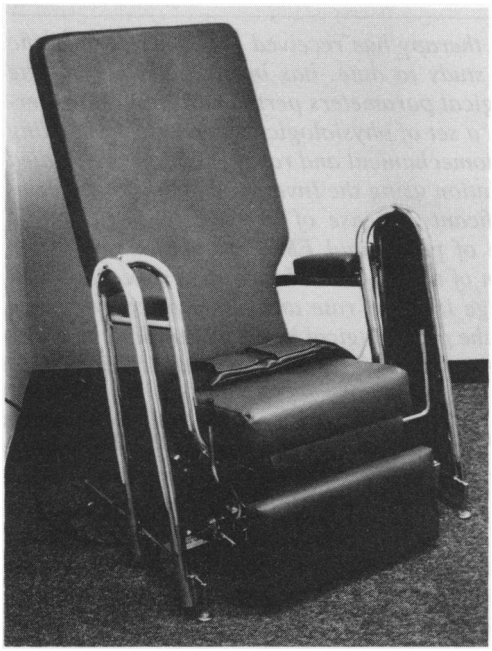

Figure 1: The Inverchair device.

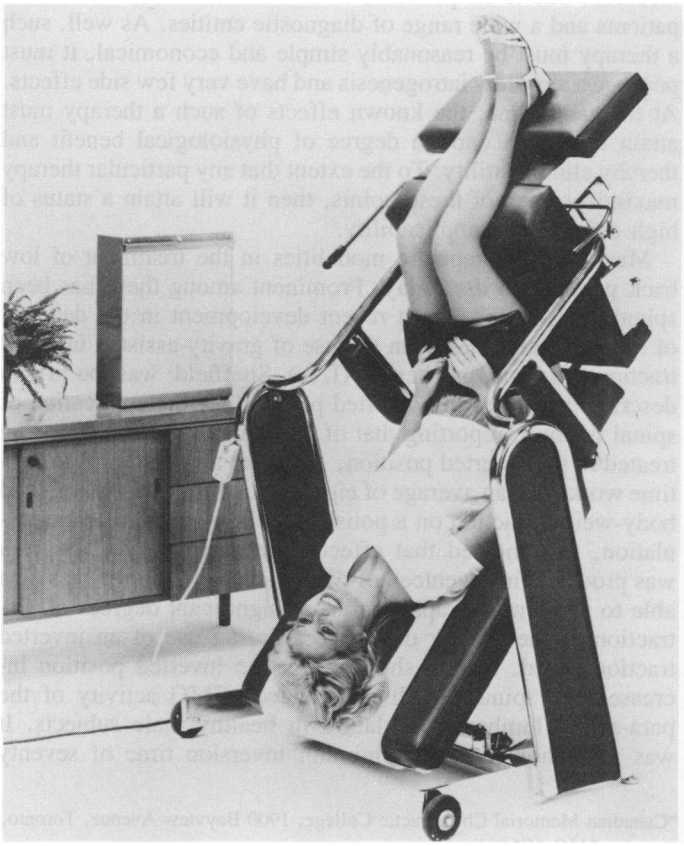

Figure 2: Subject secured in the Inverchair at full inversion.

raw values downwards to reflect absolute measurements of disc space height.

The data for blood pressure and heart rate were assessed by the analysis of variance technique with an acceptable p-value at .05. The data for forward flexion, lateral flexion, straight leg raising and for the radiographic analysis were assessed using the students t-test with an acceptable p-value at .05. The EMG data were not analyzed statistically as the baseline sensitivities were not constant across the sample.

Results

The results of both studies are displayed in Tables 2 through 5. In the first study, biomechanical and cardiovascular parameters were investigated. With regard to the range of motion tests only forward flexion showed a statistically significant change amounting to a 25.5% increase. Lateral flexions and the straight leg raising tests were virtually unchanged. (see table 2) As can be seen from table 3, at 3 minutes of inversion 52.5% (n=21) of subjects exhibited a decrease of paraspinal EMG activity while 32.5% (n=13) showed an increase and 15% (n=6] exhibited no change. It can, however, be seen (Fig. 3) that the number of subjects exhibiting a decrease in EMG activity is increasing through the 3 minute test period, while the opposite is true for those exhibiting an increase in EMG activity.

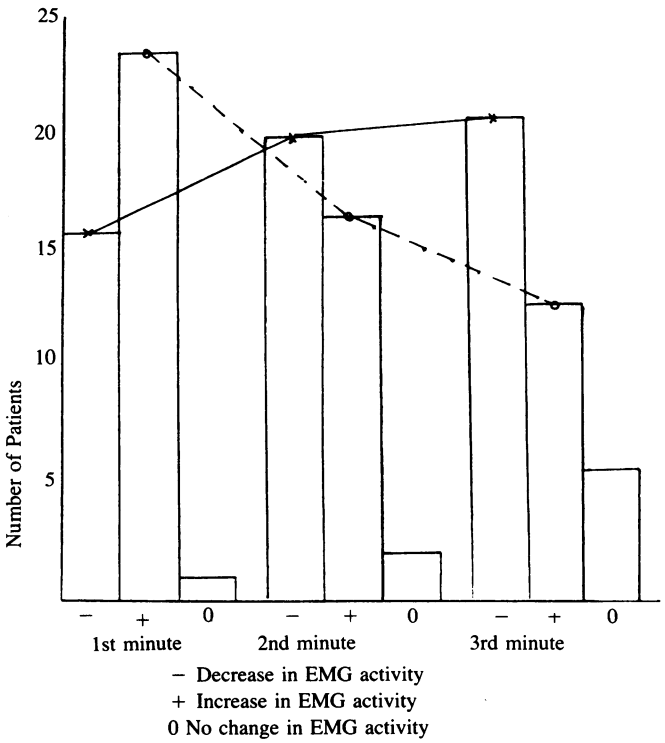

Figure 3: Frequency histogram of paraspinal E.M.G. activity at 1,2, and 3 minutes

Table 2: STUDY I: RESULTS OF ORTHOPAEDIC TESTS

Parameter	Pre IT	Post IT	Level of Significance
Forward Flexion	9.82±6.64	7.32±6.03	P < .005
Lateral Flexion			
Right –	45.12±5.03	44.56±5.27	N.S.
Left –	45.23±4.79	44.61±5.02	N.S.
SLR			
Right –	78.1±9.19	75.6±12.32	N.S.
Left –	76.4±10.24	77.3±9.36	N.S.

Table 3: STUDY I: RESULTS OF EMG TESTING COMPARING THE RESTING SITTING WITH THREE MINUTE INVERSION POSITIONS

Percent Change :	+ 100-50%	+ 50%-1	no change	−1-50%	−50-100%
Number of subjects (N=40)	3	10	6	18	3

Table 4: STUDY 1: RESULTS OF CARDIOVASCULAR PARAMETERS

Parameter	Sitting	1 Minute	3 Minutes	Post-Inversion Sitting	Level of Significance
Heart rate	62.95±7.3	62.0±7.4	60.07±6.52	66.3±7.89	N.S.
Blood pressure	152.22/ 76.07	120.2/70.6	120.05/74.03	119.5/77.2	N.S.

Table 5: STUDY II: RESULTS OF LUMBAR DISC SEPARATION (MEAN VALUE IN MM)

	Anterior	P-Value	Posterior	P-Value
L4-5	1.65±.58 (N=8)	P < .025	.98±.43 (N=8)	P < .05
L5-S1	2.24±1.49 (N=15)	P < .005	1.73±.54 (N=11)	P < .005

With regard to the cardiovascular parameters it can be seen from Table 4 that these remain virtually unchanged throughout the 3 minute test period.

Table 5 reveals the extent of increases shown in the intervertebral disc spaces. The L4-5 interspace showed a mean increase of 1.65 mm anteriorly and .98 mm posteriorly; while the L5-S1 interspace showed a mean increase of 2.24 mm anteriorly and 1.75 mm posteriorly. These findings are all statistically significant.

Discussion

The results of these studies characterize the effects of inverted traction in a group of normal, non-symptomatic patients in the third decade of life. These results can be discussed within three categories: 1) cardiovascular, 2) biomechanical, 3) radi-

ographic. With regard to the first category, these results demonstrate that the cardiovascular system, in general, is stable through three minutes of seated inversion. There may be individual and local aberrances, but the general pattern shows an adequate compensation by cardiovascular regulatory mechanisms. These findings are contrasted with those of Klatz et al who found significant elevations of systemic blood pressure and pulse rates. Our speculation on this difference centers on the difference in the position of the body while undergoing inversion. In Klatz's study the subjects were fully vertical suspended from their ankles. He explains the increases in cardiovascular parameters on both the increased inflow to the right atria and on neurogenic factors which would arise as a result of the stress of inversion. In the seated posture, with the hip flexed at 90° with only 60° of inversion, and with the full comfort and support of the chair-back these factors may be sufficiently decreased so as to dampen any stimulative cardiovascular reaction. Studies should be done however, to more closely investigate cerebral and peripheral perfusion. Until this is done, a good case history should elicit the important contraindications of cerebral and cardiovascular disease. With proper screening, three minutes of seated inversion can be accomplished with adequate safety.

With regard to the second category of results, a pattern emerges showing a general reduction of paraspinal muscle activity coupled with a significant increase in the range of active spinal forward flexion, while showing no effect on straight leg raising and lateral spinal flexion. This indicates a specific effect on the lumbar posterior musculo-ligamentous tissues, as opposed to those in the pelvic or hip regions. (ie. the hamstring muscles) The lack of increase in lateral trunk flexion may implicate a different musculo-ligamentous system which coordinates that activity, and which does not respond to distraction.

The third category of results, radiographic, presents two findings of importance (see Figures 4 to 10). The first is a flattening of the lumbar spine which was observed uniformly throughout the second study sample. This flattening necessarily involves a stretching of the posterior myofascial structures as well as a stretching of the posterior ligamentous system. This correlates well with the observed tendency toward EMG reduction and the increase in active forward flexion. However, our results show a second phenomenon of disc space distraction, superimposed onto the flattened lumbar spine occurring at both the anterior and posterior disc space margins. As such the operative dynamic in inversion therapy is not merely a posterior gapping caused by passive lumbar anteflexion but a complete axial separation of the vertebrae. Colachis and Strohm indicated that this was the most important effect of spinal traction[5].

The average values of this distraction, are displayed in Table 5, and are compared to others in the literature in Table 6. The findings of this study would theoretically be sufficient to reduce the majority of intervetebral disc protrusions (those termed

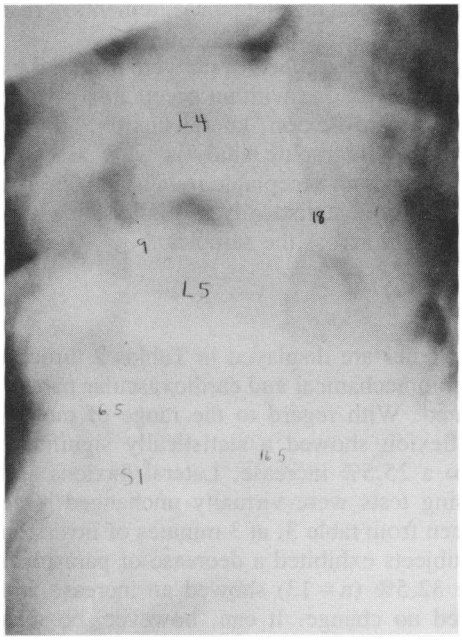

Figure 4: Patient #1. Pre-Inversion radiograph.

slight to mild, 2-3 mm) and help reduce the disco-radicular conflict involved in those moderate to severe protrusions (4-6 mm).

Table 6: COMPARISON OF RESULTS OF INTERVERTEBRAL DISTRACTION USING TRACTION

	Mean amount of distraction (in mm)	Number of subjects	Type of traction
Vernon (1983)	L5-S1 anterior 2.24 mm posterior 1.73 mm L4-5 anterior 1.65 mm posterior .98 mm	16	Inversion
Gupta (1978)[6]	.5 mm	14	Supine-gravity assisted with weights
Colachis & Strohm (1969)[5]	50 lbs./15 min L5-S1 .35 mm L4-5 .60 mm 10 lbs./15 min. L5-S1 .10 mm L4-5 1.55 mm	10	Supine
Mathews (1968)[7]	2.0 mm		
Lawson & Godfrey (1958)[8]	0 mm	6	Supine
Lehmann & Brunner (1958)[9]	L5-S1 2.6 mm L4-5 1.5 mm L3-4 1.3 mm	19	Vertical traction
DeSeze & Levernieux (1951)[10]	1.5 mm	cadaveric experiments	

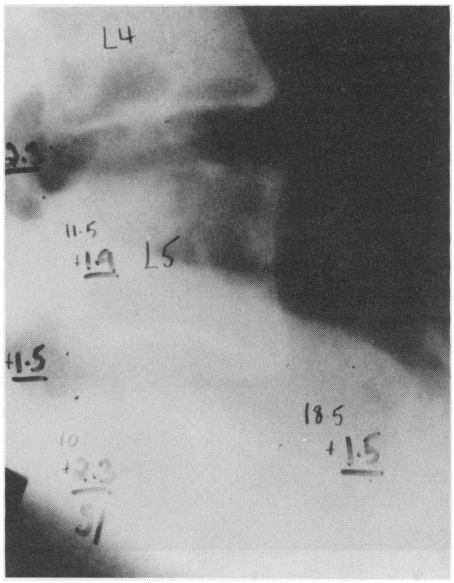

Figure 5: Patient #1. Post-Inversion radiograph. Underlined measurements have been reduced by a factor of 1.3.

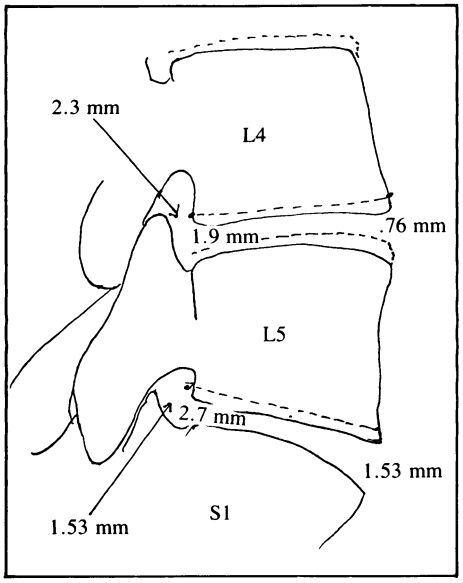

Figure 6: Overlay of Patient #1 demonstrating the mean increases in anterior and posterior disc space height as well as the intervertebral foraminal height at L4-5 and L5-S1.

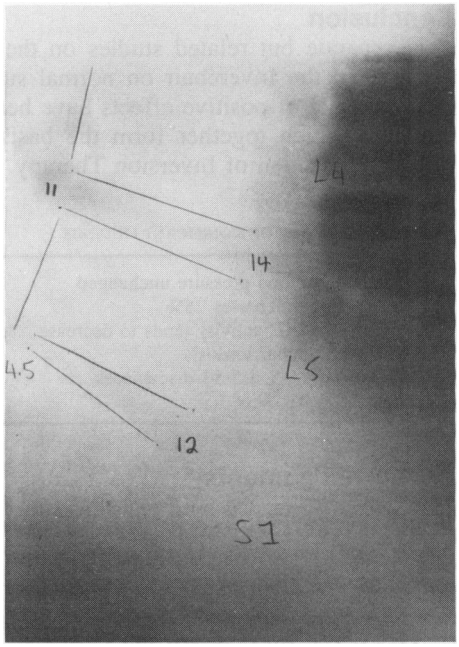

Figure 7: Patient #2. Pre-Inversion radiograph.

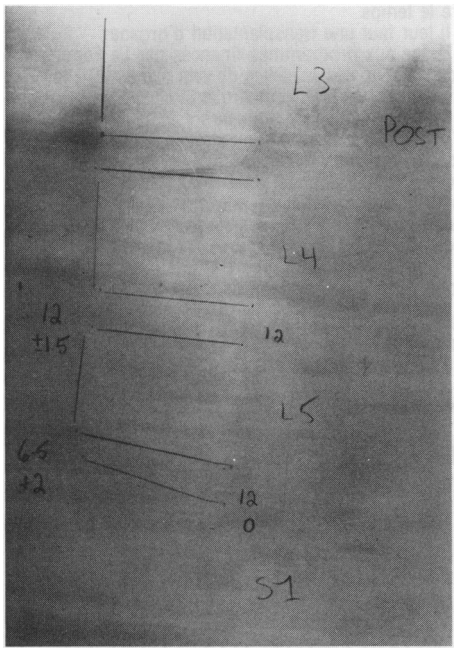

Figure 8: Patient #2. Post-Inversion radiograph.

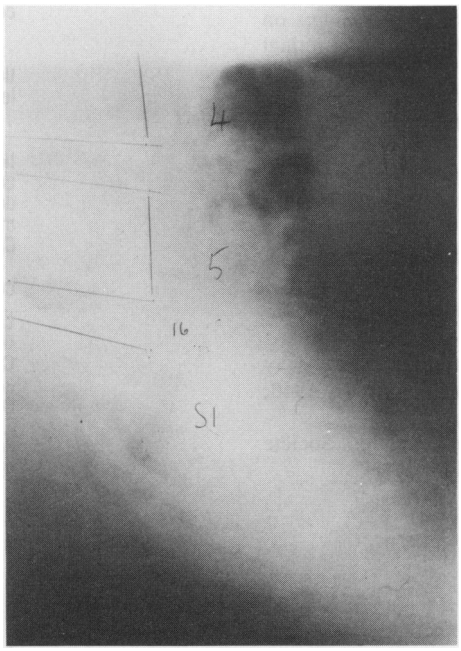

Figure 9: Patient #3. Pre-Inversion radiograph.

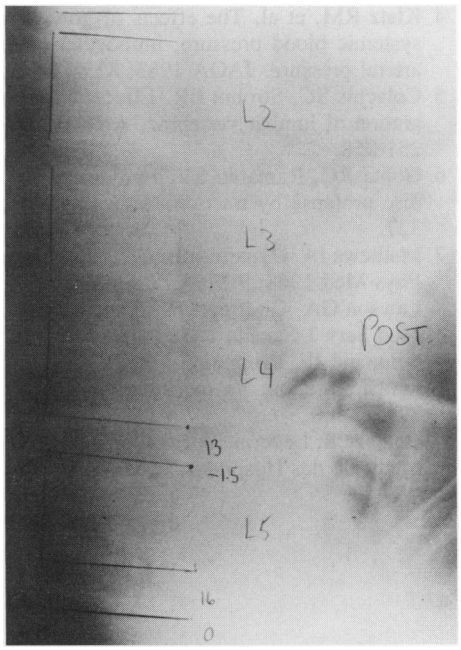

Figure 10: Patient #3. Post-Inversion radiograph.

Conclusion

Two separate but related studies on the effects of Inversion Therapy in the Inverchair on normal subjects have been reported. A set of positive effects have been demonstrated (see Table 7) which together form the basis for the appropriate clinical utilization of Inversion Therapy.

Table 7: SUMMARY OF SIGNIFICANT FINDINGS

- heart rate and blood pressure unchanged
- forward flexion increases 25%
- paraspinal E.M.G. activity tends to decrease
- flattening of lumbar lordosis
- distraction of L4-5, L5-S1 disc spaces
- opening of IVF's

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