Printed in
Orthopedic Physical Therapy Clinics of North America Dec./99

A New Technologic Approach to Managing Lumbar Stability

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Lumbar instability is one of the most challenging spinal diagnoses seen in orthopedic physical therapy. The literature has amply documented the methods that have been used to assess and treat the lumbar area. [2,3,5,7,8,15-18,23] What has not been available is a reliable system to access the spinal curves and segmentally strengthen the paraspinal musculature while providing long-term stabilization. Over the past 10 years, the Pneumex Corporation (Sandpoint, ID) has done a significant amount of research with the aid of many physical therapists, including the senior author (S. A. S.), in designing what is now known as the *Pneu-Back* (distraction system). This program has clinically been shown to be one of the most advanced and effective systems for assessing and treating lumbar instabilities. Based on feedback from practitioners in more than 200 clinics nationwide, this program has been effective in treating cervical and thoracic segments as well (S. Sodorff, unpublished study, 1997).[4] This article introduces the reader to new technology in treating lumbar instabilities. The three components of the Pneu-Back Exercise Program and the key elements targeted for treating instabilities with this equipment are presented.

MEASURING THE SPINAL CURVES

Spinal alignment is determined by the relationship of the lumbar, thoracic, and cervical curves.[9] A healthy posture requires little muscle work to maintain good posture in any human static and dynamic situation.[21,22] In the Sagittal plane, forward lean has an extreme influence on spinal stability and the ability of the spine to tolerate increased loads.[1,21] The Pneu-MAP (Fig. 1) functions to evaluate and measure the patient's progress. This component of the Pneu-Back System consists of a freestanding tracing grid accompanied by software that interprets the data from the spinal curve tracings.

The actual postural tracing is done according to a set protocol established by the manufacturer. The patient stands with his or her back to the MAP. A small *tracing wheel* is centered at the lumbar spine then placed cephalically at an area beginning slightly above the apex of the cranium. The patient is given specific instruction on assuming normal relaxed posture. The postural curve is traced by running the wheel (which is connected by a small horizontal bar to an erasable felt pen to the surface of the grid) along the path of the patient's spine. The tracing begins at the cranial apex and ends at the most prominent point on the sacral curve in the area of the sacral cleft. The postural tracing, once overlaid onto the Pneu-MAP grid, is then evaluated for the horizontal run and vertical rise of each curve and identified by six points (Fig. 2). As seen in Figure 2, the recorded values are taken at the apex of the cranium, cervical, upper and lower thoracic, and lumbar curves. Forward lean is computed by comparing the horizontal distance and vertical rise between the lumbar and the cervical apexes.

By virtue of its design, this standardized mapping system

creates a reproducible evaluation procedure. An interrater and intrarater study is in the process of completion by McElroy and Williams[12] at Arizona State University that shows no significant deviation in the mapping data. A second almost completed study by Tehan[20] at Arizona State

University shows that the Pneu-MAP tracings have a greater than 90% correlation with spinal curves seen on x-ray.

The computer model has established the normal curve value at 10. This value is purely a mathematical value established by the manufacturer as a measurable point on a vertical axis. Values above the 10 axis were greater, whereas values below were less. It follows then that a curve value of less than 10 indicates a flattened curve, whereas a value greater than 10 identifies an excessive curve. To determine the relative norm, 400 postural screens were evaluated. Table 1 shows the normative values of each curve.

TABLE 1 Normative Values for Spinal Curves

Curvature	**Minimal**	**Normal**	**Excessive**
Cervical	<7	7-13	>13
Upper thoracic	<8	8-12	>12
Lower thoracic	<8	8-12	>12
Lumbar	<8	8-12	>12

Once the MAP has been performed and the patient's curve value has been computed, the patient is identified in one of four posture types. An example of each type is described in Figure 3.

KEY ELEMENTS

To attain stabilization, three key elements have to be present: postural balance, flexibility, and strength. Good postural balance can be measured by forward lean. The amount of forward lean is one of the most important indicators of lower back pain and lumbar instability.[4] A pilot study done by several clinics using the Pneu-MAP seems to support this. Four individual screenings were performed with populations of 67 – 214 subjects, over a period of 2 years, and indicated that 85% of those with a forward lean of greater than 3° reported lower back pain (Table 2).[4] A further illustration of the effect of forward lean was shown in a study done by Weinhuffer et al.[24] They showed that the intradisdal pressure at L3-4 and L4-5 disks with 10° of forward flexion increased dramatically to 100% and 500%. Once one has assessed the forward lean, the next step is to formulate a treatment plan that addresses these issues in a predictable, effective manner.

When considering the cause of lumbar instability, one has also to consider the overall spinal balance and its integrity as a whole entity. Kapandji[9] compared the spine to axial compression forces on a column with three flexible curves. He demonstrated that an individual curve, the lumbar in this instance, if pronounced is a dynamic curve and if attenuated is a static curve. A pronounced curve value of 8 to 12 correlated as a functional curve, whereas a curve of less than 8 represents a more compromised inflexible curve. Kapandji's study states that when combining the lumbar curve with the thoracic curve, the resistance factor increases from 2 to 5, and when all three curves are balanced, the resistance factor increases to 10. It can be inferred from this study that a normal lumbar curve would resist injury or deterioration more effectively than a compromised curve.[9]

The second key element in the program is flexibility. Poor flexibility in the hips and lower extremities adversely affects motion in the spine by reducing the ability of the pelvis to move effectively in the Sagittal plane. The reduced lordosis caused by the tight hamstrings produces sacral counternutation, a most unstable position at the sacroiliac joint. The tight hamstrings require greater spinal muscle motor control for load transference at lumbosacral and sacroiliac regions.[10,11,22] Any deficits in the hamstrings, Piriformis, gluteals, tensor fascia lata, or iliopsoas are identified then addressed in the clinic and home exercise program. The home program is

designed specifically to correct and enhance the patient's posture according to *posture type* and flexibility issues.

Strength, the last element, is assessed during the objective examination. The assessment and biomechanical implications of trunk strength deficits are discussed in greater detail by other authors in this issue. Nevertheless, assessing strength both helps to establish a starting point for the exercise program and targets the areas of weakness with which the therapist needs to work. Once it has been established that there is a lumbar instability, the patient's posture type has been identified, and strength and flexibility have been assessed, a course of treatment can be determined.

PNEU-BACK CHAIR

At this point, the Pneu-Back Chair (fig. 4), which is also known as an *Isolation Back Chair*, is introduced into the treatment plan. The Pneu-Back Chair is designed to stabilize the pelvis by eliminating the recruitment of the gluteal and hamstring muscles.[4] The erector spinae musculature are isolated and recruited for strengthening. The chair also provides specific quadriceps stabilization for both postural alignment and additional trunk stability during exercise. The back chair becomes part of the evaluation procedure because of its ability to assess the spinal range of motion and strength levels. Range of motion is calculated by measuring the distance the trunk travels during the extension exercise against the resistance cylinder.

Isolation is a product of positioning and external fixation. With the patient seated properly, Velcro straps are fixed at the waist and slightly superior to the knees. Pneumatic pressure is applied to both the posterior pelvis and the bottom of the feet locking the femur into the pelvis. Once isolated, the patient learns to relax the lower extremity muscles and begin specific segmental paraspinal muscular recruitment.

The protocol for the Pneu-MAP software for the back chair gives the clinician a baseline to start treatment. Basic strengthening of the lumbar paraspinals is accomplished by having the patient complete a single set up to 15 repetitions maximum or failure as per protocol. To prepare a patient for the lumbar exercises, the patient completed a 10-minute warm-up exercise (i.e., treadmill or stationary bike). This activity is followed by active and passive range of motion of the hamstring, gluteal, and lumbosacral musculature. By increasing the core body temperature and stretching the soft tissue, the patient is ready to begin exercising on the Pneu-Back Chair.

Strengthening the lumbar segment involves extension and flexion in a 70° arc of motion consisting of approximately 45° of extension and 25° of flexion.[4] The patient is stabilized with 20 to 40 pounds per square inch (PSI) depending on tolerance. The exercise resistance level for the lumbar musculature is 35 to 40 PSI. The chair has an adjustment for patients with excessive lumbar lordosis. If the lumbar curve is greater than 15°, adjusting the seat to decrease its angle enables the operator to flatten the lumbar curve. When the lumbar curve is less than 8°, a lumbar roll is used to increase the lordosis during the isolation extension exercise.

TABLE 2 Postural Lean Values

	Neutral	**Anterior**	**Posterior**
Lean	Between –1 and 2	> 2	≥ 1

When treating lumbar instability, the exercise protocol calls for two sessions per week. The patient is taught how to stabilize the trunk by tightening his or her *inner* and *outer* units.[10,11,19] The length of treatment seems to be age dependent. It is recommended that treatment duration of 4 weeks is appropriate for patients younger than 20 years old. Treatment for 7 weeks for patients 45 years old and older may be necessary. Frequency and duration of treatment are still dependent on the acuity of the patient's symptoms.

PNEU-TRAC DISTRACTION DEVICE

The third component of the Pneu-Back Program is the Pneu-Trac (Fig. 5). Similar to the back chair, it is a pneumatically driven distraction device measured in PSI. By distracting the lumbar spine while actively recruiting the paraspinal musculature during treatments, simultaneous unloading and strengthening is provided. This method can be effective with patients who are unable to tolerate normal weighted exercise. It allows the patient to exercise with less loading to facilitate conditions of optimal tissue healing and ease of exercise.[4]

The Pneu-Trac distraction has been used with patients with ruptured or herniated disks, spondylosis, or lumbar stenosis; postsurgical patients; and chronic or acute patients with scoliosis. Depending on the diagnosis, the lumbar paraspinal strengthening in distraction can be done in extension, neutral or flexed position. The distraction is generally done at 50% body weight, which is tension necessary counter weight, the upper trunk.

To distract the lumbar segment, the patient wears a Pneumex unweighting vest, and the lumbar spine slowly unloads until the patient is pain-free. The distraction is applied for 8 to 10 minutes to allow the paraspinal musculature to relax and lengthen, reducing the stress on soft tissues and pressure on disk spaces. Once the patient has been distracted for the appropriate time, a posterior pelvic tilt is performed using the abdominal musculature. A maximum of 15 repetitions is completed.

There is a threefold reasoning behind the exercise and its effectiveness. First, by distracting in a specific postural attitude with a fixed pelvis stabilization, an effective lumbar distraction technique is accomplished, and the erectors begin to relax. Second, by firming the abdominals to obtain mobilization through the lumbar region with the muscles in a distracted and relaxed state, a negative and positive hydraulic pressure is initiated. This action creates a normal balance and circulation through the affected region as it is facilitated.[1,13]

When patients begin an exercise program in the Pneu-Back Chair with or without distraction, there is a minimal learning curve. First, the patient needs to be able to relax the lower extremity musculature so that he or she avoids substitution. Second, the patient has to be able to initiate segmental recruitment of the paraspinal musculature. Many patients whose paraspinal strength is significantly compromised may fail during the extension exercise to reach the 15 repetitions, and they substitute the lower extremity musculature. If this situation occurs, the exercise is discontinued at the point of failure because the isolation has been lost, making the exercise no longer effective.

The most common lumbar instability that is seen in the clinic is the *type I* posture, which is characterized by a reduced lumbar curve and forward lean (see fig. 3*A*). There is usually an immediate change in the measurable forward lean after properly exercising in the chair. Several case studies by the author (unpublished, 1997), ongoing clinical studies, and Fulton's[6] work at the university of Florida have substantiated this change. It is essential to have a good home program that reinforces the patient's clinic program, enhances his or her lumbar stability, and subsequently provides significant pain reduction. The inadequate ligamentous structures in the spine cannot

control unwanted movement in the spine. By reducing the lean and by isolating and segmentally strengthening the paraspinals, physical therapists enable patients to maintain better trunk control. Because the primary restraints of accessory motion can no longer be controlled by the ligaments, the muscles must take over.

CONCLUSION

The combination of the Pneu-MAP, Pneu-Back Chair, and Pneu-Trac offers an innovative approach to the evaluation and treatment of lumbar instability. The ability to distract the lumbar spine and actively recruit the erector spinae musculature is unique to other stabilization programs. Standardization of care combined with simple principles and predictability of results makes the Pneu-Back program invaluable in the treatment of lumbar instabilities.

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