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THE ORTHOTIC MANAGEMENT OF LUMBAR LORDOSIS AND THE RELATIONSHIP TO THE TREATMENT OF THORACO-LUMBAR SCOLIOSIS AND JUVENILE KYPHOSIS

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Historically an attempt has been made to reduce the lumbar lordosis somewhat when casting a patient for a Milwaukee CTLSO. This attempt has been made with varying degrees of concern and usually with varying degrees of success.

Recognizing that the orthotic management of the lumbar lordosis is necessary in the treatment of juvenile kyphosis (Scheurmann's disease), and thoraco-lumbar scoliosis with a CTLSO or TLSO, this paper will present the rationale for such management, beginning with the development of the lumbar posture and its relationship to the overall spinal positioning.

Postural Development in the Saggital Plane

Posture can be defined as the relationship of the parts of the body to the line of the center of gravity (4). The sagittal curves of the spine, through development and growth, play an important role in maintaining the proper postural and body relationships to the center of gravity.

Beginning in the uterus the fetus is in the position of flexion with the convex curve of the spine lying against the curve of the uterine wall. Following birth the development of posture is affected by the constant forces exerted by gravity.

The newborn lies either supine or prone and the gravitational force is exerted on a horizontal plane and tends to unroll the primary ventrally convex curve or "coiling" that was assumed in the uterus. (Fig. 1A)

The infant between two and six months begins to lift its head and to sit, causing the development of a cervical compensatory curve. (Fig. 1B)

The nine- to eighteen-month old begins to stand and walk in an upright position and the weight of gravity is exerted in a vertical direction resulting in the development of the lumbar compensatory curve or lordosis. (Fig. 1C)

This stage of development results in four curves in the sagittal plane, a) the thoracic and sacral curves *concave* ventrally (the primary curves because they were present during fetal life), and b) the cervical and lumbar curves *convex* ventrally, the secondary or compensatory curves (developed after birth) (2).

The three curves above the sacrum, the cervical, dorsal, and lumbar, are functional and add to spinal elasticity and strength. The three afford a greater resiliency to the weight forces of head and body, and those exerted by gravity, than would a single curve. The

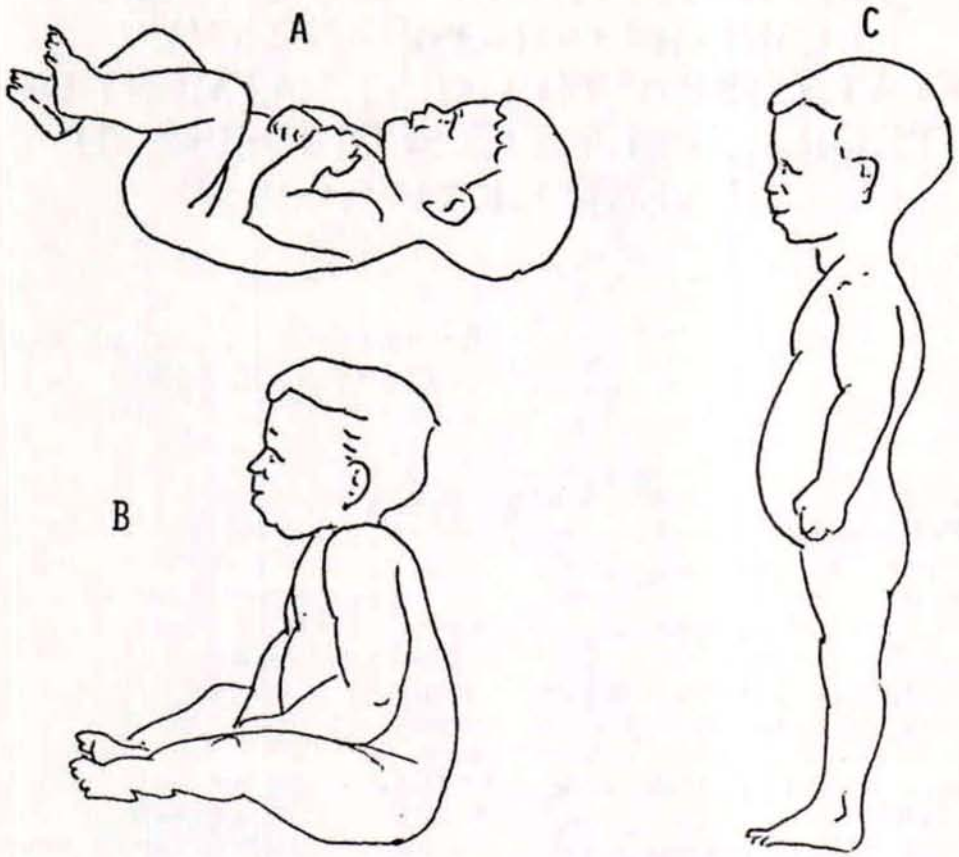

Fig. 1. The development of posture.

weight is transmitted to the sacrum and then to the pelvis and hips. The sacral curve is an adaptation to the inclination of the pelvis and is not a factor of weight transmission.

The Lumbar Lordosis - Pelvic Tilt Relationship

The pelvis is the base upon which the spinal column rests, the lumbo-sacral joint, (lumbar five and sacral one,) and any changes in its inclination will result in a corresponding change in the position of the 5th lumbar vertebra in relation to the sacrum. This results in an alteration of the posture of the entire spine. An increase in the inclination of the pelvis causes any increase in the lumbar curve. A decrease in the inclination causes a decrease in lumbar lordosis.

Inclination of the pelvis is controlled by the muscles of the hip. It is decreased by contraction of the hip extensors, the glutei, hamstrings, and the posterior portion of the hip adductors; and is increased by contraction of the hip flexors, the iliopsoas, rectus

femorus, pectinieus, and the anterior position of the hip adductors. The spine is flexed by the iliopsoas and abdominals and is extended by the erector spinae.

The abdominals act synergistically with the glutei, the latter decreasing the pelvic inclination and the former reducing the lumbar lordosis (3) (Fig. 2).

The "Fick" angle of inclination is one measurement used to determine the degree of pelvic tilt. The angle of a line from the foremost portion of the pubic symphysis, to the superior posterior spine of the ilium, measured to the horizontal. The normal male angle of inclination is 50 deg., with a slight increase in the female (Fig. 3).

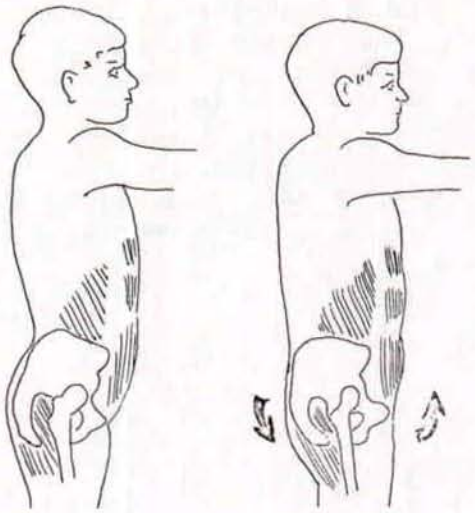

Fig. 2. Pelvic tilt.

The range of pelvic tilt is determined by the tension in the hip joint capsule and reenforcing ligaments, principally the "Y" ligament. If further pelvic tilt is attempted, flexion of the hips is necessary.

In the sitting position the ligaments no longer restrict the pelvic tilt so that the Fick line angle becomes horizontal. This is accompanied by a flattening of the lumbar lordosis.

The Lumbar Lordosis - Thoracic Spine Relationship

The orthotic management of the lumbar lordosis becomes important in the treatment of idiopathic scoliosis and juvenile kyphosis. The righting reflex, the re-alignment of ligaments and muscle leverages, and the neutralization and direction of forces must be considered.

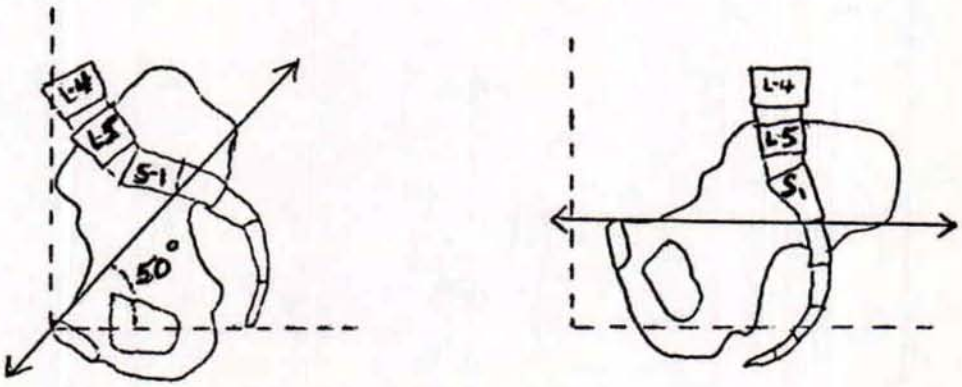

Fig. 3. Fick angle of pelvic inclination.

The Righting Reflex

In juvenile kyphosis, Scheurmanns disease, the anterior wedging of the thoracic vertebrae and the increase of the thoracic curve in the sagittal plane appear as a postural rounding of the back. The increase in the primary thoracic curve results in the development of an increase in the compensatory cervical and lumbar curves, caused by the effort of the body to right itself over the center of gravity, thus creating an even greater "apparent" postural deviation.

Conversely, in the orthotic management of juvenile kyphosis with the Milwaukee CTLSO, the force systems employed, namely 1) the three-point force system of an inferior and superior anterior force countered by a posterior force just below the apex of the kyphus, and 2) the distractive force between the iliac crests and the base of the occiput, are re-enforced and aided by the "righting" reflex created by the correction of the lumbar lordosis. As the lordotic curve is reduced, the shoulder and head are projected more anteriorly, and again the body's mechanism to right itself over the center of gravity results in an anti-kyphotic force and an extension of the thoracic spine (Fig. 4).

The reduction of the lumbar lordosis in the pelvic base of the orthosis results in the righting reflex assisting the anterior posterior forces maintained by the orthosis as well as an immediate "better" posture and the positive beginning of the treatment program.

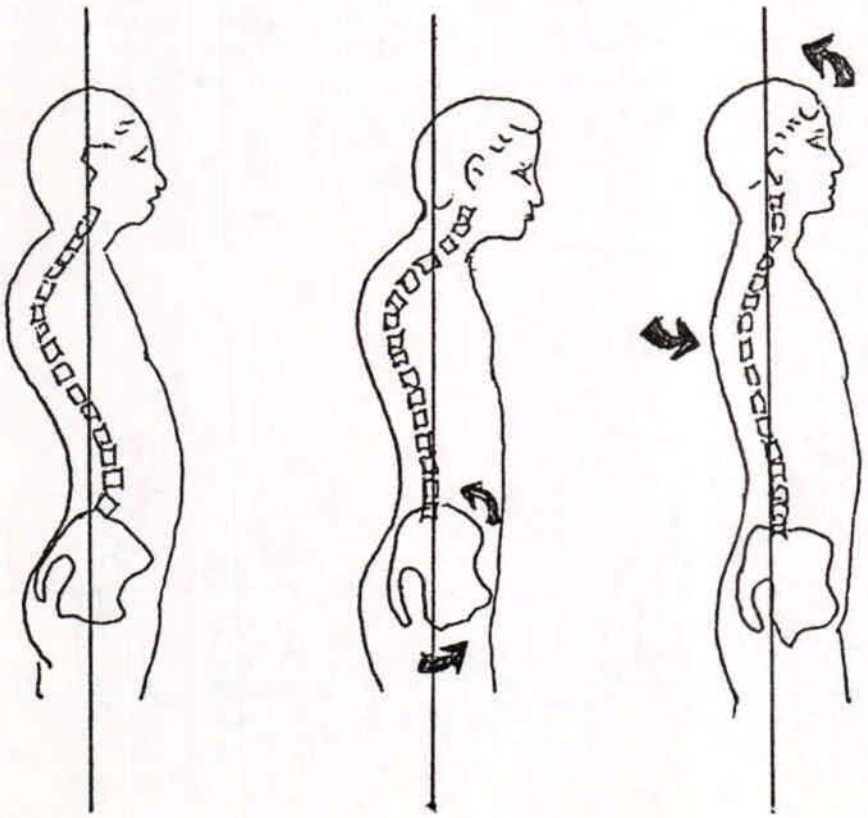

Fig. 4. "Righting" reflex to center of gravity.

Fig. 5. Left, x-ray of spine before treatment; right, x-ray of spine in Milwaukee CTSLO.

An example of the effectiveness of this concept is seen in the comparison x-ray views shown in Fig. 5. On the left is a view of an untreated lordosis, and on the right the same lordosis in the base of a Milwaukee CTLSO, casted in a reduced lordotic position.

For comparison, the angle of lordosis is measured from the inferior border of L-5 to the superior border of L-1 by the "Cobb" method.

The untreated degree of lordosis on the left is 50 deg. The corrected positioning on the right measures 30 deg.

The comparison view of the thoracic spine (Fig. 6) demonstrates the results of the lumbar positioning in the Milwaukee CTLSO. The degree of kyphosis on the left measures 72 deg. The corrected position on the right measures 46 deg.

The reduction of the lordotic and kyphotic curves are readily seen in the clinical comparison slide (Fig. 7) of the patient with and without his Milwaukee orthosis.

The Re-Alignment of Ligament and Muscle Leverages

In the management of thoraco-lumbar scoliosis the control of the lumbar lordosis allows re-development of the mechanical advantages: 1) the re-alignment of ligament and muscle levers, 2) the neutralization and direction of forces, and 3) the stabilization of the pelvis and the lumbar spine.

It is recognized that the scoliotic spine not only deviates laterally but also rotates in the direction of the convexity. This deformity involves the spine and ribs along with the muscle and ligaments attached.

The muscle mass acting on the spine is a multi-layered complex of long and short fibers extending in many directions. Some remain mid-line from vertebra to vertebra, while others project laterally from mid-line to transverse processes and to rib angles. The long fibers divide into parallel columns along the spine spanning from two to ten vertebrae. In scoliosis as the spine deviates

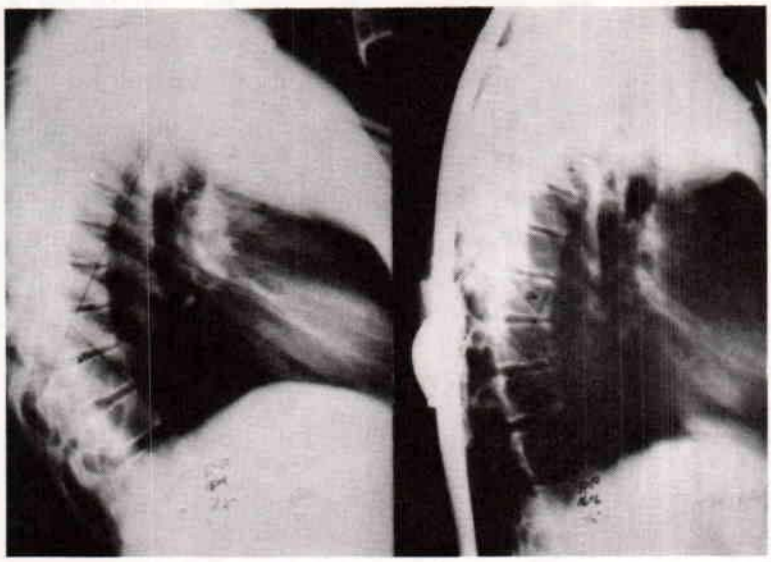

Fig. 6. X-rays of thoracic spine: left, untreated; right, with use of Milwaukee CTSLO.

laterally and the vertebrae rotate, the muscle attachments re-align adversely so they lose their leverages on the spine.

In the thoracic spine the lateral and rotational deviations are seen as a prominence of the rib cage, posterio-laterally (Fig. B). Because of the presence of the rib cage an external force applied to the rib prominence, a postero-lateral to anterior force, has an effect on the vertebrae involved. A lateral force applied to the rib affects the vertebrae at least two levels above where applied. Normal rib angulation is downward so that the lateral rib border is two vertebral levels below its attachment to the spine (1).

In the lumbar spine the absence of rib attachments results in no lateral projections upon which to apply a corrective force. In lumbar scoliosis the lateral and rotational deviations are seen as a muscle prominence and a pelvic obliquity towards the convex side (Fig. 9). Add to this the tendency towards a lumbar lordosis and there develops a three directional deviation.

Re-positioning the vertebrae and thereby re-establishing the muscle and ligament at-

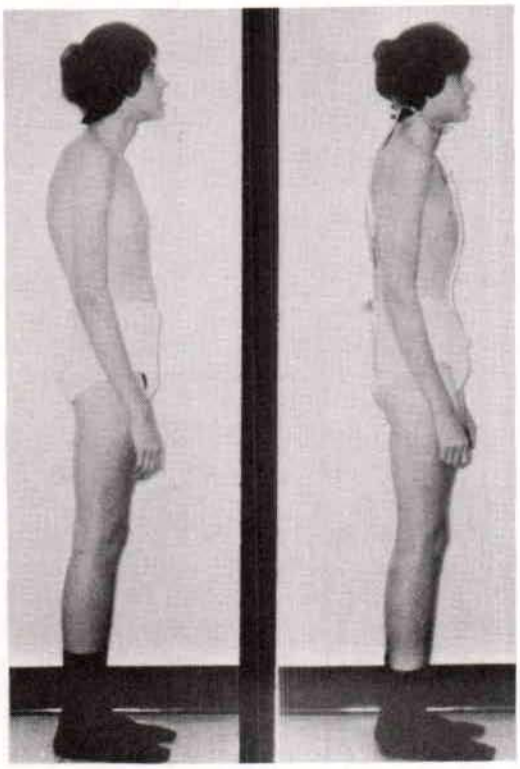

Fig. 7. Patient without and with Milwaukee CTSLO.

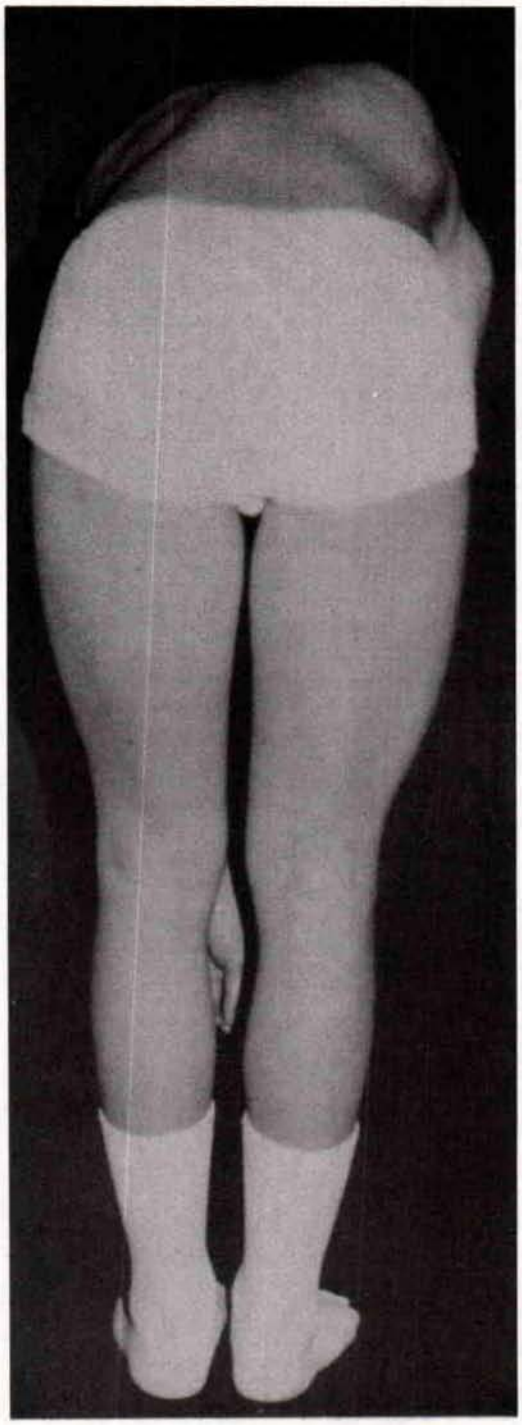

Fig. 8. In the thoracic spine the lateral and rotational deviations are seen as a prominence of the rib cage, postero-laterally.

tachments to their position of leverage becomes a primary concern.

In the management of lumbar scoliosis it is necessary to reduce the lumbar lordosis and to straighten the posterior to anterior "sway", positioning the vertebrae in a mechanically advantageous position before applying a lateral corrective force. Since the corrective force is directed from a posterio-lateral angle, the force lessening the lordotic posture neutralizes the posterior to anterior moment of the corrective force and increases the effect of the lateral moment on the spine. The rotation of the vertebrae and angulation of the transverse processes along with the muscle bulge towards the convexity, are also held in position by the anti-lordotic force to accept the corrective exterior force.

A mechanical advantage is also realized in releasing the stretch of the anterior and posterior longitudinal ligaments caused by the excessive lordosis. The stretch of the anterior ligament and bowing of the posterior ligaments in the lordotic position is critical when the vertebrae are rotated in the scoliosis. The ligaments align more laterally in the scoliosis and when released in the reduction of the lordosis allow more flexibility and less resistance to the corrective lateral forces being applied.

The stabilization of the pelvis upon which to build the orthosis and the increase in intra-abdominal pressure by the encompassing girdle add to the necessity for the reduced lordotic positioning.

Summary

This paper has emphasized the importance of proper orthotic management of lumbar lordosis and its relationship to the treatment of juvenile kyphosis and thoraco-lumbar scoliosis.

In the orthotic management of juvenile kyphosis with a CTLSO the effect of the

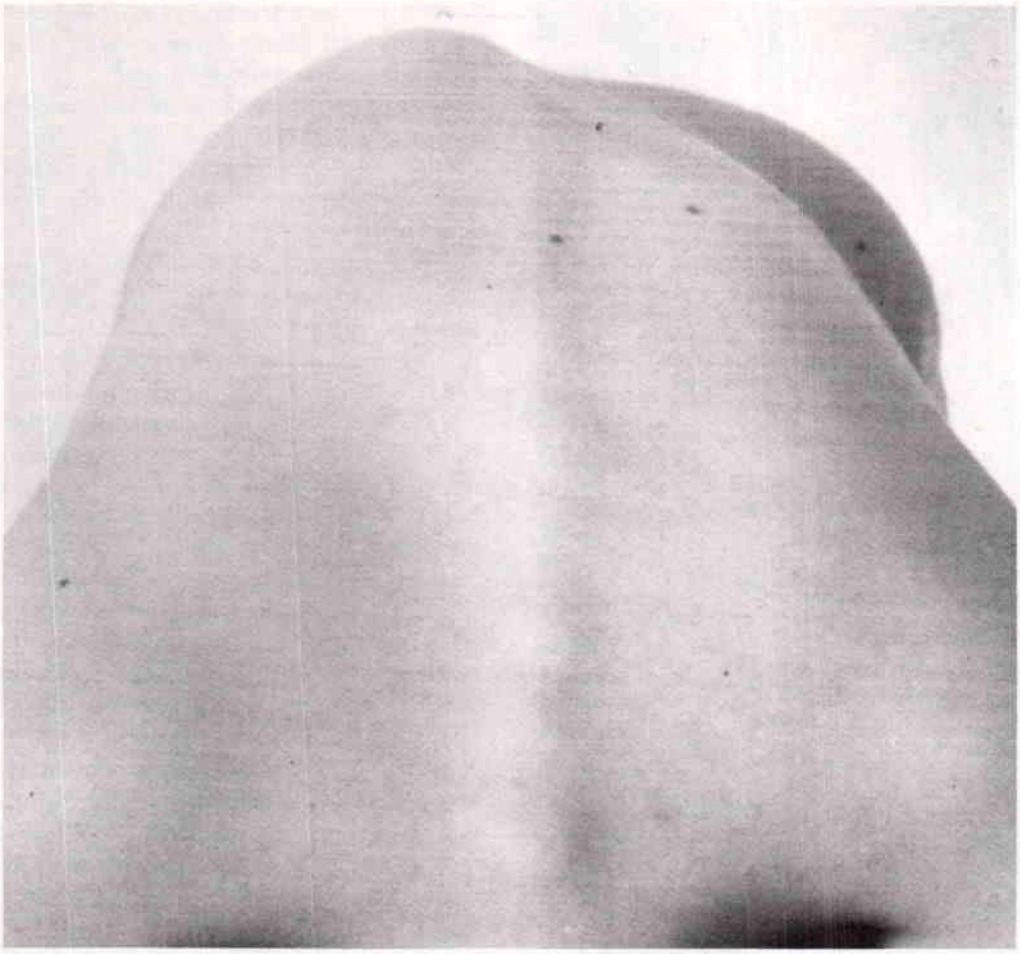

Fig. 9. In lumbar scoliosis the lateral and rotational deviations are seen as a muscle prominence and a pelvic obliquity towards the convex side.

body's righting reflex, as an adjunct to the externally applied corrective forces, has been recognized.

In the orthotic management of the lumbar scoliosis with a TLSO the re-positioning to advantage of the rotated vertebrae and muscle-tendon attachments has been outlined.

Literature Cited

1. Blount, W.P., M.D., Moe, J.H., M.D., *The Milwaukee Brace*, Williams and Wilkins Co., Baltimore, 1973

2. Breathnoch, A.S., M.D., *Fraziers's anatomy of the human skeleton*, Little Brown Co., Boston 1965

3. Brunnstrom, Signe, M.A., *Clinical kinesiology*, 3rd edition, F.A. Davis Co., Philadelphia 1972

4. Tachdjian, Mihran O., M.D., *Pediatric orthopedics*, W.B. Saunders Co., Philadelphia 1972

Footnotes

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