SPINAL ORTHOSES

THESIS

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Aknowledgement

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بسم الله الرحمن الرحيم

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I. INTRODUCTION

The greek word "ortho" means straightening, or more accurately, rectitude.

After the World Warr II, brace makers began to use the word orthotics, and in I955, Dr. Robert Bennet of warm spring, Georgia, first used the word orthotics as the title of an exhibition of braces and other appliances for the increase of the functional capacity of the severely disabled person.

Licht, defined an orthosis as any device that when in contact with the body, improves function.

Interest in bracing and functional aids has increased in this century because of advances in technology and of materials and ways to use them.
There has been a vast increase in the use of braces, to improve function, relieve pain, and to make life more useful and pleasant for the handicapped.

The art and science of brace making have been helped by the introduction of materials that are light, sturdy , and resistant to water and other substances that shorten the life of the orthosis.

Spinal orthoses are orthoses for the cervical spine and for the thoracolumbosacral spine.

Cervical orthoses are collars of various types such as foam collar, Thomas's collar, and rigid supports such as moulded cervical orthosis, sterno-occipital-mandibular-immobilizer brace, four-poster cervical brace, and halo-body orthosis.

Thoracic and lumbosacral orthoses are either supportive or corrective.

Supportive such as fabric spinal orthoses(spinal belts and corsets)and rigid spinal orthoses as Taylor spinal brace and Fisher spinal brace.

Corrective as Milwaukee and Boston brace.

The aim of this work is to review recent advances in spinal orthoses,types,indications,fitting,materials, advantages and effects in order to be awair of the proper choice of each type and detect the possible defects which may interfer with their function.

II. ANATOMY

The spine is a mechanical multisegmental structure that functions by allowing physiologic motion between the trunk and the pelvis and that and that provides protection of the spinal cord(Lucas,1983).

The spine is composed of functional units, each unit is composed of two segments, the anterior portion, which is the weight bearing structure, and the posterior portion, which functions in directional guiding.
The weight bearing portion of the functional unit is composed of two vertebral bodies separated by a hydrodynamic shock absorber, the intervertebral disc.
Adjacent vertebrae articulate with one another in a controlled manner by a complex system of joints and ligaments. Stability of the spine is brought about by various ligamentous structures, but most of the mechanical stability of the spine comes about through a highly developed system of muscles. The paravertebral muscles posteriorly and the abdominal muscles anteriorly provides dynamic stability of the spine.

The intervertebral disc is an unique structure and the largest avascular structure in the body.
The disc has an inner nucleus pulposus composed of 80 to 90%

of water plus collagen and glycoprotiens, the remainder of the disc is composed of a surrounding fibrous ring called the annulus fibrosus and cartilaginous end plate.
The nucleus pulposus acts much like a ball bearing between the vertebrae, allowing motion in flexion, extention,bending, and rotation of one verteora on another.

The posterior portion elements of the functional unit consists of pedicles and laminae which form the circular arch comprising the spinal canal(Fig. I).
The posterior spinal arch contains the posterior articular joints of the functional unit.
The facet joints are true joints much like the larger joints of the body(Lucas,1983).

The vertebral column has seven cervical vertebrae, twelve thoracic vertebrae and five lumbar vertebrae, the sacrum consisting of five pieces and the coccyx of four pieces.

Curves are physiologically present in the vertebral column. A forward convxity in the lumbar and cervical spine forms the lordosis and an opposite curving with posterior convexity, known as kyphosis is noted in the thoracic and sacral spinal components.

In the erect posture, the entire vertebral column is supported on the oblique sacral base that oscillates

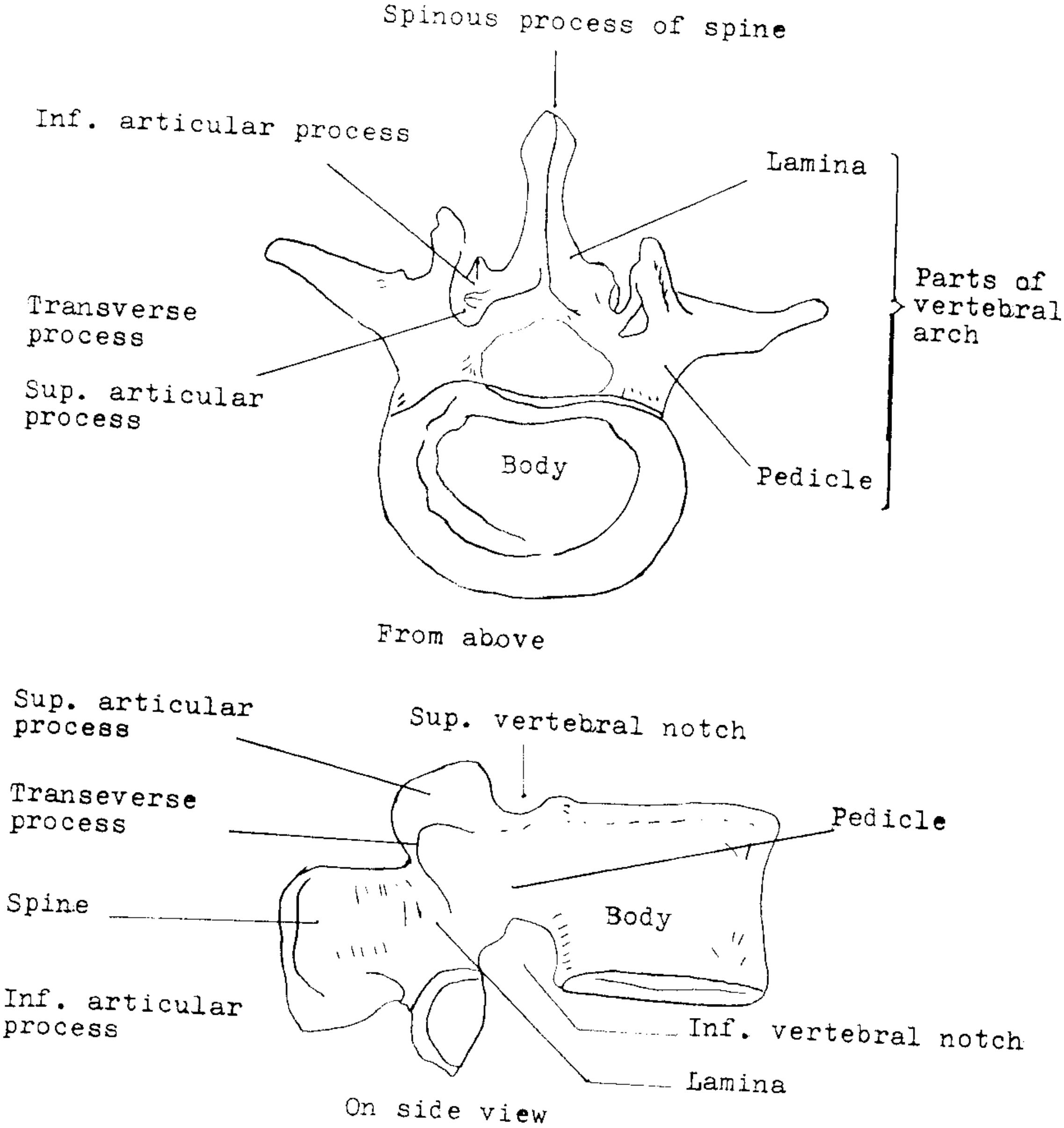

Fig. (I) A Vertebra

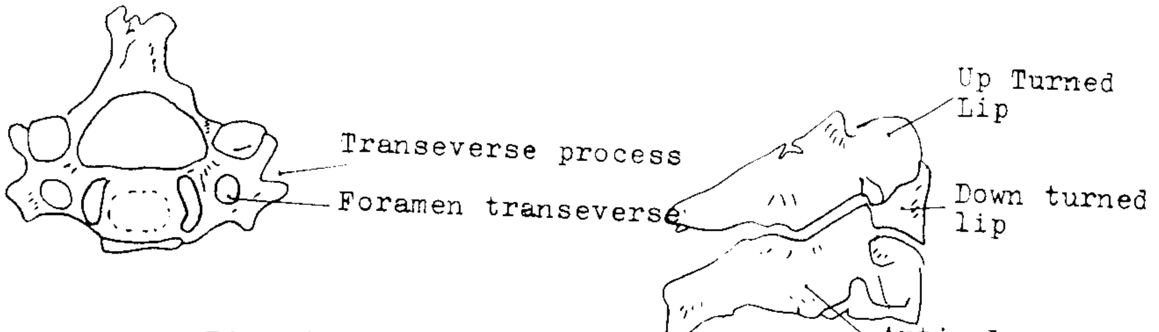

Fig. (2) Cervical vertebra

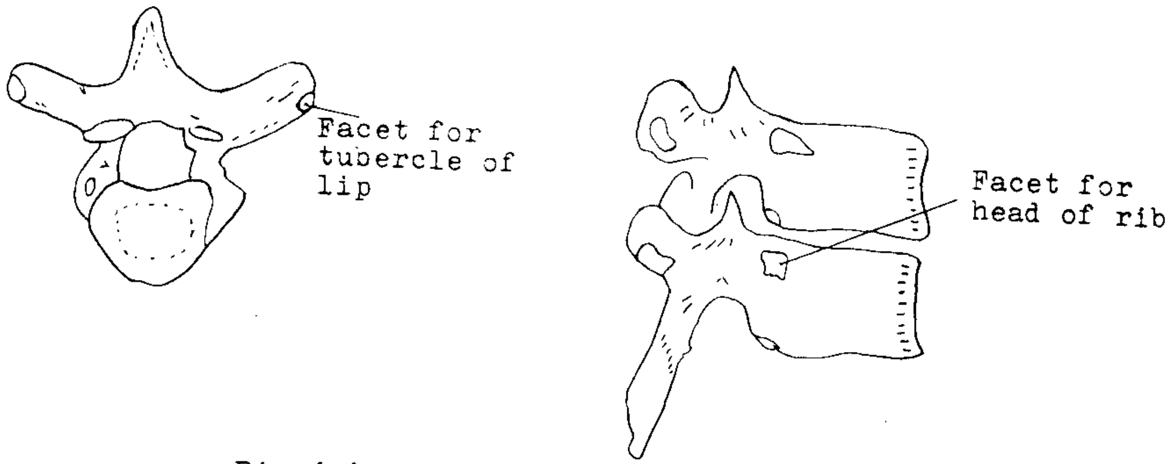

Fig.(3) Thoracic vertebra

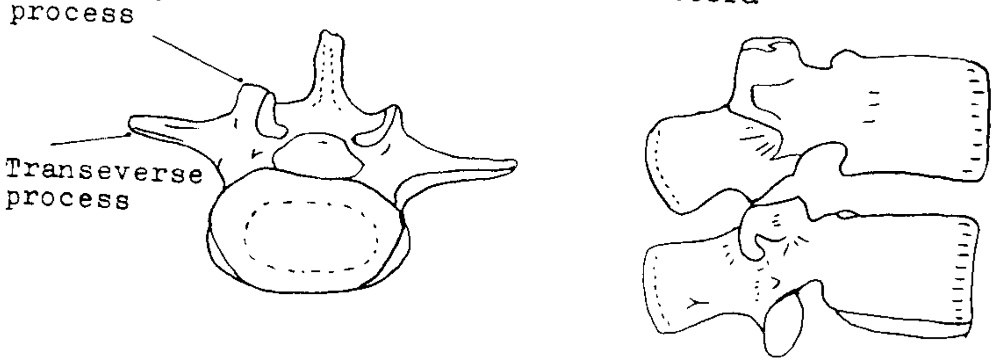

Fig.(4) Lumbar vertebra

between the two hip joints.

The angle of the superior surface of the sacrum is termed the lumbosacral angle, upon which balances the entire vertebral column with all its physiologic curves.

All curves are dependent on the lumbosacral angle to retain its balance to the center of gravity.

Increase of angle demands increase of the other, there are varying degrees of lumbosacral angle, depenent upon the culutural, genetic, and racial differences(Cailliet,I98I).

III. BIOMECHANICS

The vertebral column is a complex and a mobile structure with a wide ranging capacity for withstanding the stresses imposed upon it by movements of the body, manual work, and the outside invironment.

Control of spinal motion:

Stripped of its muscles, the vertebral column is wholy unstable. The muscles which support the spine stabilize it posturally, they control intervertebral motion during movements of the whole column in addition to be its prime movers, and they stabilize intervertebral posture during work when the spine transmits the reactions between hands and feet.

All the muscles of the hand have some supportive role:

- The erector spinae muscles in controlling extension, the rate of flexing under gravity, rotation and lateral flexion.
- The rectus abdominis in flexing the trunk against gravity and resisting extension.
- The oblique abdominal muscles in rotation and lateral flexion as well as flexion of the trunk.
- The quadratus lumborum in lateral flexion.
- The psoas muscles in controlling hip/trunk flexion and lumbar posture.

Static tension in any of these muscles induces a reaction in the spine, equal in magnitude and direction. Thus, the trunkal muscles arranged parallel to the spinal axis induce vertebral compression and rotator or lateral flexor muscles induce an equal and opposite spinal torque,depending on the direction of the muscle fibres and on the function of the muscle at the time.

The direction of muscle fibres varies movement and in different postures and the reaction of the spine to muscle tention varies accordingly(Troup,1979).

The myoelectric activity of some of the posterior muscles of the back was studied by Andersson et al. 1977, using signal amplitude estimation and power spectrum analysis. Surface electrodes were placed on both sides of the trunk at T4, T8, L3,and L5 levels. Four different angles of forward flexion were studied during external loading of the spine with 200 N. at 30 degrees of forward flexion, studies were made when the load was increased from 0 to 300 N. Assymetric loading was studied with the trunk erect, in lateral flexion, and in rotation.

The myoelectric activity increased when the angle of flexion increased and when the external load was increased at a fixed angle of flexion.

During assymetric loading, comperatively higher activity was found on the contralateral side in the lumbar region, and on the ipsilateral side in the thoracic region.

Dynamic characteristics:

When the spine is rapidly loaded as on falling, the deceleration of the base of the spine on landing is successively diminished by dissipation of energy at each verteoral level, the stiffer the spine the less efficient the dissipation of energy.

Stiffening is partly a function of age or a disease such as ankylosing spondylitis, but it can be induced temporarily by prestressing the spine, a shoulder load of 9 kg for 20 minutes is enough to produce measurable loss of vertebral hight in young male adults, recovery being apparent IO minutes after removal of the load.

Whenever the compressive load on the spine exeeds the osmotic pressure in the disc, fluid is expelled and its hight is reduced, this is a creep effect and it leads to changes in the dynamics of the intervertebral motion segment because of the approximation of the facets of the apophyseal joints associated with the loss of the disc hight(Kazarian,I975).

In their study on the simulated models of the lumbar spine Kulak et al. I975., found that the nucleus pulposus in the