EVALUATION OF A.T.L.A.S INSTRUMENTATION

FOR THORACOLUMBAR INSTABILITY

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE M.D DEGREE IN ORTHOPEDIC SURGERY

BY

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CAIRO UNIVERISITY

2013

ACKNOWLEDGMENTS

This project would not have been possible without the support of many people. Many thanks to my adviser, ***Prof. Dr.Talaat El Hadidi***, who read my numerous revisions and helped, make some sense of the confusion. Also thanks to ***Prof. Dr.Wisam Gaber*** for his ***helpful*** support and continuous advices to complete this work. Thanks also go to junior staff and theater personnel for their help and during this work.

And finally, thanks to my family, and numerous friends who endured this long process with me, always offering support

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LIST OF ABBREVIATIONS

A.T.L.A.S	Anatomic ThoracoLumbar Anterior System
ALIF	Anterior Lumbar Interbody Fusion
ALL	Anterior longitudinal ligament
AP	Antero-posterior
ASF	Anterior spinal fusion
CASP	Contoured Anterior Spinal Plate System
cm.	Centimeter
CT	Computed tomography
ECG	Electrocardiogram
I.C.U.	Intensive care unit
i.e.	in other words
I.V.	Intravenous
IAR	instaneous axis of rotation
L.	Lumbar
Lat.	Lateral
Mls	Milliliters
MRI	Magnetic resonance imaging
N	Newton
PA	postero-anterior
PLIF	posterior lumbar interbody fusion
PLL	Posterior longitudinal ligament
PMMA	polymethylmethacrylate block
Pt.	Patient
Pts.	Patients
SR	Smooth Rod
SSEP	Somatosensory evoked potential
T.	Thoracic
TSRH	Texas Scottish Rite Hospital
VB	Vertebral body
VSP	variable screw placement
Ys	Years

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INTRODUCTION

Anterior fixation techniques through the 1950s continued to rely on the use of rigid implants of bone rather than metallic implants. The development of anterior fixation devices generally has lagged behind that of posterior instrumentation. Dwyer and colleagues (1969) developed the first commonly used device for anterior fixation. This was a flexible device and was used for correction of spinal deformity only.[1] Zielke and coworkers (1978) modified the Dwyer technique to include a thin threaded rod rather than a flexible cable. Their design is semi rigid and has greater applicability to severe spinal deformities and injuries. Humphreys and coworkers (1971) reported on the use of an anterior plate for either one-level or two-level anterior spine fusions. Werlinich (1974) reported on the use of an anterior staple for single-level fusions. Kostuik (1983) reported on the development of an anterior device using Harrington distraction rods and modified Dwyer screws. He cautioned that the device did not provide good control of rotation and lateral bending and recommended the use of a supplementary external orthosis. Dunn (1984) described the evolution of an anterior fixation system from a semi rigid to rigid classification. This device subsequently was reported instances of aortic erosion with its use. Kaneda and colleagues (1984) described an anterior device similar to that of Dunn with two solid threaded rods placed laterally over the vertebrae. This device was further modified to include a cross-link to provide enhanced torsional stability. To date, there have been no reported instances of aortic erosion with this device[2].

There are many systems for anterior use being developed and tried on a clinical basis. They generally rely on segmental fixation and are either rigid or semi rigid [3].

ATLAS system is invented in Egypt and manufactured abroad. After biomechanical studies and clinical trials it is proved to be very efficient in restoring stability and balancing through the anterior approach.

RELEVANT SURGICAL ANATOMY

General Vertebral Features

A vertebra essentially has a ventral body and a dorsal vertebral (neural) arch, extended by lever-like processes, together enclosing a vertebral foramen, occupied by the spinal cord, meninges and their vessels (Fig. 1) [4, 5].

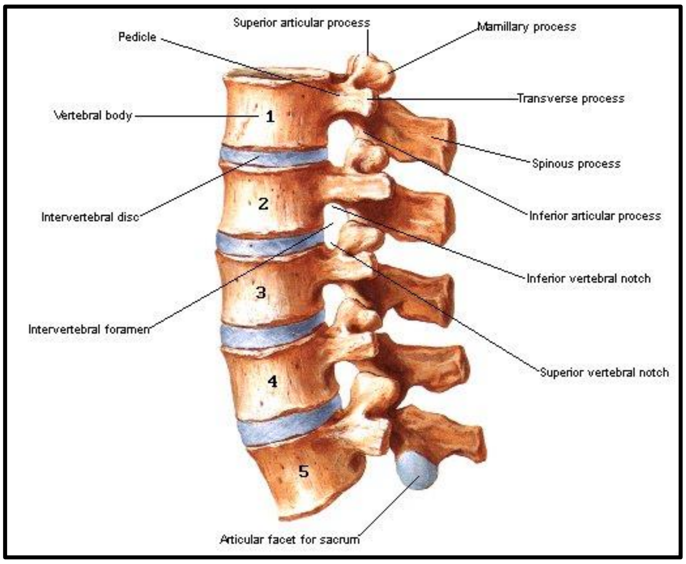


Figure 1. Lumbar spine lateral view [5]

Opposed surfaces of adjacent bodies are bound together by intervertebral discs of fibrocartilage. The complete column of bodies and discs forms a strong but flexible central axis of the body supporting the full weight of head and trunk. It also transmits even greater forces due to muscles attached to it. The vertebral foramina form a canal for the spinal cord. Between adjoining neural arches, near their junctions with vertebral bodies, intervertebral foramina transmit mixed spinal nerves, smaller recurrent nerves blood and lymphatic vessels. The vertebral arch has on each side a vertically narrow ventral part, the pedicle, and dorsally a broader lamina. Projecting from their junctions is paired transverse, superior and inferior articular processes; dorsally is a median spinous process (Fig. 2) [6].

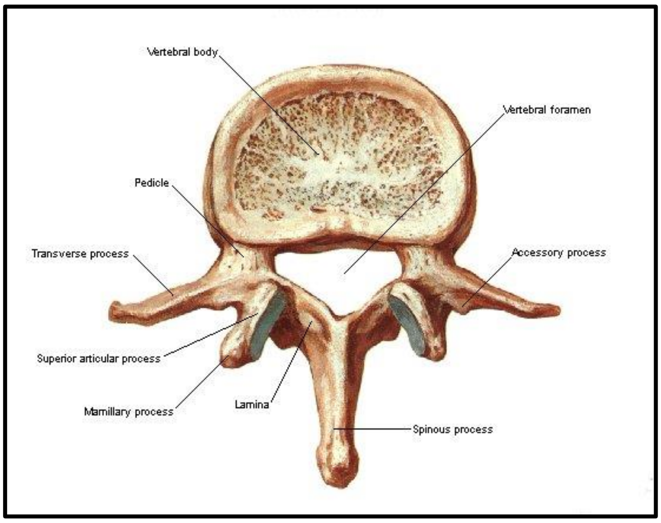


Figure 2. Lumbar vertebra, superior view. (2)

Morphology Of The Vertebral Body

Both the width and the height of the vertebral bodies increase as one descends in a cephalic to caudal direction (Fig. 3). The vertebral body height also increases in a cephalic to caudal direction (Fig. 4) [7].

The progressive increase in size of the vertebral bodies as one descends caudally, correlates with strength or stress-resisting ability. The decreased incidence of spine fractures observed in the lower lumbar spine is related, at least in part, to the increased strength of the vertebrae in this region. Fig.(5) [7].

Morphology Of The Vertebral Endplates

Accurate knowledge of the bony anatomy of the spine is necessary for optimal placement of the intersegmental grafts to stabilize the segment. Moreover, specific information describing the geometry of the vertebral body endplates is necessary for the development of spinal implants and surgical instruments [8].

Hall et. al; , analyzed the dimensions and shapes of the vertebral body endplates of inferior L4, inferior and superior L5, and superior S1. The endplates resembled a cardioid at the inferior L4 level and became more elliptical toward the superior S1 level. Fig.(7) [8].

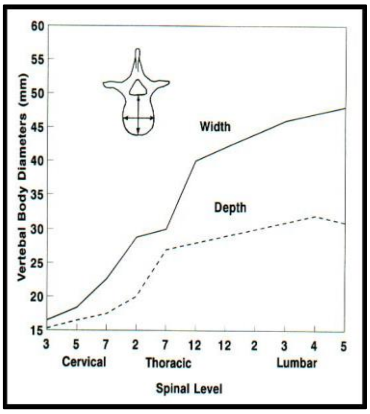


Figure 3. VB diameter versuss pinal level

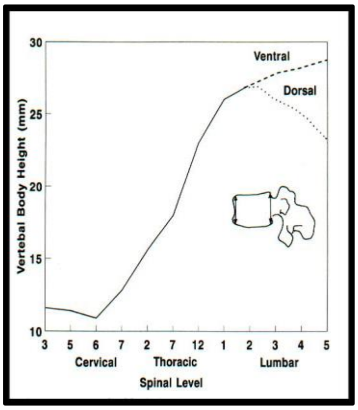


Figure 4. VB height versus spinal level

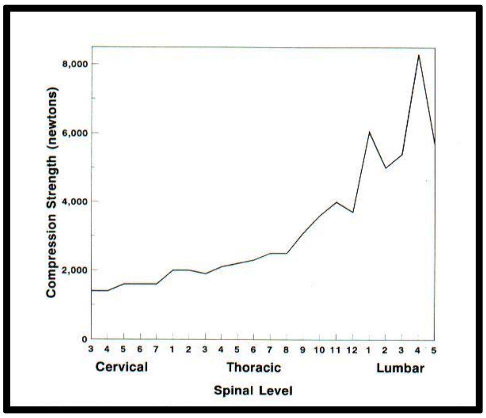
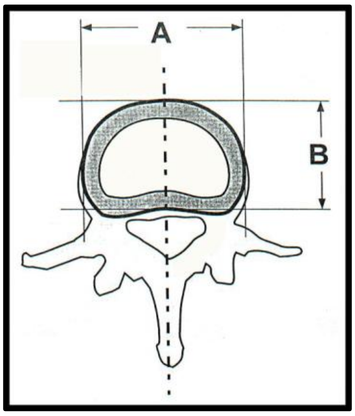


Figure 5. Vertebral compression strength versus spinal level

The sagittal diameter of the endplate was defined as the anteroposterior width in the midsagittal plane, and the transverse diameter was defined as the maximum width of the endplate perpendicular to this line[9].

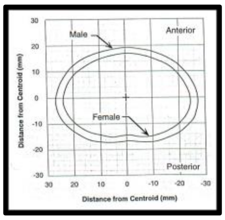


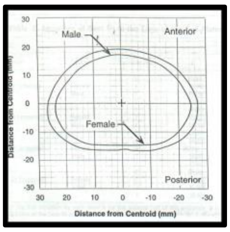
(A) Transverse (B) Sagittal

Figure 6. Diagram representing a lumbar vertebra showing the maximum diameters of one of its endplates. [6]

The average dimensions of the male endplates were 35.8 mm (sagittal) and 53.7 mm (maximum transverse). The female endplates were an average of 10% smaller (31.9 mm, 48.1 mm, respectively).Fig.(6) [10].

The average shapes of male and female endplates at each level appear as follow (Fig. 7)





L4 L5

Figure 7. Average contours of the inferior endplate of the L4 & L5 vertebra from male and female subjects. [10]

Thoracolumbar Junction

The anatomic transition into the lumber spine begins in the lower thoracic region. It is typified by the alteration in facet orientation to the sagittal plane alignment, with a concomitant decrease in rotational freedom and increase in sagittal plane motion. Changes in the vertebral morphology include increasing anterior vertebral height and larger lumbar discs, resulting in lordosis[4].

The Ligaments

A variety of well-studied spinal ligaments provide varying degrees of support for the spine. These include the interspinous ligament, the ligamentum flavum, the anterior and posterior longitudinal ligaments, and the capsular ligaments[11](2).

The anterior longitudinal ligament (ALL) increases in tensile strength on approaching the thoracolumbar junction. Together with the intervertebral disc, the ALL provides the Thoracic considerable stability to rotational and transitional forces[12]. The annulus fibrosus is firmly attached to both anterior and posterior longitudinal ligaments. Superiorly and inferiorly, fibers attach to the bony endplates peripherally by means of Shapley's fibers [13].Fig.(8)

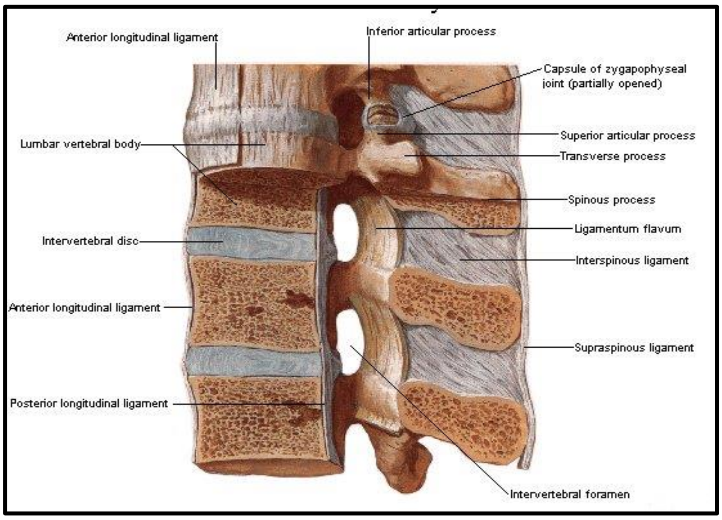


Figure 8. Ligaments of the lumbar spine [2]

Thoracic And Lumbar Sagittal Contours.

Normal thoracic kyphosis measures +15° to +45°, whereas the average lordosis in the lumbosacral spine is -50°, the thoracolumbar junction(D11-L1) is straight (0°).The average kyphosis at the lower thoracic region is +5° while the average lordosis between D12 and L3 is -16°[14].