ROLE OF MAGNETIC RESONANCE IMAGING IN DIAGNOSIS OF INTERVERTEBRAL DISC LESIONS

THESIS

Submitted in Partial Fulfilment of

The Master Degree in

RADIO-DIAGNOSIS

BY

HANY HALIM TAWADROS EL-ABD

M.B., B. Ch.

SUPERVISED BY

Prof. Dr. ***MOHAMED SAMY EL-BEBLAWY***

Head of Radiology Department &

Professor of Radiodiagnosis

Faculty of Medicine,

Ain Shams University

Dr. ***MOHAMED ABU EL-HODA DARWISH***

Lecturer of Radiodiagnosis,

Faculty of Medicine

Ain Shams University

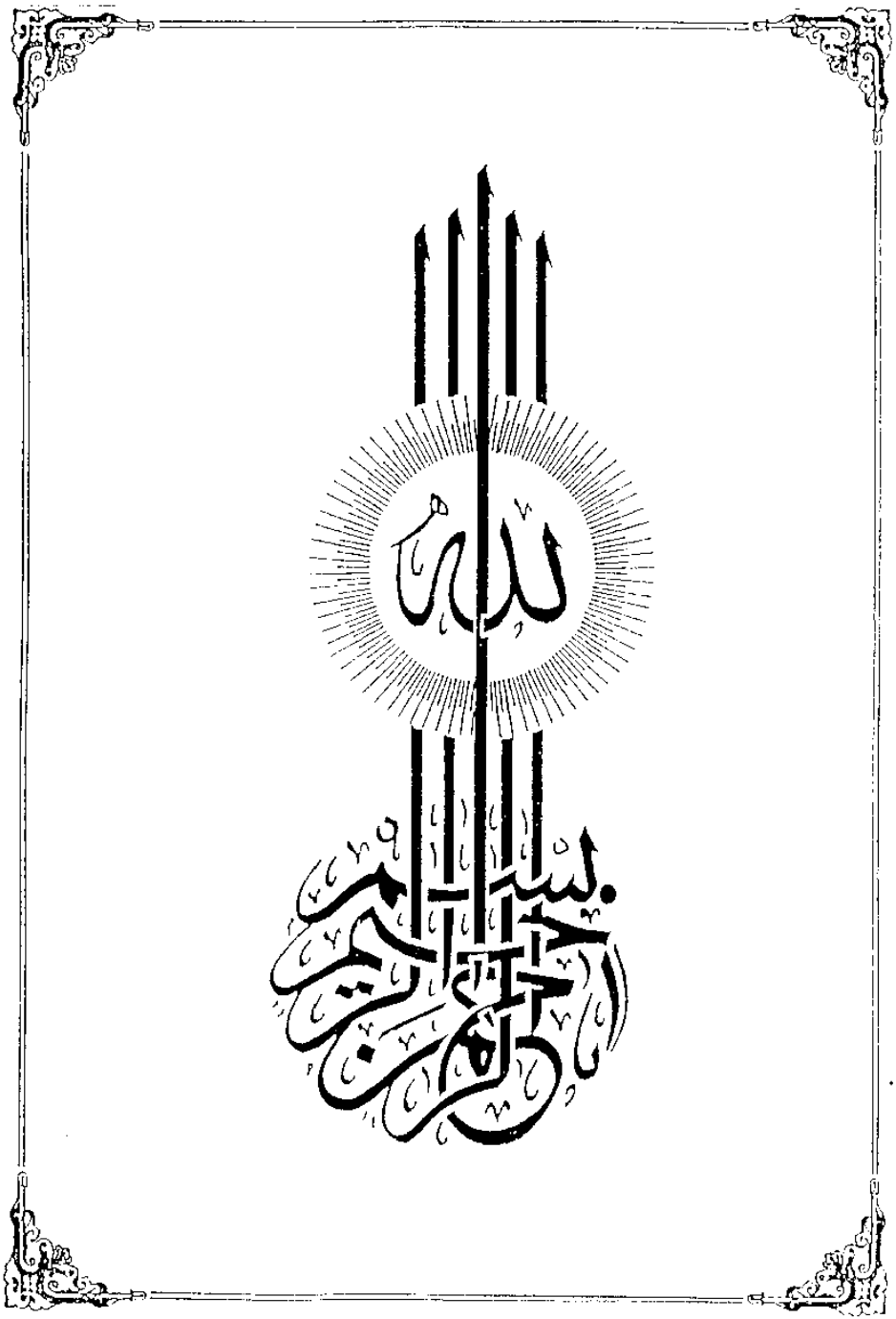
(1990)

ACKNOWLEDGEMENT

I wish to express my deepest gratitude and sincerest thanks to Prof. Dr. ***MOHAMED SAMY EL-BEBLAWY****, Head of Radiology Department, Ain Shams University, for suggesting this subject, his invaluable guidance and supervision, sincere technical advice and generous personal encouragement.*

I am also deeply grateful and greatly indebted to Dr. ***MOHAMED ABU EL-HODA DARWISH****, Lecturer of Radiodiagnosis, Ain Shams University, for his co-supervision, valuable guidance and offering every possible help.*

Hany Halim Tawadros El-Abd



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Disc lesions represent a major and frequent clinical problem which needs good evaluation for proper subsequent management.

Different imaging modalities for diagnosis of intervertebral disc lesions such as plain radiography, myelography and CT are already available and play a good role in evaluation of different disc lesions.

Magnetic resonance imaging (MRI) is a new rapidly evolving non-invasive imaging modality that uses no ionizing radiation and has a multiplaner imaging capability. It, thus, promises a great potential in the evaluation of the spinal axis.

The aim of this work is to discuss the role of MRI in the diagnosis of different intervertebral disc lesions.

ANATOMY OF THE INTERVERTEBRAL DISC

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Intervertebral discs are interposed between adjacent surfaces of vertebral bodies, from the axis to the sacrum and are the chief bonds of connexion between them.

The vertebrae from the second cervical to the first sacral are articulated to one another in two ways:

1) Vertebral bodies are united by intervertebral discs of fibrocartilage (Fig. 1) and by the anterior and posterior longitudinal ligaments (Fig. 3).
2) The vertebral arches are united by apophyseal synovial joints and by a group of ligaments which are:
   - Ligamenta flava : between the laminae of vertebrae (Fig. 4)
   - Supraspinous and interspinous ligaments between spinous processes. In the cervical region, they are replaced by the ligamentum nuchae.
   - Intertransverse ligaments : between the transverse processes.

A typical vertebra is made of two principal parts, the vertebral body which is anterior and a posterior vertebral arch, which encloses the vertebral foramen.

The vertebral arch is formed of a pair of pedicles and a pair of laminae. It supports seven processes, viz, two superior and two inferior articular processes, two transverse processes and a spinous process. (Gray, 1980).

The shape of the intervertebral discs corresponds with that of the bodies between which they are placed e.g. the L_1-L_2 through L_4 - L_5 discs are reniform in shape with a slight posterior midline concavity. The posterior margin of the L_5 - S_1 disc is flat or slightly convex.

Their Thickness varies in different regions of the column, and in different parts of the same disc. They are thicker in front than behind in the cervical and lumber regions, and thus contribute to the anterior convexities of these levels, while they are of nearly uniform thickness in the thoracic region, the anterior concavity of this part of the column being almost entirely due to the shape of the vertebral bodies.

The discs are thinnest in the upper thoracic region and thickest in the lumber region. The height of upper four lumber discs range from 8 to 15 mm; L_5 - S_1 disc is usually narrower, particularly in its posterior portion. They are adherent to thin layers of hyaline cartilage which cover the superior and inferior surfaces of vertebral bodies.

The intervertebral discs are connected to the anterior and posterior longitudinal ligaments and in the thoracic region they are joined laterally, by means of the intra-articular ligaments, to the heads of those ribs, which articulate with two vertebrae.

The intervertebral discs constitute about one fifth of the length of the vertebral column, exclusive of the first two vertebrae; but this amount is not equally distributed, the cervical and lumber portions having, in proportion to their length,a much greater amount than the thoracic region, with the result that these parts possess greater pliancy and freedom of movement (Gray, 1980).

Structure of intervertebral discs :

Each disc consists of an outer laminated periphery, the annulus fibrosus, and an inner core, the nucleus pulposus. (Fig. 1).

1. ***The annulus fibrosus*** :

It consists of a narrower outer zone of collagenous fibres and a wider inner zone of fibrocartilage. Its laminae are convex from above downwards and form concentric incomplete collars which are connected by strong fibrous bands and overlap or dovetail into one anothr. In the posterior region of the disc, the laminae join with each other in a complex fashion .

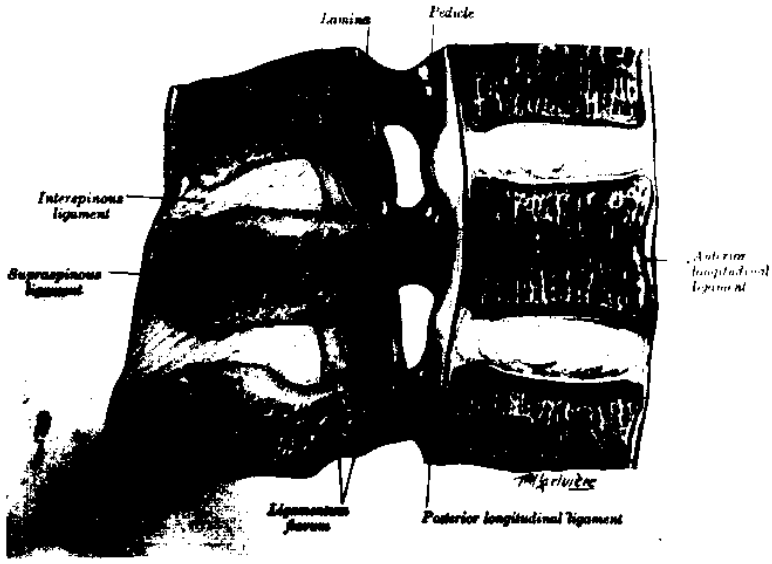

Fig. (1): Structure of intervertebral disc:

The disc is composed of an outer annulus fibrosus and an inner and slightly posterior nucleus pulposus.

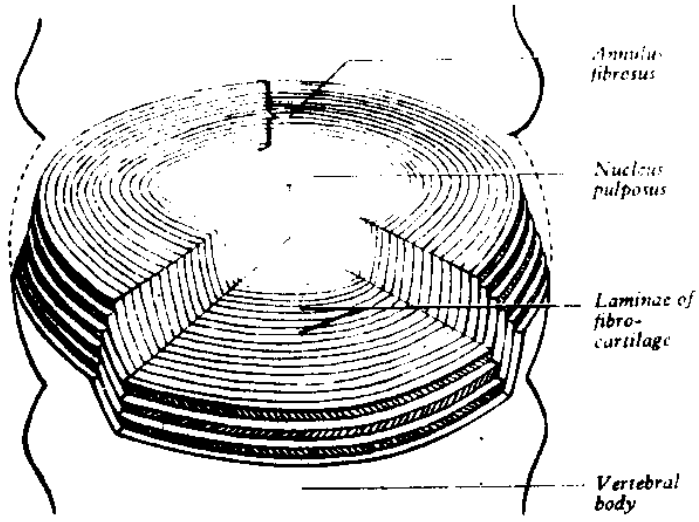

Fig. (2): Schematic representation of the disc :

Showing multiple concentric fibrocartilagenous annular laminae and different oblique directions of collagenous fibres is each lamina.

Within each lamina the majority of the fibres lie in parallel and run obliquely between two vertebrae, the fibres in contiguous laminae run in different directions and lie at an obtuse angle to each other, thus excercising control over the rotatory movements in different directions (Fig. 2).

The lamellae of the annulus fibrosus are fewer in number, more closely packed, and thinner between the nucleus pulposus and the posterior margin of the disc when compared with the anterior margin, structural characteristics that may be important in the pathogenesis of posterior disc displacement (Grant, 1972).

A predominantly vertical direction of fibres in the posterior part of the annulus fibrosus has been described with the suggestion that this predisposes to herniation.

The annulus fibrosus is attached to the adjacent vertebral bodies in two fashions:

1. The collagen in the annulus (as well as in the anterior longitudinal ligament) is continuous with that in the bone by strong connections, termed Sharpey's fibres attaching the annulus to the cortical surfaces of the vertebral body.
2. The annulus fibrosus is inserted into the cartilagenous end-plates and marginal rim of the vertebral body by calcified cartilage (Gray, 1980).

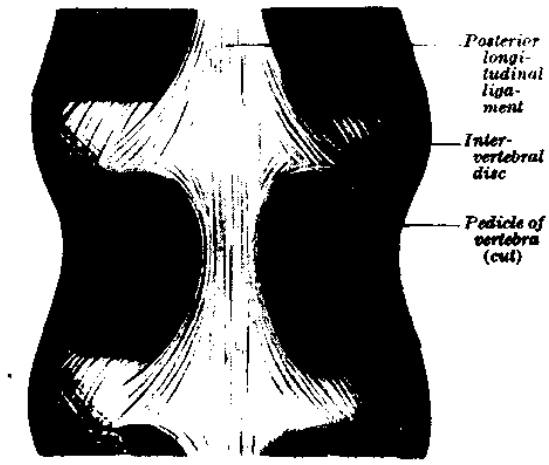

Fig. (3): Posterior longitudinal ligament.

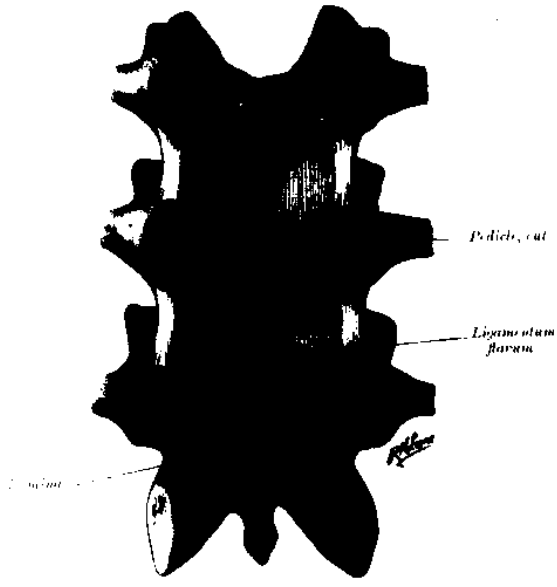

Fig. (4): Ligamenta Flava (Anterior aspect).

2. ***The nucleus pulposus*** :

It is composed of a soft, pulpy highly elastic material that is an embryological remnant of the primitive notochord.

Nucleus pulposus is better developed in the cervical and lumber regions than in the thoracic part of the spine. It is nearer the posterior than the anterior surface of the disc.

The structure of the nucleus pulposus varies at different age periods:

* *At birth* :

It is soft, gelatinous, relatively large and consists of mucoid material containing a few multinucleated notochordal cells, into the periphery of which extend cells and fibres from the inner zone of the adjacent annulus fibrosus.

The outer zone of the annulus fibrosus forms a relatively thin layer of densely packed collagenous fibres which run with varying degrees of obliquity. In the inner zone of the annulus , the individual laminae of the fibrocartilage are separated from one another by cartilage cells and tissue spaces.

* *In the child* :

The annulus fibrosus thickens and its fibrocartilage becomes denser. The nucleus pulposus, which is still relatively large, contains numerous collagenous fibres and small groups of cartilage cells in its mucoid ground substance, from which notochordal cells rapidly disappear and can rarely be identified after the age of 10 years.

* *By the third decade* :

The annulus fibrosus had increased in thickness, especially on the anterior aspect of the disc where it adapts itself to the growth of the vertebral bodies. As a result the nucleus pulposus is slightly nearer the posterior aspect of the vertebral body.

The ground substance of the nucleus pulposus is less translucent, more gelatinous and of firmer consistency. Further, it now contains a quantity of loosely arranged fibrocartilage, derived from the cells of the annulus fibrosus and also from cells of cartilagenous plates covering the upper and lower surfaces of the vertebrae.

* *In the following decades* :

The collagenous fibres of the disc grow coarser and become hyalinized, with gradual replacement of the mucoid material by fibrocartilage. The nucleus pulposus also looses fluid and becomes desiccated.