Light Microscopic Study of The Lumbar Intervertebral Disc Showing Inherent Difference Between Anterior & Posterior Annulus Fibrosus - A Risk Factor For Posterior Disc Herniation

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Abstract
The present study is based upon the light microscopic observations made on the foetuses to determine the structural discrepancy in anterior and posterior annulus fibrosus in the development of human foetal lumbar intervertebral disc. A morphological comparison of the structure of anterior and posterior annulus fibrosus was made to consider the arrangement of lamellar bundles. As the foetus advances in age, the anterior annulus fibrosus becomes thicker than the posterior annulus. A very intricate structure was observed in posterior annulus with large number of loose and discontinuous lamellar bundles and more fibre-interlacing angles. Loose connection of the lamellar bundles in posterior annulus of almost all the foetuses indicates an inherent weakness which may lead to posterior rupture of the disc in later life.

Key Words
Annulus fibrosus, Nucleus Pulposus, Intervertebral Disc, Lamellar Bundles

Introduction
The intervertebral discs are the major structural links between adjacent vertebrae. They serve to allow greater motion between vertebral bodies than would occur if vertebrae were in direct opposition. Each intervertebral disc consists of central gelatinous nucleus pulposus, contained within the more collagenous annulus fibrosus peripherally and cartilage end plates inferiorly and superiorly. The annulus fibrosus forms the outer boundary of each disc. It is composed of fibrocartilagenous tissue and fibrous proteins, which are arranged in concentric layers or lamellae, with fibres in the outer lamellae continuing into the longitudinal ligaments and vertebral bodies (1). Disc composition changes significantly during development, growth, aging and degeneration and this in turn alters how discs respond to mechanical stress (2). The matrix of intervertebral disc comprises mainly a fibrillar collagen network that offers tensile strength. The clinical picture of backache and lumbar herniated disc has often been an enigma in the medical practice. Most of the herniation occurs in the posterior region of the intervertebral disc at the lumbosacral joint. This region carries most of the strain of spinal column and half of the motion between the lower thoracic region and sacrum takes place here. Major age related changes in the intervertebral disc in humans are reported to occur at the end of first decade of life. Even before this, as early as two years of age, mild microscopic degenerative changes are seen (3). It has been observed that the disc undergoes degenerative changes earlier in life than other tissues do (4). This indicates that the disc begins to show signs of degeneration at a very early age. Although studies have been conducted on the structural variation of the anterior
and posterior annulus fibrosus in adults but there is paucity of the literature depicting structural difference in the annulus fibrosus in foetal life which would be indicative of the posterior disc herniation in later life. This study has been directed at comparing the structure of anterior and posterior annulus fibrosus in foetal life and to analyse the extent of variation between these two parts.

**Material And Methods**

The 35 foetuses ranging from 53 to 300 mm CR Length were collected from operation theatres and labour rooms of the Government Medical College, Jammu and various nursing homes and preserved in 10% formalin followed by measurement of CR length. The lumbar region of vertebral column was dissected out and subjected to histological processing (5). Serial sections of 7 µm were cut in transverse and longitudinal manner and stained with H&E and Masson's trichrome stains and then analysed under a binocular research light microscope.

**Results**

All the foetuses have been studied in the ascending order of their crown rump lengths. In smaller foetus the disc is composed of the central notochord which differentiates into nucleus pulposus, surrounded by the mesenchymal tissue which forms the annulus fibrosus. The annular structure was identifiable from 65 mm CR length foetus and the laminate structure rapidly became more obvious with the advancing age. The thickness of anterior and posterior annulus is almost the same in smaller foetus and nucleus pulposus is in the centre but from 95 mm CR length foetus, the dorsal migration of nucleus pulposus begins thus it comes to lie relatively posteriorly.

As the foetus advances in age, the anterior annulus gradually becomes thicker than the posterior and consisted of complete bundles of collagen fibres (lamellae) arranged in a concentric manner and are closely packed in a uniform way (**Fig.1a**), whereas the posterior annulus was made of very intricate structure with numerous incomplete and discontinuous lamellae, due to splitting and jolting of fibres of different lamellae and an interlocking of various lamellae (**Fig. 1b**). The fibres are vertical rather than arched in the posterior part. The collagen fibres of consecutive bundles form a crisscross pattern forming the fibre interlacing angles, which seemed to be greater in the posterior than in the anterior annulus fibrosus. The number of distinct bundles was significantly greater in
the anterior outer annulus fibrosus than the posterior outer annulus in all the foetuses ranging from 180 to 300 mm CR length (Fig.2a). In the posterior annulus, a net like separation of lamellae was observed forming a very complex arrangement which is suggestive of loose connection between the lamellae (Fig.2b).

Discussion
The histological sequence of intervertebral disc of foetuses under consideration shows central notochord, which differentiates into the nucleus pulposus and the peripheral condensation of primitive embryonic mesenchyme, which shows progressive differentiation into the annulus fibrosus with well formed collagenous tissue.

The present study indicates that there is a gradual increase in the thickness of annulus fibrosus due to increase in collagen bundles, which are arranged in lamellae lying parallel to one another. The fibres of consecutive bundles form a crisscross pattern forming the fibre interlacing angles which are more obvious in the posterior annulus fibrosus corroborating the results from previous reports (6, 7). Although the thickness of the individual lamella was not measured but the total thickness of the anterior annulus was greater than the posterior.

The laminate structure in the current study indicates that the structure is very complex in the posterior region of the disc, which involves a great number of discontinuous lamellar bundles. The splitting and jolting of the collagen bundles which forms the fibre interlacing angles, showed a wide range of variation between anterior and posterior annulus fibrosus. It is of interest that the netlike separation of lamellar bundles in the posterior annulus fibrosus is apparent from foetal life, which suggests an inherent characteristic of the laminate structure of the disc. There is loose connection of the posterior annulus with increased fibre interlacing angles in all the foetuses studied in the present series which suggests that the posterior portion of the disc begins to give way first, may be because of its inherent weakness.

Though mechanical factors (8) are also responsible for intervertebral disc rupture and herniation in adults, but the incidents of disc herniation in adolescents in some cases suggest that these may not be the only etiological factors. The embryological variation in the structure of the disc may be a high risk factor in the etiopathogenesis of disc prolapse. Whether this inherent difference in the anterior and posterior part of the disc acts as precursor for degenerative changes commonly seen in posterior part of the disc in juvenile and adult life needs to be further investigated.

References