HISTOMORPHOLOGICAL CHANGES IN INTERVERTEBRAL DISCS OF OFFSPRING EXPOSED TO EXPERIMENTAL HYPOTHYROIDISM: THE IMPACT OF HYPODYNAMIA

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Abstract: This article examines the impact of hypodynamia on the histomorphological characteristics of intervertebral discs in offspring developed under conditions of experimental hypothyroidism. Particular attention is given to the potential structural alterations in the nucleus pulposus, annulus fibrosus, and cartilaginous endplates associated with thyroid hormone deficiency and reduced physical activity. The study focuses on changes in cellular organization, extracellular matrix composition, and tissue architecture, emphasizing the possible combined effects of endocrine dysfunction and mechanical unloading. Histological and morphometric approaches are considered essential for evaluating these alterations and identifying potential mechanisms of intervertebral disc degeneration. The investigation aims to contribute to a better understanding of the relationship between thyroid dysfunction, hypodynamia, and the structural development of intervertebral discs in offspring.

Keywords: experimental hypothyroidism, hypodynamia, intervertebral disc, offspring, histomorphological changes, nucleus pulposus, annulus fibrosus, extracellular matrix, cartilage tissue, disc degeneration.

INTRODUCTION

Intervertebral discs play a crucial role in maintaining spinal flexibility, stability, and mechanical resistance. Their structural development is closely associated with hormonal regulation, metabolic activity, and mechanical loading. Thyroid hormones are essential for cartilage maturation, cellular differentiation, and extracellular matrix formation. Experimental hypothyroidism may disrupt these processes, leading to structural abnormalities in the intervertebral discs of offspring. Hypodynamia, characterized by reduced physical activity, may further influence disc metabolism and tissue organization. The combined effects of thyroid hormone deficiency and limited mobility remain insufficiently understood. Therefore, this study aims to investigate the histomorphological changes in intervertebral discs of offspring exposed to experimental hypothyroidism and evaluate the potential impact of hypodynamia on their structural integrity.

MAIN BODY

The development of intervertebral discs is closely influenced by thyroid hormone activity, which regulates cartilage maturation, cellular metabolism, and extracellular

matrix formation. During embryonic and postnatal development, thyroid hormone deficiency may interfere with the differentiation of chondrocytes and the structural organization of spinal tissues. In offspring exposed to experimental hypothyroidism, these disturbances may affect the nucleus pulposus, annulus fibrosus, and cartilaginous endplates, potentially altering their morphological and functional characteristics. The nucleus pulposus contains a hydrated extracellular matrix rich in proteoglycans, particularly aggrecan, which enables the disc to withstand compressive forces. Thyroid hormone deficiency may disturb matrix synthesis and cellular activity, potentially affecting tissue hydration and elasticity. The annulus fibrosus, composed of concentrically arranged collagen fibers, may also undergo structural modifications associated with altered collagen metabolism. Changes in the organization of these fibers could influence the mechanical stability of the intervertebral disc. Reduced physical activity introduces another challenge to spinal tissue development. Under normal physiological conditions, alternating mechanical compression and relaxation contribute to disc homeostasis by influencing cellular responses and nutrient transport. Hypodynamia reduces the frequency and intensity of these mechanical stimuli, potentially modifying proteoglycan turnover and extracellular matrix organization. Since intervertebral discs have limited vascular supply, prolonged changes in mechanical loading may affect their metabolic environment. When hypothyroidism and hypodynamia occur together, their effects on disc morphology may interact. Impaired hormonal regulation can influence the development and maintenance of cartilage tissue, while reduced mechanical stimulation may limit its adaptive responses. The resulting alterations may include changes in chondrocyte distribution, extracellular matrix density, collagen fiber arrangement, and the relative dimensions of disc components. However, the extent and direction of these changes depend on the duration of exposure, developmental stage, and experimental conditions. Histomorphological assessment allows these potential abnormalities to be examined at the tissue level. Hematoxylin-eosin staining provides information about cellular organization and general disc architecture, whereas Alcian blue and Safranin O staining help evaluate proteoglycan-rich matrix components. Morphometric measurements of disc height, nucleus pulposus area, annulus fibrosus thickness, and cellular density offer quantitative indicators for comparing experimental groups. A comparison of offspring exposed to hypothyroidism, hypodynamia, and their combined effects can help determine whether reduced physical activity modifies the structural consequences of thyroid hormone deficiency. Such analysis is particularly relevant for distinguishing developmental abnormalities from degenerative changes associated with altered mechanical loading. The findings may improve understanding of how endocrine and

biomechanical factors interact during spinal tissue development and contribute to the identification of potential mechanisms underlying intervertebral disc pathology.

CONCLUSION

Experimental hypothyroidism and hypodynamia may jointly influence the structural development and morphological integrity of intervertebral discs in offspring. Thyroid hormone deficiency can disrupt cartilage maturation and extracellular matrix metabolism, while reduced physical activity may alter mechanical adaptation and cellular organization. Their combined effects could contribute to changes in the nucleus pulposus, annulus fibrosus, and cartilaginous endplates. Histological and morphometric investigations are essential for identifying these alterations and evaluating their significance. Understanding the interaction between endocrine dysfunction and mechanical unloading may provide valuable insights into the mechanisms of intervertebral disc degeneration and support further research into the prevention of spinal disorders.

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