LUMEN ET VIRTUS

Chronic low back pain and its clinical management

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ABSTRACT

Chronic low back pain is a multifactorial condition that affects the spine and has a complex pathophysiological basis. This article aims to analyze the clinical consequences and factors that influence the phenotypic diversity of this condition. Phenotypic variation is crucial to allow adaptation throughout evolution, but this variation must be controlled to avoid compromising the vital functions of the musculoskeletal system. Vertebral structures maintain their characteristics and signaling pathways over time, with conserved epigenetic modifications. Phenotypic diversity in the vertebral unit occurs due to processes of ontogeny, remodeling, phenotypic variation, adaptation, and environmental sensitivity. These processes involve internal and external stressors, orderly transitions of cell development, temporal changes in development, rapid adaptation, and epigenetic modifications.

Keywords: Chronic Low Back Pain, Spine, Physiological Adaptation, Evolution.

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INTRODUCTION

Chronic low back pain is a multifactorial condition that affects the spine, with a pathophysiological basis centered on the interactions of the microenvironments of the vertebral unit. Basically, the stimulation of mechanoreceptors triggers the release of inflammatory cytokines, which lead to the degradation of surrounding tissues. During the process of ontogenesis, after the stressor stimulus and the response to it, there is a process of adaptation to maintain functionality. Phenotypic diversity arises as a result of various remodeling or adaptation processes, influenced by orderly cell cycle transitions, epigenetic modifications, and adaptive development. In other words, the adaptive response of the vertebral unit can be modulated by the environment as well as by genetic mutations or by evolutionary lineage.

Chronic low back pain is characterized by the complex interaction between several microenvironments in the vertebral unit. In this context, the structures of the spine and its tissues play a key role in triggering this process. The phenotypic diversity observed in the vertebral unit results from the interaction of multiple factors, including ontogeny, remodeling, phenotypic variation, adaptation, and influence of the environment. These processes are driven by both internal factors, such as biomechanical stresses, and external factors. In addition, coordinated transitions during cell development, along with temporal changes, contribute to the complexity of this process. The ability to quickly adapt also plays a crucial role, allowing adjustments in response to changing conditions.

It is important to note that epigenetic modifications are also involved in this scenario. They play a significant role in regulating gene expression and responding to stimuli from the environment. Therefore, the pathophysiology of chronic low back pain is an interaction of several factors, which culminates in the dysfunction of the vertebral unit and the development of the condition.

METHODOLOGY

This is a literature review, whose databases were taken from the SciELO and PubMed data platforms. The research period was from July 2023, following the inclusion criteria that covered articles published between 2000 and 2023, in Portuguese and English, available online and in full text. For a more accurate evaluation of the texts, the following health descriptors (DeCS) were used: "Chronic Low Back Pain", "Clinical Management" and "Risk Factors".

DISCUSSION

Chronic low back pain is a multifactorial condition that affects the spine, resulting from a combination of factors. Some of these factors are non-modifiable, such as aging and genetic predispositions, while others can be modified, such as obesity, repetitive mechanical stress, and

muscle imbalances. The structures of the spine have their origins in ancient biological mechanisms, conserved throughout evolution, and have adapted to sustain terrestrial life, maintaining signaling pathways and essential epigenetic processes. Phenotypic variation is crucial for evolutionary adaptation, however, this variation needs to be controlled to avoid compromising the vital functions of the spine and, consequently, the integrity of the musculoskeletal system.

The pathophysiology of chronic low back pain involves the interaction of different components of the vertebral unit, with the intervertebral cartilage and surrounding tissues playing key roles. Mechanical receptors, such as integrins, detect mechanical stress and initiate signaling cascades that result in the production of inflammatory and catabolic cytokines, leading to tissue degradation and imbalance between repair and destruction processes. However, for the health and maintenance of the spine, an adequate balance is necessary, with moderate and intermittent loads.

The vertebral unit follows a complex evolutionary model, where morphogenesis involves mesenchymal stem cells that give rise to the specialized cells responsible for maintaining the structure and function of the spine. This process of cell differentiation, called ontogenesis, is critical for the healthy and adaptive development of the spine, allowing for lifelong remodeling and response to mechanical stimuli. The microecological environment of the vertebral unit is influenced by several factors, such as nutrition, mechanical load, oxygen availability, and genetic variations. Phenotypic stability within this environment, known as channeling, is a conserved characteristic that ensures the homeostasis of the spine.

Epigenetic mechanisms, including DNA methylation, histone modification, and non-coding RNA, play a key role in spinal health. Throughout evolution, new families of miRNAs have emerged, allowing for significant morphological adaptations. These miRNAs act as modulators, ensuring that protein translation occurs within specific limits, which is essential for phenotypic channeling.

The phenotypic diversity of the vertebral unit arises through processes of development, remodeling, adaptation, and response to environmental stressors. These processes, influenced by internal and external factors, allow the spine to adapt and remodel in response to environmental changes, without relying solely on genetic mutations or new evolutionary signaling pathways.

FINAL CONSIDERATIONS

Thus, it is essential to understand that chronic low back pain has an evolutionary history, marked by musculoskeletal adaptations and modifications, resulting from changes in signaling pathways, epigenetic factors, and environmental influences. While phenotypic variation is crucial for adaptation throughout evolution, it is equally essential that there is phenotypic conservation to maintain the functionality of the organism and avoid structural collapse. Therefore, the evolution of

chronic low back pain over time can be analyzed, observing the characteristics inherent to each period and the need for a clinical approach that considers these nuances for effective management.

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