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Biomechanics & Anatomy of Musculoskeletal System: An Overview

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Abstract

The human body is an engineering marvel capable of performing a wide range of movements required for locomotion. These movements include flexion, extension, abduction, adduction, supination, pronation, and circumduction, as well as complex actions such as walking, running, jumping, crawling, and climbing. Such movements are executed smoothly and precisely through the coordinated interaction of bones, joints, and muscles. Muscles function in harmony either to stabilize joints or to facilitate their movement. Even the simple act of standing requires proper alignment of bones and joints, supported by coordinated muscular activity.

Joints are classified into three types: synarthrosis, amphiarthrosis, and diarthrosis, ranging from immovable to freely movable joints. Movement at these joints is associated with peak mechanical loads that must be effectively managed to prevent excessive translation. For instance, the walking cycle is characterized by two peak load phases-heel strike and toe-off. The musculoskeletal system functions to control these loads and maintain stability while minimizing unnecessary vertical translation. These biomechanical considerations are particularly important in procedures such as joint replacement.

There exists a strong interrelationship between muscular strength and movement. Force couples generated by muscle groups produce opposing forces that help regulate movement and stabilize joints. An example of this coordinated mechanism is the screw-home mechanism of the knee joint, which locks the knee into a stable and rigid position, allowing efficient upright standing.

Muscles may be classified as pennate or non-pennate and may cross one or more joints, producing different movements depending on the functional requirements of locomotion. Their coordinated activity enables both closed-chain and open-chain movements.

Finally, the nervous system plays a crucial role in the musculoskeletal system. It not only regulates and coordinates movement but may also be affected by pathological conditions involving the musculoskeletal structures.

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