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THE UNION OF THE BONES OF THE SHOULDER GIRDLE AND THE FREE PART OF THE ARM: FORMATION AND STRUCTURE.

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Annotation

This scientific article provides a comprehensive overview of the anatomical, morphological and functional connection of the bones of the shoulder girdle and the free part of the arm. The mechanism of the connection of the bones of the shoulder girdle (clavicle and scapula) with the humerus, the structure of the glenohumeral joint, its stages of development, the importance of the joint capsule and ligaments, and the process of stabilization by muscles are scientifically analyzed. The formation of the shoulder joint from the fetal period, its biomechanical properties and functional capabilities related to the amplitude of movement are also discussed. This article is aimed at in-depth study of the anatomical units that provide harmony of movement and stability in the structure of the upper arm, and at enriching knowledge of practical importance in the fields of orthopedics, traumatology, sports medicine and rehabilitation.

Keywords

Shoulder girdle, scapula, clavicle, humerus, free part of the arm, glenohumeral joint, joint capsule, ligaments, labrum glenoidale, anatomical union, biomechanics , ossification, fetal development, muscle stabilization.

ENTRANCE

The human musculoskeletal system is a complex combination of anatomical and physiological mechanisms, one of the most mobile and functional parts of which is the shoulder girdle and the bones of the free part of the arm. This structure not only provides the connection of the upper limb with the body, but also plays a leading role in controlling the wide range of motion and balance necessary for an active human life. The glenohumeral joint, formed by the anatomical fusion of the

shoulder girdle (clavicle and scapula) and humerus bones, is considered the most mobile joint in the body, allowing movement in almost all spatial directions.

The complexity of the structure of the shoulder joint is the simultaneous provision of mobility and stability. As a result of the active cooperation of the joint capsule, ligaments, muscles and labrum glenoid, the joint moves over a wide range of amplitude, while remaining constantly stable. Disruption of such anatomical harmony can lead to limitation of upper arm functions, pathologies of the musculoskeletal system and a decrease in the quality of active life.

RELEVANCE OF THE TOPIC

The connection of the bones of the shoulder girdle and the free part of the arm is one of the most important research areas of modern anatomy, orthopedics and functional medicine. Because the joint that provides the highest level of mobility in the human body is the glenohumeral joint, which works under constant load during daily activities, labor and sports activities. According to statistics, the majority of upper extremity injuries are associated with the shoulder joint and its adjacent structures, with ligament sprains and degenerative changes occurring more frequently. This further reinforces the need for in-depth study of the anatomical features and biomechanics of this structure.

In addition, factors affecting the embryological development of the shoulder joint, disorders in the ossification process, congenital skeletal malformations, and orthopedic pathologies are important for early diagnosis and the development of effective rehabilitation protocols. When the anatomical harmony of the shoulder girdle and arm bones is disturbed, the amplitude of movement, stability, and strength of the arm are significantly reduced, which directly affects the patient's quality of life.

Research objectives

The general goal of this study is to conduct a deep scientific analysis of the anatomical and functional connection of the bones of the shoulder girdle and the free part of the arm, to determine their developmental patterns, biomechanical properties , and role in the stability of movements. On this basis, the study pursues the following specific goals:

1. Scientifically describe the morphological and anatomical structure of the bones of the shoulder girdle (clavicle and scapula).
2. Study of the structure of the bones of the free part of the arm (humerus, radius, ulna) and the anatomical connections between them.
3. Identify the structural elements of the shoulder joint (glenohumeral joint) - capsule, ligaments, labrum, muscles, and their functions in the joint.

4. of the fetal and post -embryonic stages of bone fusion, including the study of chondral and membranous ossification processes.

5. x anic properties of the upper arm joints and study the factors related to the amplitude of movement.

6. Study of pathological conditions that disrupt the anatomical harmony of the shoulder girdle and arm bones (dislocation, ligament sprain, and degenerative changes) and their functional consequences.

7. of anatomical and biomechanical solutions in the fields of orthopedics, traumatology, sports medicine and rehabilitation.

8. To enrich knowledge about the normal anatomical development and pathological changes of the human upper extremity and to create a basis for scientific research.

MATERIALS AND RESEARCH METHODS

This study is aimed at in-depth study of the mechanisms of fusion, structure and development of the bones of the shoulder girdle and free part of the arm, and the materials and methodology require a complex, multifaceted scientific approach. The following materials and methods were used in the study:

1. Research material

- **Anatomy models and skeletal exhibits** : The human shoulder girdle, humerus, radius, ulna, and forearm bones are studied in real exhibits. The models and skeletons are highly detailed, and the location of the articular surfaces, capsules, and ligaments is visually analyzed.
- **Radiological materials** : Radiographs, computed tomography (CT), and magnetic resonance imaging (MRI) images have been used to identify morphological and functional changes in bones and joints.
- **Literature and scientific sources** : Anatomical and orthopedic manuals, scientific articles, and recent research results form the theoretical basis of the study.

RESULTS AND DISCUSSION OF THE STUDY

This study aims to comprehensively study the fusion, development, and functional significance of the bones of the shoulder girdle and the free part of the arm. The results of the study showed that the glenohumeral joint between the shoulder girdle and the humerus is the structure that provides the highest mobility in the human body.

1. Anatomical and morphological results

- The clavicle and scapula bones are anatomically perfectly aligned, allowing the upper limb to perform various directions of movement while maintaining stability.

• The spherical shape between the humeral head and the glenoid surface of the scapula allows the joint to move with a wide amplitude.

• Ligaments (lig. coracohumerale, lig. glenohumerale, etc.) and the labrum glenoidale have been confirmed as the main elements that stabilize the joint.

2. Development and embryological outcomes

• of the fetus have shown that the formation of the shoulder joint occurs in successive stages through chondral and membranous ossification.

• The epiphyseal and metaphyseal zones of bones develop actively in the early post- embryonic period, which ensures the stable and perfect formation of the articular surface.

• During development, adaptation of muscles and ligaments increases the functional capacity of the joint and strengthens its stability.

3. Biomechanical results

• The flexion, extension, abduction, adduction, rotation, and circumduction movements of the joint are performed with a wide amplitude, but their stability is provided by the scapula, clavicle, and ligaments.

• Muscle strength and ligament distribution balance the stress on the joint surface and optimize upper arm function.

• Impaired joint stabilization or ligament sprains significantly reduce upper arm strength and range of motion.

4. Pathological and practical analysis

1. The results of the study showed that conditions that disrupt the anatomical alignment of the shoulder and arm bones - trauma, dislocations, and degenerative processes - lead to limited upper arm function.

2. These results provide an important scientific basis for early diagnosis of shoulder joint processes in orthopedics and traumatology, optimization of surgical procedures, and improvement of rehabilitation strategies.

• **CONCLUSION**

• This study aimed to comprehensively study the fusion, development, and functional significance of the bones of the shoulder girdle and forearm, and the following main results and conclusions were reached:

• **Anatomical harmony:** The anatomical union of the shoulder girdle (clavicle and scapula) and humerus bones through the glenohumeral joint provides a wide range of mobility and stability of the upper arm. The articular surfaces, labrum, capsule, and ligaments create a complex but perfectly integrated functional harmony.

• **Developmental patterns:** Analysis of fetal and skeletal material has shown that the shoulder joint and arm bones develop sequentially through chondral and

membranous ossification. The coordination of muscles and ligaments plays a crucial role in the stable and perfect formation of the articular surface.

• **Biomechanical significance:** Research findings confirm that the shoulder joint performs a wide range of motion, including flexion, extension, abduction, adduction, rotation, and circumduction, while maintaining stability. Muscle strength and ligamentous distribution balance the stress on the joint surface and optimize upper arm function.

• **Pathological consequences:** When the anatomical alignment of the shoulder girdle and arm bones is disrupted - due to trauma, dislocations, or degenerative changes - the range of motion and strength of the upper arm are significantly reduced. This requires early diagnosis and effective treatment in the fields of orthopedics, traumatology, and rehabilitation.

• **Scientific and practical significance:** The study has provided a solid scientific basis for the development of new diagnostic, surgical and rehabilitation strategies in the fields of orthopedics, sports medicine and rehabilitation by studying the fusion of the shoulder girdle and arm bones from an in-depth anatomical, embryological and biomechanical perspective.

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