THE COUNTERFORTS OF THE HUMAN PELVIS BONES

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Abstract: Functional significance of densed regions (counterforts) of pelvis bones as supporting constructions which combine the axial skeleton, the pelvis girdle and the lower limbs into one biomechanical system is demonstrated with the use of morphometry and radiography.

Key words: pelvis, counterfort, bone, biomechanical system

Introduction

To the present day, studies of the constructional features of structure, functions and strength of the human pelvis bones remain one of the actual problems of human anatomy and biomechanics as well as expert and clinical medicine [1-4].

This article presents the results of research, in which 7 pelvis specimens were tested in vitro. The radiographs of these pelvis specimens in different projections and more than 30 radiographs of living subjects of different sexes and ages were also studied.

The morphometrical method was applied and also photographs were taken from different distances using the standard technical equipment (rings, lighting equipment under different illumination). Only materials with the absence of pathological changes were examined. Then the statistical analysis was done.

Much attention was given to the regions with different architectonics and bone density. They usually form the same picture in the shape of several curved lines. We call these lines as "counterforts" using the craniological term. Each pelvis bone has three counterforts. As a rule the counterforts are not situated symmetrically as the left and the right sides of the pelvis are not mirror-reflected. The counterforts come out of the anatomy boards of the pelvis. The different counterforts can be called using the places of their beginning and ending (Figs. 1, 2): № 1 - "vertebrofemoral", № 2 - "pubicoalate", № 3 - "ischiospinous ".

Fig. 1. The counterforts of the human pelvis. The radiograph of one of the investigated specimens. A distinct pattern of regions with higher density of the bone tissue is clearly seen.

Fig. 2. The scheme of the counterforts of the human pelvis.
**Analysis of the counterforts**

The counterfort № 1 often begins at the region of the 4th lumbar vertebra. Here the left and the right counterforts make the angle $60\pm 10^\circ$, each of them passing the side masses of the sacrum and crossing the sacroiliac joint plane almost perpendicularly. Then it runs over the great sciatic notch into the body of the ilium, goes projectively to the femur head and crosses the hip joint. Further it continues down slantwise and laterally along the lower part of the femur neck and ends at the cortical layer of the lesser trochanter. These results are in good agreement with ones described in study [1].

The counterfort № 2 (Fig. 3) begins at the symphysis and goes up slantwise and laterally to the iliac crest. Its projection is a convex down lateral arch. It crosses the pubic bone and the iliac bone in the place of their symphysis.

The counterfort № 3 begins at the region of the ischium tuber and goes up and laterally to the upper flaring portion of the ilium. It crosses the counterfort № 1 and often the counterfort № 2.

The radiograph of the ilium in oblique projection (Fig. 4) distinctly shows the lines of higher bone density, i.e. the counterforts № 2 and № 3.

Morphometrical analysis shows that the iliac crest thickness in the counterfort region is nearly twice as large as one in the fossa region. The thickness turned out to lie in the range between 17.5 and 25 mm in the counterforts regions and between 9 and 11 mm in the fossa regions.

Note that such a join of three bones into the hipbone is determined by both genetic reasons and requirements of the provision of stable support and locomotions of working parts of the skeleton. The construction of the pelvis is expedient and economical: the counterforts are located at the most loaded regions, whereas notches and holes are located at lesser loaded or unloaded regions of the bone.

![Fig. 3. The photograph of the upper flaring portion of the ilium. Arrow shows the shadow of thickening of the upper part of the counterfort № 2.](image)

![Fig. 4. The radiograph of the left upper flaring portion of the ilium in an oblique projection. The lines of higher density of the bone tissue are clearly seen. These lines are the counterforts № 2 and № 3.](image)
The way of each counterfort of the pelvis demonstrates the functional and structural adaptability of bone construction. Each counterfort has the pattern of one or two connected arches, which provide the hardness and elasticity.

The pelvis counterforts (in the same manner as the head counterforts) are not located within the only bone. They go through its borders and combine the axial skeleton, pelvis girdle and lower limbs into one biomechanical system.

Conclusions
1. The functional meaning of the counterforts in the human pelvis was investigated.
2. The spreading of the counterforts out of the anatomical boards of the bones proved the integrity of the bone system as the part of the musculoskeletal system.
3. The available knowledge of bone organs constructions and their unions allowed to speak about the generality of the principles of their constructions.
4. To look more closely at the meaning of the counterforts in the anatomy of bone organs it is necessary a wide application of biomechanics methods.

References
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функционально и морфологически связать воедино позвоночный столб, тазовые кости и нижние конечности.

По местам начала и конца контрфорсов их можно назвать следующим образом: позвоночно-бедренный, лобково-крыловой и седалищно-остевой. В работе дано подробное описание расположения всех указанных контрфорсов.

Ход каждого контрфорса таза демонстрирует функционально-структурную адаптивность конструкции кости. Все они имеют вид одной или двух сопряженных дуг, которые сочетают в себе свойства твердости и эластичности.

Срастание трех костей таза в единую тазовую кость обусловлено не только генетически, но и необходимостью обеспечения надежной опоры и локомоцией несущего участка скелета. Целесообразное и экономное построение тазовой кости проявилось в виде контрфорсов в местах повышенного силового нагружения. Мало или совсем не нагруженные участки реализовались в виде выемок и отверстий.

Рассмотрение контрфорсов как элементов конструкций позволяет более глубоко понять особенности функционирования костной системы человека, что открывает новые возможности для биомеханики и клинической медицины. Библ. 4.

Ключевые слова: таз, контрфорс, кость, биомеханическая система

Received 03 March 1999