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THE STRUCTURE OF MORPHOLOGICAL FEATURES IN THE TISSUES OF THE STERNAL-RI B COMPLEX IN CHILDREN WITH FUNNEL CHEST DEFORMATION

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Resume,

This article presents the material of morphological studies of the biopsy material of the costal-cartilage part, taken from 66 children (3-18 years old). For histological examination, intraoperatively removed tissue pieces from the anatomically modified cartilaginous elements of the sternum-costal complex of the anterior chest wall during thoracoplasty, were fixed in an aldehyde-osmium solution, and were placed in aralditis. A quantitative study of reactive changes in chondrocyte cartilage was carried out.

The quantitative studies of changes in the chondrocytes of the cartilage of the sterno-costal complex indicate pronounced changes in the chondrocytes of the surface zone with a decrease in the nuclear-cytoplasmic index with a more significant increase in the volume fraction of cytoplasm. The obtained results indicate a rather high degree of severity of compensatory reactions of the cartilage tissue of the sterno-costal complex in children.

Morphological studies show that properly selected preoperative administration of patients with funnel chest deformity leads to a significant prevention of residual effects of connective tissue dysplasia, which also reduces the likelihood of the formation of gross morphological changes in the structures of the sterno-costal complex.
Структура морфологических особенностей в тканях грудино-реберного комплекса у детей при воронкообразной деформации грудной клетки

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Резюме,

Представлен материал морфологических исследований биопсийного материала реберно-хрящевой части, отобранной у 66 детей (3-18 лет). Для гистологического исследования интраоперационно изымали кусочки тканей из анатомически измененных хрящевых элементов грудино-реберного комплекса (ГРК) передней грудной стенки во время торакопластики, фиксировали в альдегидно-осмиевом растворе и заключали в аралдит. Проведено количественное исследование реактивных изменений хондроцитов хряща.

Проведенные исследования изменений хондроцитов хряща грудино-реберного комплекса отмечают ярко выраженные изменения хондроцитов поверхностной зоны со снижением ядерно-цитоплазматического индекса с более значительным ростом объемной доли цитоплазмы. Полученные результаты свидетельствуют о достаточно высокой степени выраженности компенсаторных реакций хрящевой ткани грудино-реберного комплекса у детей.
Морфологические исследования показывают, что правильно выбранное предоперационное введение больных с ВДГК приводит к значительному предотвращению остаточных явлений дисплазии соединительной ткани, что также снижает вероятность формирования грубых морфологических изменений в структурах грудино-реберного комплекса.

Ключевые слова: воронкообразная деформация грудной клетки, морфология, соединительной ткани, дисплазия.

BOLALARDA KO’KRAR QAFASINING GIRDOBSIMON DEFORMATSIYASI TO’SH QOVURG’A KOMPLEKSI TO’QIMALARINING MORFOLOGIK XUSUSIYATLARI

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Rezyume

Ushbu maqolada 66 nafar (3-18 yosh) bolalardan olingan qovurg’aning tog’ay qismidan olingan biopsiya materialini morfologik o'rganish materiallari keltirilgan. Gistologik tekshiruv uchun torakoplastika paytida ko'kraq oldingi qismidagi qovurg’aning tog’ay qismidan anatomik jihatdan o'zgartirilgan sohasi olib tashlangan to'qimaga bo'laklari aldegid-osmiy eritmasiga o'rnatilib, aralditga joylashtirildi.

To’sh qovurg’a kompleksidan olingantogay to’qimasidagi xondrositlardagi o’zgarishlarni miqdoriy tadjiq qilish, zuza zonas xondrositlardida aniq o’zgarishlarni, yadro-sitoplazmatik indeksning pasayishini va sitoplazma hajmining
sezilarli darajada ko'payishini ko'rsatadi. Olingan natijalar bolalarda to’sh qovurg’a kompleksdan olingan to'qimalarning kompensatsion reaktssiylalarining yuqori darajada ekanligini ko'rsatadi.

Morfologik tadqiqotlar shuni ko'rsatadiki, ko'krak qafasi deformatsiyasi bo'lgan bemorlarni operatsiyadan oldin to'g'ri tanlanganligi biriktiruvchi to'qima displaziyasining qoldiq ta'sirining oldini olishga olib keladi, bu esa to’sh qovurg’a kompleksida yalpi morfologik o'zgarishlarning paydo bo'lish ehtimolini kamaytiradi.

Kalit so'zlar: ko'krak qafasining deformatsiyasi, morfologiya, biriktiruvchi to'qima, displaziasi

Relevance

Funnel chest deformity (CFD) is the most common type of deformity in children, the frequency of which is more than 90% of all congenital chest deformities. VDHK is a developmental defect manifested by a retraction of the sternum and cartilaginous parts of the ribs of various shapes. According to various researchers, EDHC occurs in boys 3 times more often than in girls [1,2,5,6,7,10,13].

Early morphological studies of the sternocostal complex (HRC) in children with funnel chest deformity have shown that the cause of HRV is destructive changes in the cartilaginous lining [1,3,4,7,8]. At the same time, the results of biochemical studies suggest that with such changes the cartilage retains a high capacity for restitution [7,8,11,12]. The data obtained make it possible to judge only indirectly about an increase in the number of profiling cells and the level of gene expression, and on an increase in biosynthetic activity. An increase in the number of actively producing cells is the main source of regenerative processes in the cartilaginous tissue of the GRC. It is known that the size of a cell is closely related to its functional state [5,10]. The study of the plasticity and reactivity of the cartilage tissue of the GRC is of great theoretical and practical interest. In the available literature to date, the questions of the structure of the morphological features of the cartilaginous tissue of the GRC remain quite controversial.
Purpose of the study. According to the biopsy surgical material, to establish an assessment of the reactive changes in chondrocytes of the GRC cartilage with its morphological characteristics of the components of the sternocostal complex in children with funnel chest deformity.

Material and methods

Biopsy materials were subjected to morphological examination in 66 children (3-18 years old), among whom there were 17 (25.8%) children before school age, 30 (45.4%) children of the second childhood, 10 years and older - 19 (28.8%) patients. Morphological changes in tissues were analyzed in 2 groups of patients: group 1 (28) children underwent preoperative preparation; to stimulate the collagen synthesis process, ascorbic acid, mucopolysaccharide preparations (chondroitin sulfate, glucosamine sulfate), calmazin, in combination with B vitamins (B1, B6) and microelements (copper, zinc, magnesium, manganese, etc.); Group 2 - (38) - children did not undergo preoperative preparation.

To conduct histological studies, the parents' permission was obtained for the operation and morphological examination of the cartilaginous tissue (Contract f. 245 dated 22.06.2010), and the permission of the Ethics Committee of the Ministry of Health of the Republic of Uzbekistan (protocol No. 34, dated 18.09.2003).

For histological examination, intraoperatively removed pieces of tissue (cartilage) from the anatomically altered elements of the sternum cartilage and the GRC of the anterior chest wall, during thoracoplasty. Cartilage samples after aldehyde-osmium fixation were embedded in araldite. Taking into account the zonal structure of the costal-sternum cartilage, the pieces were oriented so that the plane of the slices was perpendicular to the articular surface, which, according to some authors [4, 8], makes it possible to apply principle A. Delesse [5]: \( V_{vi} = A_{ai} \) where \( V_{vi} \) is the volume fraction of the i-structure in the total volume of the object, \( A_{ai} \) is the fraction of the sectional area of the i-structure in the area of the cut — the two-dimensional equivalent of the three-dimensional object. Stereological analysis was carried out using a series of semi-
thin (0.5-1.0 µm) sections, which were prepared on a Nova ultratome from LKB (Sweden). The use of araldite as a sealing medium and glass knives minimized the deformation of the object during the production of the sections, and their thickness made it possible to neglect the Holmes effect [6,8]. The preparations stained with methylene blue according to Weekley were examined on a photomicroscope of the "Option" company (Germany) with the hardware-software complex "DiaMorph" (Moscow). The cartilage image was digitized at a magnification of 1250, cytokaryometry was performed in the superficial, intermediate and basal zones of the GRC cartilage, the maximum (D max) and minimum (Dmin) diameters of the cell and nucleus were determined, and their shape (Ff) was analyzed. The measurements were carried out in micrometers after geometric calibration of the images using the image of the object-micrometer scale digitized at the same magnification. For each zone, the volumetric density of chondrocytes (Vvc) in the tissue, their cytoplasm (Vvc) and nucleus (Vvc) in the cells were calculated, the nuclear plasma index (NPI) was calculated as the ratio Vvz \ Vvc.

For histological examination, intraoperatively removed tissue pieces from various anatomical elements of the anterior chest wall during thoracoplasty and fixed in a 12% solution of neutral formalin, dehydrated in alcohols of increasing concentration and embedded in paraffin. Sections 5-8 microns thick were stained with hemotoxylin-eosin and Van Gieson's method.

**Result and discussion**

In the light-optical study of semi-thin sections of the GRC cartilage, destructive changes were noted in the surface zone: the death of individual cells, a violation of the homogeneity of the intercellular substance, and the appearance of focal fibrillation. These changes were evidence of a biopsy of the GRK tissue. In the vicinity of such areas, chondrocytes were determined, which were distinguished by large sizes, round in shape. An increased number of isogenic groups was observed in the intermediate
and basal zones. Single chondrocytes retained a high biosynthetic potential, as evidenced by the intense metachromasia of the territorial matrix.

In a quantitative study of chondrocytes in the surface zone (Vvkhts), their number was 2 times higher than the control value. The minimum and maximum cell diameters were increased 2.6 and 1.2 times, respectively. The Ff values of cells and nuclei exceeded the control values (up to 0.59 ± 0.02 and 0.67 ± 0.02; in the control, 0.47 ± 0.02 and 0.5 ± 0.02, respectively). The increase in the volumetric density of the cytoplasm was expressed to a greater extent than the increase in the volumetric density of nuclei, as a result of which the NPI was 0.37 (in the control 0.7).

Morphological changes in tissues were analyzed in groups of patients, depending on the preparation in the preoperative period, as well as taking into account age characteristics. For histological examination, intraoperatively removed tissue pieces from various anatomical elements of the anterior chest wall of the HRC during thoracoplasty and fixed in a 12% solution of neutral formalin, dehydrated in alcohols of increasing concentration and embedded in paraffin. Sections 5-8 microns thick were stained with hemotoxylin-eosin and Van Gieson's method.

The characteristics of morphological changes in patients who received conservative treatment in the preoperative period, aimed at improving the trophism of the connective tissue, had gross changes in the early stages (Fig. 1). Fibrous structures were built from fibrous connective tissue, collagen fibers were unevenly concentrated and had different thicknesses. In the intercostal ligaments, a shift in the ratio between collagen and elastic fibers is determined, more towards the latter. In the accumulated elastic fibers, thickened homogenized bundles are observed (Fig. 1). In some places, unidirectional collagen fibers form homogeneous hyalinized fields. The phenomena of hyalinosis are more pronounced in the places of their attachment to the perichondrium. In the walls of blood vessels, between the bundles of fibrous structures, insignificant zones of lymphoid-histocytic infiltration are determined. A number of endothelial cells, in the walls of medium caliber, are morphologically almost intact.
In children of school age and older, despite the preoperative therapeutic measures taken, fibrous structures consisted of parallel bundles of coarse fibrous connective tissue with pronounced hyalinosis with cell-free zones. In the walls of small-caliber vessels, there is a chaotic arrangement of cells, some of which are partially thrombosed.

At a later age (12-18 years), fibrous structures around the costal-sternal joints, mainly formed by scar tissue. Homogenization of collagen fibers is aggravated up to degenerative - dystrophic changes (Fig. 2). Among the scar tissue, foci of infiltration are found. Cicatricial changes increase with age. The wall of the arteries is thickened due to hypertrophy of the muscle layer.

During histological studies in biopsy specimens, in pathogenetic untreated sick children with VDHK, more gross changes in the microstructure were determined. Found ingrowth of coarse fibrous connective tissue between bundles of muscle fibers, continuing to fibrous structures. Along the multidirectional ligaments, signs of chronic inflammation are found, with round-cell infiltration. The lumens of the vessels are narrowed, and some arteries of small caliber are thrombosed. Along with inflammatory infiltrates and edema, necrobiotic areas appear, in which collagen fibers lose their structure.

A histological examination of the costal cartilage revealed pronounced degenerative changes. The fibrous cartilage of the ribs consists of coarse fibrous connective tissue. In the thickened collagen fibers, fields with pronounced dystrophic changes are visualized. Especially in areas of significant hyalinosis, connective tissue picrinophilia is determined (Fig. 3). Cartilage cells of different sizes and shapes are unevenly located. In some areas of the preparation, the cartilage matrix is replaced by coarse-fibrous connective tissue containing thin-walled vessels with round-cell infiltrations. Fuchsinophilia is noted in areas of cartilage that have retained a normal structure. Changes in muscle tissue are expressed in dystrophy and replacement by degenerative tissue. The sarcoplasm is homogenized, the nucleus is pale, their number is reduced, and in some places the foci of necrobiosis and necrosis of muscle fibers are determined (Fig. 4).
It should be noted that in the case of HDHC, which are formed as a result of connective tissue dysplasia, the entire GRC undergo profound morphofunctional changes, which are accompanied by incorrect static effects. In sick children treated in the preoperative period by methods of improving tissue trophism (physiotherapeutic procedures with medications) and statics (functional splints), morphological changes are not so deep, i.e. reversible, which predetermines the expected effect of surgery.

Thus, the morphological studies carried out show that the correctly selected preoperative administration of patients with VDHK leads to a significant prevention of residual phenomena of connective tissue dysplasia, which also reduces the likelihood of the formation of gross morphological changes in the structures of the sternocostal complex.

Fig. 1. Thickening is observed in homogenized elastic fiber bundles. In some places of the preparation, unidirectional collegiate fibers form homogeneous hyalinized fields. Staining with hematoxylin and eosin. Ob. 40, approx. 10 (Uv. 300).
Fig. 2. Homogenization of collagen fibers is aggravated up to degenerative-dystrophic changes. Among the scar tissue, foci of infiltration are found. Staining with hematoxylin and eosin. Ob. 40, approx. 10 (Uv. 400).

Fig. 4. The phenomena of hyalinosis are more pronounced in the places of their attachment to the perichondrium. In the walls of vessels of medium caliber fibrous structures, the chaos of endothelial cells is determined. Staining with hematoxylin and eosin. Ob. 40, approx. 10 (Uv. 400).

The results of the obtained quantitative studies made it possible to establish that pathologically altered chondrocytes are determined with VDHK, with a change in their size and volume. The increased number of isogenic groups is a consequence of
overstretching of the fibers of the cartilaginous base, most pronounced in the minimum and maximum sizes of the surface zone. In turn, the increase in the volumetric density of the cytoplasm is increased to a higher extent than the increase in the volumetric density of the nuclei. The result of this condition was an increase in the NPI.

Considering morphological changes in tissues, it should be noted that the method of preoperative preparation has a certain influence on the structure of tissues, which consists in the implementation of conservative tactics. Depending on the age of the patients, the structure of the cartilaginous base is represented by fibrous connective tissue, where collagen fibers are concentrated unevenly with a change in thickness upward. It is impossible not to notice that homogeneous hyalinized fields are found, especially distinguished in the places of their attachment to the perichondrium. Lymphoid-histocytic infiltration constitutes insignificant zones.

Typical changes in morphological structures are established in schoolchildren, whose distinctive feature is the formation of fibrous structures from bundles of coarse fibrous connective tissue, with a chaotic arrangement of cells and their partial thrombosis. In the places of the sternocostal joints, the formation of scar tissue is established, increasing with age parameters. The homogenization of collagen fibers to generative-dystrophic changes is also distinctive.

In patients without the necessary preoperative preparation, morphological changes were characterized by gross changes with ingrowth of coarse-fibrous tissue into the spaces of muscle fibers to fibrous structures. Signs of chronic inflammation are marked by round cell infiltration, manifestations of necrobiotic changes.

Histological, in this group of patients, coarse fibrous growths with pronounced degenerative changes, pycnophilia of connective tissue, uneven arrangement of cartilage cells, the sizes of which are heterogeneous, were noted. If in some places the cartilage matrix is replaced by coarse fibrous connective tissue, then there is a severity of dystrophy of muscle fibers to their degeneration and necrosis.

Consequently, in patients who received sufficiently planned conservative therapy in the preoperative period, cartilaginous and muscle tissues have certain
compensatory factors for the restoration of connective tissue. It is this factor that is the resultant in the implementation of the operation to restore the VDHK.

Conclusions

1. The obtained quantitative data on changes in the chondrocytes of the GRC cartilage indicated a sufficient degree of expression of the compensatory reactions of the cartilage tissue.

2. Conducted histological studies of changes in the structures of the HRC in EDHK in children, establish their increase with the age of patients.

1. In the early stages of VDHK, in the soft tissue components around the GRC, as a result of a violation of the ratio between elastic and collagen fibers, the formation of scar tissue is observed, and at a later date, cicatricial changes increase.

2. The above morphological data can contribute to the pathogenetic targeted preoperative administration of patients with HDHC, lead to a significant prevention of residual phenomena of connective tissue dysplasia.

LIST OF REFERENES:


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