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ENGINEERING SCIENCES

SOME ASPECTS OF CREATING INDIVIDUAL SPLINT SYSTEMS

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Abstract*. The article deals with the problem of the use of universal splint systems, which are used during recovery after surgery on the upper respiratory tract. The main disadvantage of universal splint systems is that they do not take into account the individual anatomical structure of the patient's nasal cavities, which can cause additional pressure on the lateral wall of the nasal cavity. Thus, the presented study describes some aspects of the creation of individual splint systems based on the use of the results of the patient's tomographic scan. Most doctors use the results of a CT scan when planning surgery. Special software was developed to work with DICOM files, which performs pre-processing of tomographic sections and their segmentation.*
Keywords*: wall nasal splint system, nasal breathing, three-dimensional model, prototyping.*

Introduction. Intranasal silicone splint is intended for use after septoplasty. It fixes the reconstructed nasal septum in the middle position.

Problems splint systems − use universal shapes and sizes. Splints do not take into account the individual structure of the nasal cavity and its architectonics, so it is not possible to adversely affect the lateral wall of the nasal cavity due to additional pressure [1-6].

The results of the study. Before the construction of the unit system the patient is examined by a medical institution, which scans the upper airways using spiral computed tomography. The sections of the upper respiratory tract are stored in a DICOM file. With the help of special software, an operation is performed to locate local bowel movements.

In the window of the work program, the user needs to select the most informative section from the topogram (the most informative is the section where the pathological process of the nasal septum is visible most), on this section the user should select a rectangular plane (Fig. 1), which should be trapped by the nasal line. After highlighting the required plane, there is an automatic pre-processing and segmentation of the image, which outlines the contour of the nasal septum, then calculates the geometric parameters of the nasal septum and localizes the curvature. This data is stored in the program for later prototyping [7-12].

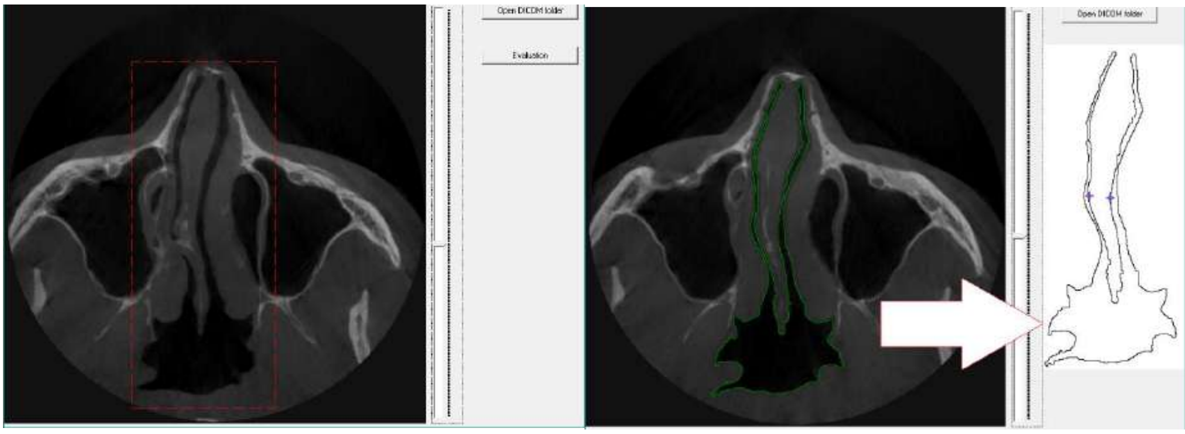
Figure 1 a show that the left nasal passage is blocked and does not have the ability to move air, so the segmented model will be created exactly to the area and is defined as the localization point of the curvature.

If the partition is segmented completely, then the algorithm for finding the localization of the curvature is reduced to finding the global extrema in two contours, as shown in Fig. 1 b. The first contour starts from the top of the segmented model and ends with the end point of the nasal septum. The second contour starts from the extreme point of the nasal septum and ends with the other tip of the model. The lowest extremum is taken into account, since it is important to choose the length correctly when constructing an individual splint, so the extremum above the topogram is not informative.

Together with the localization of the curvature, the point of the end of the nasal septum is sought by global extremes, and the global minimum between the two global maxima (the points of the nasal septum start) is searched for.

Based on these data, the program determines L2 (the length of the nasal septum to distortion) and L1 (the total length of the nasal septum) and stores the data for further prototyping.

The pre-processing program is the starting point in the individualization of septal tires. It has significant drawbacks, such as the need to use a qualified user to determine the information slice; segmentation inaccuracy when creating a rectangular plane.



a) *b)*

Fig. 1. Appearance of the developed software (a − Selection of nasal septum; b − result of segmentation of nasal septum)

For the correct construction of the 3D model, previously in the program for 3D visualization of Autodesk 3Ds Mach 2019 Student Version, a unified split system was created and modeled for all types of nasal septum distortions. The basis for the three-dimensional model is the «АБВГДЕЖ» hexagon (Fig. 2).

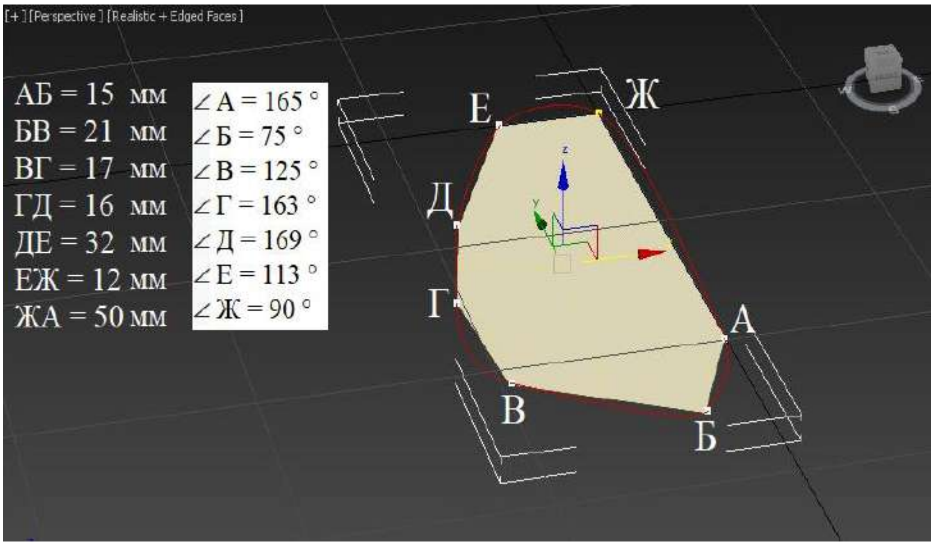


Fig. 2. Model of the septal tire base

The edges and vertices of the hexagon are rounded to eliminate traumatization of the nasal mucosa, for this purpose in the program for 3D visualization of Autodesk 3Ds Max used Bezier quadratic curves to smooth the acute angles of the hexagon.

A hollow cylindrical thickening extending along the entire length of the intra-nasal tire at the level of the lower nasal conduit and oriented to the lateral wall of the nasal cavity is performed on the tire surface, which further facilitates nasal breathing in the patient (Fig. 3).

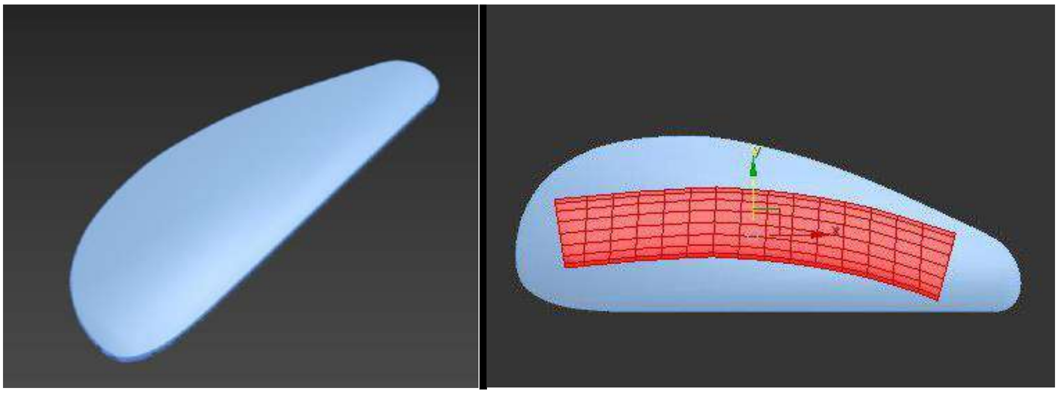
The corners when constructing the base are as follows: ∠ A = 165°, ∠ Б = 75 °, ∠ B = 125 °, ∠ Г = 163 °, ∠ Д = 169 °, ∠ E = 113 °, ∠ Ж = 90 °.

The result of building the base of the split is presented in Fig. 3.

Conclusions. 3D printing splint systems that are based on models (for individual DICOM images) has the following advantages:

- individual approach to each patient and creation of anatomically relevant splints, thus significant reduction of pain sensations;
- the ability to create splints separately for the front of the nasal septum;
- printing polymers that will not be removed in the body during the period required for treatment.

Thus, various modifications of intranasal tires will significantly facilitate the rehabilitation period for the patient, reduce the number of primary and distant complications, as well as, by reducing the pressure on the reflex areas of the nasal cavity, will ease the overall somatic condition of the patient, reduce the risk of psyche disorders activities, as well as the fear of surgery. Individual split-system will help the patient to return to normal and natural physiological breathing.



а *б*

Fig. 3. Modeled (a) split base (b) split base with roller thickener for air passage

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