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Sonography and Radiography in the Diagnosis of Injuries of the Middle Zone of the Face

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ABSTRACT

The purpose is to evaluate possibilities of ultrasonography in the monitoring of various midfacial bone fractures.

Ultrasound examination was carried out on104 patients at the age of between 6 and 59 with trauma of the maxillofacial region. All of patients were examinated sonography, radiography and multislice computed tomography.

Fractures of the maxillofacial bones confirmed in 96 patients, including 36 isolated, 60 multiple and associated injuries of bones of the maxillofacial region. All injuries were identified by CT with 3D reconstruction, thus the method was adopted as verifying.

The ultrasonography findings revealed the following: interruption of the cortical layer with or without displacement of bone fragments, bone contour deformation. In comparison with an x-ray, ultrasonography was more sensitive in detecting fractures (94.0% to 81.5%), especially in fractures of the front wall of the maxillary sinus, articular and coronoid process of the mandible. Ultrasonographic examination was carried out with 17 patients after closed reposition. The unsatisfactory positions of bone fragments, which need re- repositioning, were detected in 5. In 7 patients sonography was used intraoperatively to control the repositioning of the bone fragments, thus making it possible to achieve satisfactory results after operations.

Ultrasonography has proved to be a valuable tool in detecting fractures in the facial bones in addition to x-ray examination. Particular value of sonography is a control for repositioning bone fragments.

Key words: trauma, maxillofacial region, sonography

Introduction

Damage to the maxillofacial area in its prevalence of work time losses to material costs associated with the costs of treatment and rehabilitation represent an actual medical and social problem [1, 3]. In the general structure of injuries, the damage to the middle zone of a person is about 40% and tends to grow by an average of 2% per year, while the contingent of those affected is between the ages of 20 and 50, that is, during the period of the greatest work capacity [2].

The aim of the study is to evaluate the role and significance of sonography in the overall complex of radiation methods for diagnosing fractures in the maxillofacial region.

Materials and methods

The analysis of the survey data of 104 patients aged 6 to 59 years, with suspicions of fractures of the bones of the CHO. The majority of the examined patients were men - 90. Fractures of the maxillofacial bones were confirmed in 96 patients, including 36 isolated, in 60 multiple and combined damage to the bones of the CHO.

Within the framework of the protocol used, all patients underwent two-dimensional seroscale sonography, radiography and multislice computed tomography. Sonography was used to diagnose fractures, as well as to monitor and control reposition of bone fragments intraoperatively and after closed repositioning. The studies were carried out on a SLE-501 (Lithuania) device with a linear 7.5 MHz frequency transducer in the position of the patient lying on the back, polypositional with longitudinal and transverse sections. Radiography of the maxillofacial region was performed in special projections according to the probable damage zone (x-ray of the zygomatic bones in the semi-axial projection, roentgenography of the nose bones in the lateral projection, orthopantomography, and mandibular x-ray in the straight and lateral projections). Multislice computed tomography (MSCT) is performed in an axial projection followed by a three-dimensional reconstruction on the Somatom Emotion 6 (Siemens, Germany).

In sonography, the following anatomical structures were evaluated: skin, subcutaneous fatty tissue, masticatory muscles, cortical layer of bones - lateral, medial walls and lower contour of orbit, nose bones, anterior,

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maxillary sinus, zygomatic arch and mandible. At the same time, the study of the healthy side was conducted to compare the detected pathological changes. These structures were also evaluated in the MSCT, in addition, CT also allowed an additional assessment of the state of deep-seated bone and soft tissue structures of the maxillofacial region, such as the muscles of the hyoid bone, the muscles constituting the mouth aperture, lateral and medial pterygoids, whose sonographic visualization is difficult due to Possible artifacts from adjacent bone structures.

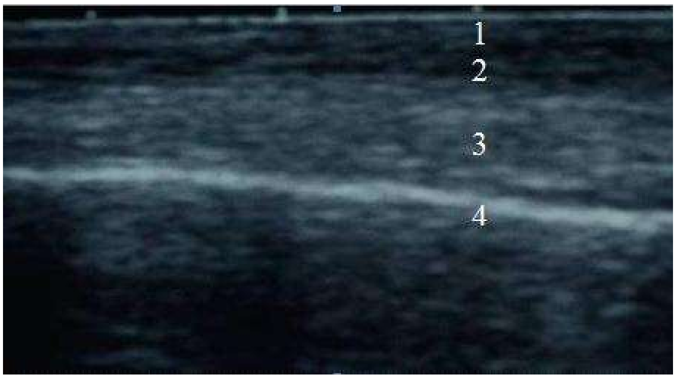
MSCT was also a reference method for evaluating the diagnostic efficacy of sonography and radiography for injuries of the maxillofacial region.

Intraoperative ultrasound monitoring was used in 7 patients with fractures of the zygomatic bone during surgical reposition of the fragments. Any wrong ratio of fragments of the fracture area was regarded as an incorrect reposition and the operation continued until an adequate and stable repositioning was obtained from the sonography data.

The control group consisted of 20 healthy individuals who underwent sonographic examination of the CHO. In addition, symmetric, corresponding undamaged bone structures served as controls.

Results

In the sonographic study of patients in the control group, the anatomical structures of the maxillofacial area showed the following features: the skin looked like a hyperechoic linear structure, the subcutaneous fat layer was a hypoechoic structure with alternating thin hyperechoic connective tissue fibers. The chewing muscles looked like homogeneous hypoechoic areas, separated by multiple parallel hyperechoic layers of connective tissue. The outer surface of the underlying bone was characterized as a hyperechoic line with a complete absence of distal ultrasound conductivity (pic.1).

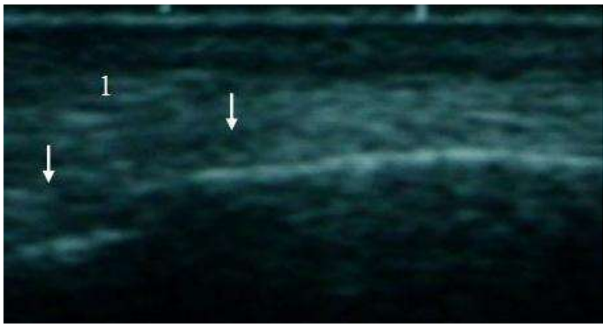


Pic.1. Sonogram of the right angle of the mandible is normal in the patient Sh., 28years. 1 - The skin; 2 - subcutaneous fat; 3 - chewing muscle; 4 - external cortical layer of bone.

Interruption of the bone surface on sonograms in healthy individuals was visualized at the lower edge of the orbit at the place of passage of the lower orbital opening and in the parasymmetric area of the lower jaw, respectively, with the opening of the mandibular nerve. Eyeballs showed a rounded form of anechogenous structures, and the medial and lower walls of the orbit completely reflected ultrasound with the formation of a hyperechoic contour around the distal parts of the eyeballs.

MSCT showed the presence of fractures of the bones of CHL in 96 out of 104 examined, including isolated patients in 36 patients, and 60 - multiple and combined injuries of the maxillofacial bones.

Based on a comparison with the MSCT data, the main signs of bone fractures in the maxillofacial region are determined in ultrasound. Fractures were manifested on sonograms by interrupting the contour of the bone with or without displacement of bone fragments, deformation of the outer contour of the bone, and the presence of bone fragments (pic 2a and 2b). In some patients, signs of a fracture in the



form of a break in the cortical layer, deformation of the bone contour were visualized with dynamic sonography using a functional test. Fractures of the lower and medial walls of the orbit were manifested indirectly in the form of an increase in their sound conductivity. Contusions of soft tissues led to their thickening, a decrease in echogenicity with fuzzy boundaries; subcutaneous hematomas looked like hypo-and anechogenous areas with clear boundaries.

PIC.2a. Sonogram of the left zygomatic arch of the patient R., 23d. 1- Edema of soft tissues; Arrows indicate bone fragments of the anterior sections of the zygomatic arch.

pic 2b. CT of the same patient, axial section at the level of the lower contour of the orbit. The fracture of the zygomatic arch on the left is determined with the formation of deformation.

Table 1.

Frequency of detectable fractures of the middle zone of the face using radiography and sonography

Chest fractures	Number of fractures	Radiologically detected	revealed in sonography
Middle zone of the face, including			
Bones of the nose	22	21	22
Orbit walls	21	18	18
The walls of the maxillary sinuses	41	20	36
Cheek bone and zygomatic arch	18	15	17
Total fractures	102	74	93

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As can be seen from the table of 102 diagnosed in the CT of the fractures of the middle zone of the face, 74 were radiorographically identified, and in sonography 93. At the same time, the sensitivity of both X-ray and sonography was very different in fractures of the walls of the maxillary sinus, the zygomatic arch.

Radiography revealed fractures of the anterior walls of the maxillary sinuses in only 6 of 22 patients, and fractures of the outer walls in 14 of 19. All fractures of the anterior walls of the maxillary sinuses were sonographically diagnosed, and fractures of the external wall of the maxillary sinus were not detected in 5 of 19 patients (pic. 3a, 3b).

pic 3a. Radiograph in the semi-axial projection of patient III, 38 years old. Convincing data for traumatic changes in the walls of the maxillary sinuses were not revealed.

Pic. 3b. Sonogram of the same patient. The arrow indicates interruption of the cortical layer of the outer wall of the right maxillary sinus.

X-ray revealed no cases of fractures of the zygomatic arch, which were well manifested in sonograms (Pic 4a, 4b). On the radiograms because of the stratification of the shadow of the body of the malar bone, the posterior sections of the zygomatic arch were not visualized. Only in one observation of the unbiased fracture of the zygomatic arch, because of the presence of an isolated hematoma, could not be visualized sonographically.

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Pic 4a. Radiography of the skull in a semi-axial projection of patient A., 42 years old. Traumatic changes in the left zygomatic arch are not noted.

Pic. 4b. Sonogram of the same patient. The arrow indicates interruption of the cortical layer at the level of the anterior third of the left zygomatic arch.

Sonography revealed signs of orbital wall fractures in 18 of 21 patients, with fractures confirmed at MSCT. In this case, the fractures of the walls of the orbit were manifested only by an indirect sign in the form of an increase in the acoustic conductivity of the orbit wall (Figs 5a, 5b). There were no signs of fracture in 3 patients, including 2 with fractures of the lower wall and 1 in the medial wall of the orbit. In these patients with computed tomography, a violation of bone integrity without dislocation of fragments was visualized.

In 2 cases sonographically false positive results were obtained about the presence of fractures of the lateral wall of the orbit, which may be due to misinterpretation of the frontal-zygomatic suture as a fracture.

Pic. 5a. Sonograms of the right (A) and left (B) orbits of patient X., 41 years old. 1 - eyeballs; 2 - decrease in echogenicity of the bottom wall of the right orbit as a result of an increase in its sound conductivity (fracture); 3 -

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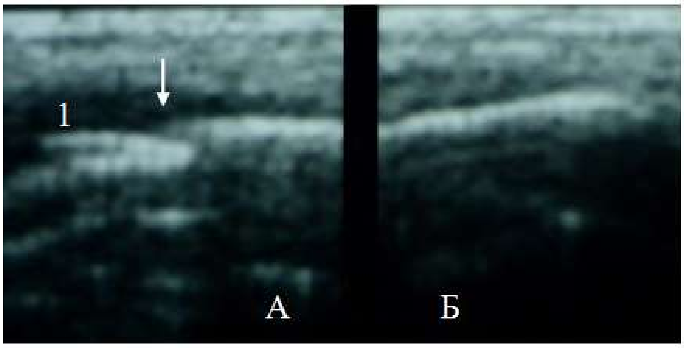
the bottom wall of the left orbit, its echogenicity is preserved.

Pci 5b. CT of the same patient, coronary image of the middle zone of the face. Fractures of the bottom wall of the right orbit, zygomatic bone and lateral wall of the right maxillary sinus are determined, with prolapse of bone fragments and cell tissue of the orbit toward the sinus.

Fractures of the nose bones in all 22 observations sonographically manifested by interruption of the bone with displacement of the distal



fragment without deviation from the median sagittal plane or with deviation of fragments outwards (pic 6). Radiography in only 1 case did not reveal a fracture of the nasal bone.

Pic.6. Sonograms of the right (A) and left (B) nasal bones of patient B., 28 liters. The arrow indicates the area of fracture of the right nasal bone, with the displacement of the bone fragments. 1 - Subcutaneous hematoma of soft tissues.

In 9 patients, ultrasound was performed repeatedly after splinting, in the early postoperative period and also after 1, 2, 4 weeks after repositioning to assess the condition of bone fragments-the zygomatic bones (7 patients) and the bones of the nose (2). The standing of the fragments was satisfactory at 6 and unsatisfactory in 3 cases. In 9 patients, sonography was used to monitor the adequacy of bone fragments in a closed and open reposition - zygomatic bones (7 patients), nose bones (2 patients). Among 11 other patients examined after a closed reposition of zygomatic bones performed without ultrasound

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monitoring, 2 revealed an incorrect standing of bone fragments.

The sensitivity of radiography for fractures of the middle zone of the face was 78.4% of sonography 91.8%, respectively.

Discussion

The results of the conducted studies showed that the use of sonography in patients with injuries of the maxillofacial area improves the detectability of fractures of the facial skull bones, which is caused by the greater sensitivity of sonography than the radiography. Similar results were noted by other researchers comparing the data of echography and radiography in fractures of maxillofacial bones (NS Serova, 2006, DA Lezhnev, A.Yu. Vasiliev, 2008, J. Siegfried, 2004; SA Ogunmiviwa , 2012; KS Singh, 2014; MPSreeram, 2016, and others).

According to our data, the sensitivity of sonography was high for midbone fractures (94%) and depended primarily on which bone structures were damaged, whether there was a complete fracture or displacement of fragments. The causes of false negative results were fractures without displacement of fragments with minor damage to the cortical layer, small fracture size, inaccessibility of bone damage for ultrasound imaging and the presence of subcutaneous emphysema. For example, sonographically, in 5 patients, fractures of the external wall of the maxillary sinus were not diagnosed because of the presence of massive subcutaneous emphysema, which prevented the visualization of the bone surface with unbiased fractures.

For fractures of the walls of orbits, errors occur equally often in sonography and radiography. The main causes are unbiased fractures, without damaging the orbital margins of the orbital walls. This, in particular, is indicated in the works of LI Sangaeva (2009), M.Sallam (2010), M.P. Sreeram (2016). According to Fredrich and co-authors (2004), the quality of the diagnostic fractures of the orbital walls is improved by using a sensor with a small surface, which allows full contact of the surface of the sensor and skin in the orbit region [4]. As our studies have shown, attention should be paid to this indirect feature, such as an increase in the acoustic conductivity of the orbit wall, since it corresponds to its fracture.

As our data showed, radiography, unfortunately, does not have the same sensitivity, because of which some fractures can be missed. Errors in the diagnosis of fractures of the cheylo-orbital complex are also common in sonography, in our studies they occurred in 4 cases. The main reason for their non-occurrence were incomplete fractures. At X-ray, fractures of the skullorbital complex did not appear even more often (6 cases). This circumstance underscores the advisability of using computed tomography for traumas of this localization, not limited to radiography and sonography.

The sensitivity of radiography in revealing fractures of the sinus of the maxillary sinus was low, amounting to 27.2% in revealing a fracture of the anterior wall, 86.6% in revealing fractures of the external wall of the maxillary sinuses. Inadequate informativeness can be explained by the summation effect in taking pictures in the semi-axial and lateral projections, as well as by the diminishing of the sinus observed in some of these patients due to hemorrhage or effusion. McCann et al. Also reported difficulties in the study in the presence of massive emphysema of soft tissue and, accordingly, discrepancies in sonography and traditional radiography in ten of 22 cases [6].

It should be agreed with the opinion of O.Yu. Pavlova (2014) that the darkening of the maxillary sinuses is an indirect radiographic evidence of the fracture [15]. This, in particular, is confirmed by our data, when out of 21 patients the existing fractures of the anterior and lateral walls of the maxillary sinus were not visualized on the radiographs, while sonography in 20 of 21 of these observations confirmed the presence of a fracture.

For all that, sonography can not replace radiography, but it must be an obligatory component of a primary examination of a patient with suspected traumatic injuries to the maxillofacial area; Especially since this research has now become widespread and accessible. For example, in Uzbekistan, the department of emergency medical care of all, without exception, district and city hospitals are equipped with separate ultrasonic scanners.

And of course, the use of sonography instead of radiography for control of repositions and for research in dynamics in the postoperative period and in the process of rehabilitation is of particular value, which reduces the radiation load.

Conclusion

The carried out researches have shown that sonography is an informative method of diagnosing bone fractures in the middle zone of the face, not inferior, and in some localizations, fractures of the anterior wall of the maxillary sinus, zygomatic arch, which is superior in sensitivity to radiography. However, sonography does not replace, but complements the radiography, in which it is possible to obtain an overview image of the maxillofacial region.

2. Fractures of the lower and outer walls of the orbit on sonograms are an indirect sign - an increase in the sound conductivity of the bone.

3. The causes of diagnostic errors in sonography during traumatic injuries of the bones of the middle zone of the face are fractures without displacement of fragments with minor damage to the cortical layer, small fracture size, inaccessibility of bone damage for ultrasound imaging and the presence of subcutaneous emphysema interfering with penetration of the echoes.

4. Ultrasonic monitoring of the adequacy of open and closed reposition of fragments improves the effectiveness of interventions and allows timely elimination of the causes of unsatisfactory standing fragments.

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