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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

RADİOLOGİCAL SEMİOLOGY OF NONNEOPLASTİC AND NEOPLASTİC PATHOLOGİES OF THE SALİVARY GLANDS

Specialty: 3225.01 – Radiology diagnostic and therapy

Field of science: Medicine

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GENERAL CHARACTERISTIC OF THE WORK

Actuality and degree of processing of the research work. A number of diagnostic difficulties emerged during the study of salivary gland diseases, create the basis for more accurate and early diagnosis of these processes with the help of modern methods of examination and, as a result, raise this issue up to date.

To obtain an accurate diagnosis – depending on the pathology – which examination to choose and in what mode of examination, the determination of the sequence of examinations – are the main factors.

The study described effective radiological diagnostic semiotics for dentists, oncologists, maxillofacial surgeons and radiologists and developed appropriate algorithms. In-depth study of some rare common salivary gland pathologies create the basis for their timely introduction to the differential order in the future.

Recently, a number of systematic studies on ultrasonography (USG), computer tomography (CT) and magnetic resonance imaging (MRI) methods have appeared in the diagnosis of salivary gland diseases[1; 2; 3; 4]. These methods are important not only for the detection of pathological process in the salivary glands, but also for differential diagnosis (DDx).

Among the population of Azerbaijan in the modern period, USG, CT and MRI are widely used in clinical practice. As a result, new real opportunities have emerged for high-quality assessment of

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[2] Обиня, Н.П. Современные лучевые методы в диагностике и планировании лечения заболеваний слюнных желёз: / дисс. канд. мед. наук. / – Москва, 2012, – 150 с.

[3] Руднев, А.И. Комплексный подход к дифференциальной диагностике новообразований больших слюнных желёз: / дисс. канд. мед. наук. / – Москва, 2013, – 100 с.

[4] Gerson, S.M. Parotid gland tumors: A retrospective study of 154 patients / S.M.Gerson, P.O.Oppermann, L.G.P.Maahs [et al.] // Brazilian Journal of Otorhinolaryngology, – 2015, 64 (3), – p. 301-306.

the pathological processes, especially tumors. To increase the diagnostic effectiveness of these capabilities, their semiotics should be clarified, and our research is devoted to this.

Recent years have been associated with increasing number of salivary glands diseases, improvement of examination methods and optimization of visualization. One of the urgent issues related to this is the study of individual anatomical structural changes of the salivary glands[5; 6]. The study of the topographic interaction of the salivary glands with vascular, nervous and other anatomical structures is very important in reconstructive surgery of the maxillofacial area[7].

The main purpose of radiological diagnostic methods is to detect the nature of the process. The differentiation of malignant and benign processes, although not quite accurate, allows radiologists to predict the origin of the process.

The importance and possibilities of USG, CT and MRI in diagnosis of salivary glands pathologies have not been fully studied and their optimal methods have not been clarified. The study of these issues is one of the urgent problems of Clinical Medicine.

Object and subject of research: newly formed stable swelling in the projection of salivary glands; also patients who had previous salivary glands disease (relapse cases, etc.) formed the object of the study. The results of prospective clinical and Radiological (USG, CT and MRI) of 100 outpatient patients with salivary glands diseases have been studied. Salivary glands pathologies were divided into 2 main groups and 6 subgroups, forming the subject of the study:

1) **Non neoplastic (n=70)**
   a) acute and chronic inflammatory processes (n = 51)
   b) sialolite-containing processes in salivary glands ducts (n = 8)

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[6] Дюннебир, Э.А. Лучевая диагностика. Оториноларингология / Э.А.Дюннебир. – Москва: МЕДпресс-информ, – 2013, – 360 с.

[7] Benjamin, K.H.L. Head and Neck Tumors: Amide Proton Transfer MRI / K.H.L.Benjamin, A.D.King, A.Qi-Yong [et al.] // Radiology, – 2018, 288 (3), – p. 781-790.

c) focal processes of cystic nature (n = 9)

d) idiopathic cases (n = 2)

2) Neoplastic (n=30)

a) benign tumor processes (n = 22)

b) malignant tumor processes (n = 8)

111 patients were retrospectively studied and these patients were included in the control group.

Purposes and tasks of the study: Investigation of syndromes of non neoplastic and neoplastic pathologies of the salivary glands with modern radiological diagnostic methods, systematization of the symptoms of the obtained examinations related to these diseases, DDx and improvement of diagnostic accuracy. The tasks are outlined below:

1.Study of the main radiological pathognomonic features of USG, CT and MRI examinations in patients with non neoplastic and neoplastic pathologies of the salivary glands;

2.Comparative analysis of the results of retrospective observation with the results of prospective radiological diagnostic examinations;

3.Retrospective analysis of accuracy, specificity and sensitivity of applied radiological examinations;

4.Analysis of histopathological-radiological correlation;

5.Development of radiological diagnostic algorithm based on received data.

Research methods: USG of salivary glands were performed on Logiq S7 Expert (HRUS, GE Company, USA), CT examination on multislice Hitachi Presto (Hitachi company, Japan) and MRI examination on 1,5 T Philips Achieva (Phillips company, Netherlands).

Main provisions for protection:

1. Tumor vascularization and the inner mobility of the cystic prosesses should be studied on USG;

2. The determination of the morphological nature of the tissue structure is most accurate on MRI;

3. The most accurate method in the visualization of calcifications is CT;

4. CT and MRI methods in the diagnosis of “simple” and “complicated” cysts are more informative than USG;

5. İn determination of epidermoid cysts the magnetic resonance diffusion-weighted imaging (DWI) method is key in symptomatology;

6. MR T2 weighted fat saturated sequence (T2 W FAT SAT) mode is key in the determination of pleomorphic adenomas (PA);

7. İn radiological diagnosis of the Kuttner’s tumor, it is recommended to use every 3 methods;

8. For early postoperative supervision, USG should be used first.

Scientific novelty of the study:

On the basis of the combined use of USG, CT and MRI examinations in radiological diagnosis of salivary gland diseases, diagnostic opportunities and limitations for each examination were studied for the first time among the Azerbaijani population.

The radiological and pathological interrelations of diseases of the salivary glands were evaluated.

An algorithm was compiled for the DDx of malignant tumors, teratogenic and congenital cysts, non-tumor and other processes in comparison with available literature data.

Theoretical and practical significance of the study. The obtained results significantly contribute to the improvement of the quality of diagnostics. The research work was planned jointly with the fields related to the specialties of Radiology, maxillofacial surgery and oncology and has great importance for specialists in this field.

Methods and criteria obtained from radiological diagnostics are important in determining the degree of prevalence of neoplastic process and determine treatment tactics and adequacy.

Approbation of the study. Fragments of the dissertation work was reported and discussed at the National Center of Oncology, at the scientific-practical conference dedicated to the birthday of national leader H.A.Aliyev – “Statistics of salivary glands pathologies (Clinical and Radiological retrospective analysis) of patients of the maxillofacial surgery department” (Baku, May 2018), at the first conference of Azerbaijan Society of Radiologists “Radiological se-

miotics of Nonneoplastic and neoplastic processes of salivary glands" (Azerbaijan Society of Radiologists, Baku, December 1, 2019), at the ASDII named after A.Aliyev, at the scientific-practical conference dedicated to the birthday of A.Aliyev – "Radiological differential diagnosis of neoplastic processes of salivary glands" (Baku, 2020), Initial discussion at the inter-departmental meeting of the Departments of Radiation diagnostics and therapy and Dentistry of the Azerbaijan state doctors improvement Institute named after A.Aliyev held on December 30, 2021, at the scientific seminar of FD 1.02 dissertation council functioning under the National Center of Oncology on the specialty 3225.01 – "radiation diagnostics and therapy" held on June 23, 2022 at the meeting (protocol №3).

Application of research results. The results of scientific work applied in the Departments of Maxillofacial Surgery of Baku City Clinical Medical Center No. 1, in the Republican Clinical Hospital named after academician Mirgasimov and in the Radiological Department of the clinic named N.Tusi. The results were also applied in the educational process, general and thematic improvement courses of the Department of radiation diagnostics and therapy of the Azerbaijan state doctors improvement Institute (ASDII) named after A.Aliyev.

The name of the organization where the dissertation work was carried out. Research work was performed in ASDII named after A.Aliev of Ministry of Health of Azerbaijan Republic (ANSA registration № – BTEB-313).

Publications. On the topic of the dissertation, 12 scientific papers were published, including 9 articles and 3 theses. Each of the above-mentioned articles was published in different journals and abstracts were included in the conference materials. All publications are included in the journals listed by the Higher Attestation Commission (HAC). One article was published in the International indexing system Web of Science, another in the Journal included in the Higher Attestation Commission of Belarus Republic. 4 articles and 2 theses were published without co-authors. The most important results and provisions of the dissertation work are reflected in journal articles.

Structure and volume of the dissertation. The dissertation work was written on 169 computer printed sheets, consists of introduction (9729 characters), 5 chapters (Chapter I – 59708 characters; Chapter II – 29977 characters; Chapter III – 40000 characters; Chapter IV – 24365 characters; Chapter V – 13200 characters), conclusion (22877 characters), conclusion (1727 characters), practical recommendations (672 characters) and list of used literature. The total volume of the dissertation with signs (without considering the contents, list of used literature, 21 tables and 49 pictures) – consists of 202255 signs. The list of literature includes 195 sources (Local, Russian and Foreign), and each of these resources has been cited in the dissertation work.

MATERIALS AND METHODS OF RESEARCH

Contingent of research. Prospective studies were conducted in patients who applied to the radiology department of the N.Tusi Clinic with salivary gland problems in 2016-2018. The total number of patients involved in the study for two years was 100 people, of which 59 were male (59.0%) and 41 female (41.0%). The mean age indicator of male patients was 43,34±2,34 and the mean age indicator of female patients was 43,49±3,43. In the neoplastic group were registered 17 men (56.7%) and 13 women (43.3%); in the nonneoplastic group 42 men (60.0%) and 28 women (40.0%) patients. The ages of the patients varied between 1 – 90 and the average age index was 43,4±2,0. Mean age was 48,77±3,19 in patients with neoplastic process aged between 7 and 81 years old and mean age was 41,10±2,41 in patients with nonneoplastic process aged between 1 and 90 years old.

Patients with radiological diagnostic examination were divided into 2 main groups: nonneoplastic (I) and neoplastic (II).

Nonneoplastic pathologies were detected in 70 (70%) patients, and neoplastic pathologies in 30 (30%). The nonneoplastic group includes patients with inflammatory changes, cysts, sialolithiasis, other processes and the neoplastic group includes patients with benign and malignant processes in the salivary glands. Of 70 patients divided into 4 subgroups in the non-neoplastic group: 51 inflammatory processes

(72.9%), 9 cysts (12.9%), 8 sialolithiasis (11.4%) and 2 other processes (2.9%). Of the 30 patients of the neoplastic group divided into 2 subgroups, 22 were benign (73.3%) and 8 were malignant (26.7%) processes. In patients with benign neoplastic pathology, the average age index was 45.18±3.70 (7 – 71 years), and in patients with a malignant process, the average age index was 58.63±5.15 (36 - 81 years).

The main complaints of group I patients were local swelling and pain. Clinical syndrome in patients with abscesses – pain in 75.0% (6 patients), local edema in 75.0% (6 patients), high temperature, parallel to local hyperthermia in 75.0% (6 patients). In a clinical blood study, leukocytosis was detected in 87.5% (7 patients), and the predominance of elements of the young form in the leukoform in 75.0% (6 patients) of cases.

Patients with benign processes included in subgroup I of the second main group were divided as follows: Warthin tumor in 4 patients (18.2%), PA in 17 patients (77.3%) and lipoma in 1 patient (4.5%).

The II subgroup of neoplastic pathologies included patients with the following malignant processes: 25.0% mucoepidermoid cancer (2 patients), 25.0% adenocarcinoma (2 patients), 37.5% adenocystic cancer (3 patients) and 12.5% non-Hodgkin's lymphoma (1 patient).

Clinically, in patients of the neoplastic subgroup, the main complaint was a gradual painless increase in the salivary glands.

Out of 100 (100.0%) patients, 27 (27.0%) received conservative, 69 (69.0%) surgical treatment and 4 (4.0%) lithotripsy. Conservative treatment was performed in 5 (16.7%) neoplastic and 22 (31.4%) neoplastic; surgical treatment in 25 (83.3%) neoplastic and 44 (62.9%) neoneoplastic; lithotripsy in 4 (5.7%) patients with sialolithiasis. Histopathological examination was performed in 64 patients (100.0%), and cytological examination was performed in 9 of them (14.0%) after fine needle aspiration biopsy (FNAB). Of the patients who underwent histological examination, 30 were from the neoplastic and 34 from the non-neoplastic group.

The retrospective study included patients who underwent examination and treatment in 2012-2016 in the departments of maxillofacial surgery of the Baku City Clinical Medical Center No. 1 and the

Republican Clinical Hospital named after Academician Mirgasymov. The study analyzed the medical history of 111 patients (74 patients from CMC and 37 patients from RCH) in total, and these patients were taken into the control group. Of the cases, 63 people were men (56.8%), 48 were women (43.2%). Their age ranged from 11 to 85 years, and the average age index was calculated at 47.9±1.4.

Research methods. USG of the salivary glands was performed on Logiq S7 Expert devices (HRUS, GE company, USA), CT in multislice Hitachi Presto (Hitachi company, Japan), MRI in 1.5 T Phillips Achieva (Phillips company, Netherlands).

Using 8-15 MHz transducers in USG, B-mode, Doppler (color, energy and spectral) and elastographic modes were applied, and a FNAB examination was conducted under USG control. CT and MRI were performed both natively and with contrast, depending on the pathology. Nonionic iodine-containing substances (Omnipaque and Ultravist) were used on CT, and paramagnetic contrast agents (10.0 Gadovist) were used on MRI. During the MRI study, polyprojection images were obtained in the sequences turbo spin Echo (TSE), T1 and T2 weighted sequences; also fluid-attenuated inversion recovery (FLAIR), short tau inversion recovery (STIR), DWI and after contrast on T1.

High resolution ultrasound (HRUS). When examining the angioarchitectonics of pathologies detected in the salivary glands and lymph nodes in the color Doppler (CD) and energetic Doppler (ED) modes, the following several techniques were worked out:

– detailed and accurate angioarchitectonics of enlarged USG images of inflammatory processes, solid and cystic formations;

– analysis of qualitative indicators of anatomical localization of vessels in the tumor structure;

– investigation of the nature of blood flow (arterial, venous), type of blood flow (main, collateral) based on qualitative indicators of spectral Doppler curves of blood flow in intra-tumor vessels.

In strain sonoelastography assesses the hardness of tumors. Compression elastographic examination yielded additional results in visualization of tumor contours and invasion boundaries.

CT and MRI. On CT and MRI, it was possible to obtain an

optimal three-dimensional (3D) projection image of the full volume and topography of the salivary glands, their localization relative to nerves, blood vessels and other important anatomical structures.

These examinations are indispensable in the study of the pathomorphological substrate and invasion into surrounding structures, as well as in determining the scope of surgical intervention.

In cases where USG imaging of the tumor is limited, CT and MRI play a key role in the overall effectiveness of the final diagnosis. If malignancy is suspected, a complex of CT and MRI comes forward when assessing deep lymph nodes, invasion of bone structures (base of the skull, parapharyngeal space).

CT and MRI are indispensable for accurate localization of the process, comparative bilateral assessment of regional structures around the salivary glands.

CT and MRI were performed before and after intravenous injection of contrast agent. Cases of non-contrast examination were associated with contraindications to these substances (high creatinine, allergy to contrast or allergic reactions in the anamnesis).

The diagnostic algorithm given below was used for CT:

– planned native axial CT series bas
– ed on the scanned area of interest;
– obtaining contrasting axial CT series of the same zone;
– comparative evaluation of the “amplification” effect;
– creating multiplanar and 3D reconstructions;
– interpretation of the received tomograms.

The standard MRI algorithm during the examination was carried out in the following order:

– native TSE, T1 and T2 weighted sequences; also FLAIR, native MRI examination in axial, sagittal and coronary projections of the zone of interest;

– repeated T1 weighted axial series after intravenous administration of contrast agent of the same zone. 10.0 Gadovist was used inside the vein as a contrast agent;

– after preliminary interpretation of the obtained tomograms, additional DWI, STIR sequences and 3D “time of flight” (TOF) an-

giographic modes of the neck vessels were also included. The thickness of the tomograms was selected depending on the technical conditions in the range of 2-7 mm;

– comparative evaluation of the "amplification" effect. "Gain effect", was studied by the medical workstation "Phillips".

After USG, priority was given to MRI, primarily due to the absence of radiation damage.

Fine needle aspiration biopsy under ultrasound control. A FNAB was performed in patients with solid and cystic changes larger than 1 cm in the salivary glands. The puncture was performed with a syringe with a volume of 10-20 ml. with a thin needle (outer diameter 0.6-0.7 mm).

Cytological and pathomorphological examination. Cytological and pathomorphological studies were carried out in the Department of Pathological anatomy of the Azerbaijan Medical University (AMU – Head of the department E. Babaev). 275 materials obtained from 64 patients were examined (FNAB – 9 patients – 30 glasses, postoperative material – 55 patients – 245 pieces).

When staining cytological materials, the following methods were used: hematoxylin, hematoxylin-eosin, Papanicolaou.

Mathematical and statistical processing of the material. Statistical analysis was carried out using the methods of variational and discriminant analysis [8; 9; 10].

Variational analysis. The groups were lined up in the specified variation series and for each variation series the values of the mean (M), the standard deviation (σ), the standard error (m), the minimum (min), the maximum (max) were calculated.

Discriminant analysis. When analyzing quality indicators in

[8] Лебедев А. Понятный самоучитель Excel 2013 / – Санкт Петербург: Питер, – 2014, – 128 с.

[9] Петри А., Сэбин К. Наглядная статистика в медицине / пер. с англ. В.П.Леонова – Москва: ГЭОТАР-МЕД, – 2009, – 168 с.

[10] Arbuckle, J. IBM SPSS Amos 21: User's Guide İBM Corp., Amos Development Corporation: [Electronic resource] / ID: 933135, – 2012, – p. 680. URL: http://www.twirpx.com/file/933135/

cross-tables, the average error of the number of fractions and percentages are calculated. For statistical processing of the obtained numerical indicators, the Pearson's χ^2-criterion (Pearson Chi-Square) was used. In the results close to the threshold values of statistical honesty ($R \approx 0.05$), the statistical honesty of the difference was additionally assessed according to the criteria of Continuity Correction, Lickelyhood Ratio, Exact Test Fisher and Linear-by-Linear Association. The decision to accept or refuse hypothesis "0" was made based on the results of most criteria. All calculations were carried out in the EXCEL – 2013 spreadsheet and the SPSS – 20 batch program, the results were summarized in tables and diagrams.

RESEARCH RESULTS AND THEIR DISCUSSION

In the inflammatory subgroup of the non-neoplastic group, the size, contours of the parotid glands, the state of the intraglandular and central ducts, vascular architectonics and the type of vascularization, as well as the state of lymph nodes in the parotid gland were evaluated.

The main DDx signs in acute processes were an increase in the size of the glands (n=13; 92.9%; 6 cases in the parotid glands, 7 cases in the submandibular gland), a decrease in echogenicity of the parenchyma (92.9%) and an increase in vascularization (92.9%) ($P<0.05$). A patient with mumps (n=1) had numerous anechoic inclusions of small size in a heterogeneous stroma of the gland.

The main DDx signs in chronic sialadenitis are the presence of multiple hypo- and anechoic cystic inclusions of small size against the background of heterogenecity of the gland structure (n=23; 100.0%; 19 cases in the submandibular gland, 6 cases in the parotid gland), mixed echogenicity (n=22; 95.7%), hypovascularization (n=14; 60.9%) and uneven contours (N=20; 86.9%) ($p< 0.05$). With obstructive sialadenitis (acute, chronic), along with the above described characteristic DDx signs, a stone in the enlarged ducts of the gland is detected.

Chronic sclerosing sialadenitis was found in the submandibular gland in 13% of patients (n=3). Specific DDx signs include increased blood supply of a radial nature; heterogeneous stroma, contour changes

and an increase in size (described in the literature as a picture of a "cirrhotic liver"). The mentioned image may resemble a tumor.

Typical clinical complaints in patients with abscesses were local pain and swelling in the projection of the salivary glands (4 cases in the submandibular gland, 4 cases in the parotid gland). The main complex radiological signs were smooth (100.0%) and clear (62.5%) contours; inhomogeneous structure with liquid content (100.0%) and the presence of a thickened capsule ($P<0.05$). Infiltration into surrounding tissues was detected in 75.0% and reactive changes in lymph nodes in 87.5% of cases. During ultrasound examination, the abscess was hypoechoic in 62.5% of cases, CD revealed a vascular capsule in 87.5% of cases. Using native CT, a hypodensity (n=3) of 75.0% was obtained. Contrast CT showed a capsule gain of 100.0% (n=4) ($p<0.05$). In MRI examination T1-hypointensive, T2-hyperintensive center were obtained (Figure1) (100.0%); post-contrast images T1 – active capsular enhancement. MR STIR and MR FLAIR modes showed 100.0% hyperintensivity; MR DWI mode gives 50.0% hyperintensivity and 50.0% hypointensivity ($P<0.05$).

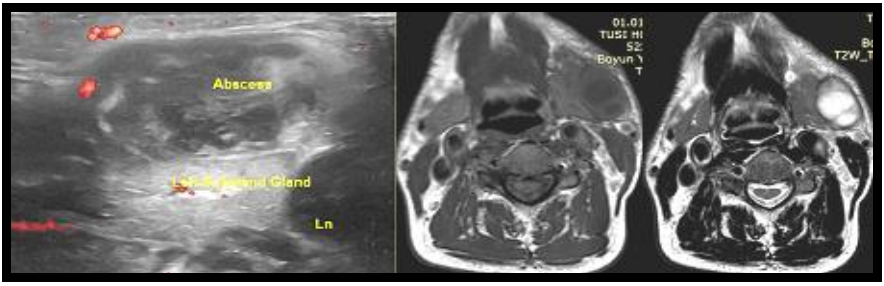


Figure 1. V. I., male, 53 years old, a/c 0012. Heterogeneous, mixed echogenic, nonvascular fuzzy and smooth-contoured abscess in the left submandibular gland in USG with ED. Infiltration into the surrounding gland tissues and reactive lymphadenopathy. Pathological foci of cystic type, T1 hypo-, T2 hyperintensive (abscess), in which unevenly located thick capsules and septa inside the abscess are observed on MRI.

Evaluation of intraparenchymatous lymph nodes of the parotid gland in patients with lymphadenitis was carried out on the basis of cri-

teria of size, shape, contours, structure, echogenicity and vascularization. B-mode USG DDx signs include an increase in the size of intraparenchymatous lymph nodes due to hypoechoic thickening of the cortical part, clear and smooth contours, homogeneous structure and increased blood supply (n=5; 83.3%) ($p<0.05$). Lymphadenitis in 16.7% was assessed as a chronic process (n=1, tuberculosis), signs of a tumor in this case – heterogeneous structure; mixed echogenicity; fuzzy, uneven contours and poor blood supply. The patient underwent FNAB under USG control and tuberculosis lymphadenitis was confirmed.

In patients who had sialoliths of different sizes (sialolithiasis), the main USG sign was a hyperechoic structure, with an acoustic shadow in the back against the background of an enlarged duct (100.0%).

In complex radiological examination (USG, CT and MRI) of salivary gland cysts (5 cases in the parotid glands, 4 cases in the submandibular gland), smooth and clear contours (100.0%), homogeneous structure (66.7%) and a thin capsule (88.9%) were observed on characteristic diagnostic images. Retention cysts were described in B-mode as homogeneous and anechoic (55.6%), with a characteristic sign “BGR” (blue-green-red) on elastography. Since the diagnosis of mixed cysts (epidermoid cysts and mucocele) was difficult with USG, therefore CT and MRI were also performed (n=5; 55.6%) and a more accurate description of the capsule, internal structure and partitions was noted compared to USG. Although on CT cysts are hypodensive, MRI gives a more accurate result when differentiating. Cysts are hyperintensive in MR T1 mode, hypointensive on T2, hyperintensive in MR STIR and FLAIR modes (100.0%). In the MR DWI mode, 40.0% of cases gave hypointensive (retention cysts), 60.0% (epidermoid cysts) hyperintensive (60.0%) signals ($p<0.05$).

In the other processes subgroup, 1 patient had a focus of postoperative fibrosis in the projection of the submandibular gland, the other had bilateral large parotid glands on the background of hypersalivation. B-mode, Doppler and strain sonoelastography performed on these patients were 100.0% effective in assessing the process.

B-mode detected a hypoechoic, hypovascular fibrous focus. Strain sonoelastography showed that this lesion is a mixture of green

and red colors (soft tissue), and the lesion was assessed as fibrous tissue. In another patient, the parameters of the echostructure of the parotid glands were within the normal range, and the result was assessed as an idiopathic case. Dynamic observation (USG) revealed no pathological changes in both patients.

When comparing USG results between inflammatory and non-inflammatory processes in the salivary glands in the I main group (n=70), sensitivity was 92.2 - 96.0%, specificity 78.9 - 88.3% and accuracy 88.6 - 92.4%. Sensitivity was 95.0%, specificity-87.0% and accuracy-91.0% according to the results obtained in the diagnosis of inflammatory processes of the salivary glands using the methods of B-mode, CD and ED.

When comparing the results of CT (n=13) and MRI (n=7) performed among the subgroups of group I, CT showed sensitivity of 100.0%, specificity of 60.0 - 81.9%, accuracy of 84.6 - 94.6%; while MRI gave results of 100% (sensitivity, specificity and accuracy).

After general radiological studies, the results obtained in I group patients were partially confirmed by the results of cytological examination (1.4% of FNAB under USG control) and became a prerequisite for surgical intervention in 61.4% of patients. The results of subsequent histological studies (48.6%) confirmed the results of complex radiological studies in all observations (USG (n=70) 88.6%, CT (n=13) 77.0% and MRI (n=7) 100.0%).

In patients with Warthin's tumor in the parotid glands (n=4; men), the average age index was 55.0±6.9, and clinically, long-term tobacco use was noted in their anamnesis. Warthin's tumor was localized in the caudal part of the parotid gland in 75% of cases during observations. Complex specific DDx signs include clear and smooth contours (n=4; 100.0%), oval shape (n=3; 75.0%), the presence of numerous small and medium cystic inclusions in its structure (n=3; 75.0%) and the presence of increased blood supply ($p<0.05$).

On USG, the tumor pattern was observed of mixed echogenicity in 75.0% of cases due to small anechoic cystic areas on a hypoechoic stroma background. With native CT (n=3), the tumor tissue showed heterogenecity (66.7%), hypodensic imaging, active and uneven am-

plification (100.0%) with contrast CT. During the MRI scan (n=1), the tumor structure gave a hypo-isointensive on T1 images, iso - hyperintensive on T2 images, an active and uneven gain pattern on post-contrast T1. Hyperintensive signals were received in MR STIR and FLAIR modes.

The average age index in patients with PA was calculated at 43.3±4.4 and women (58.8%) prevailed over men (41.2%). Thus, CT in 8 patients (47.1%), MRI in 5 patients (29.4%) and FNAB in 4 patients (23.5%) were carried out under the control of the USG.

Specific complex radiological signs of PA in the parenchyma of the salivary glands include lobulation of the shape (n=15; 88.2%), heterogenecity (n=12; 70.6%) of the structure (due to fibrosis, calcifications and cystic inclusions) and solitarity (n=17; 100.0%). PA was localized in 94.1% (n=16) of cases in the parotid gland and in 5.9% (n=1) of cases in the submandibular gland.

Specific signs of PA are the presence of acoustic enhancement behind the tumor (n=17; 100.0%), hypoechoic image (n=12; 70.6%), hypovascular peripheral blood supply (94.1%) (Figure 2). In the native CT study (n=8), a hypodens image was obtained (100.0%); in the MRI study (n=5), signals of 60.0% low intensity and 40.0% low-medium intensity were obtained in T1 images, 20.0% high intensity and 80.0% iso-hyperintensivity in T2 images. With contrast CT and T1 MRI images, PA, weakly and unevenly accumulate contrast medium ($P<0.05$).

While it is impossible to monitor blood supply when using a 12-15 MHz linear probe with CD on smaller tumors (from 15 to 25 mm), it was found that there is a very weak blood supply along the periphery of tumors when using a 5-8 MHz probe. When we used a 12-15 MHz linear probe with CD on tumors with sizes from 27 to 45 mm, we observed that the peripheral parts of the tumors have poor blood supply.

In our study, one of the main specific signs of PA was the sign (100.0%) of an identical hyperintensive signal with cerebrospinal fluid (CSF) in the T2 FAT SAT MRI mode, and this pathognomonic sign was very effective in the DDx of PA in other benign and predominantly malignant tumors ($P<0.05$).

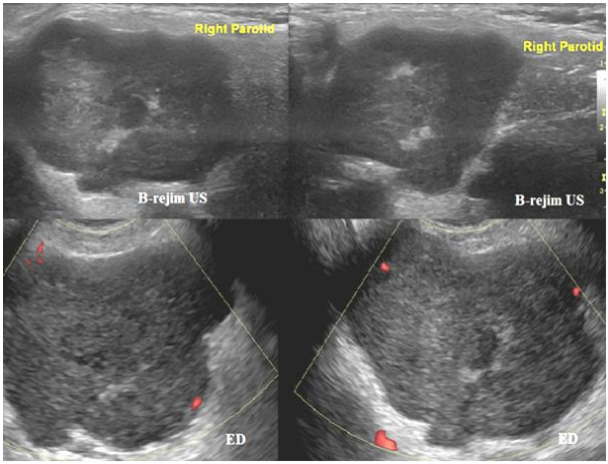


Figure 2. Patient G. B., female, 31 y.o., a/c 0321. PA covering the superficial and deep lobes of the parotid gland in the upper images (longitudinal and horizontal), B-mode images. In the central part, areas of fibrosis and necrosis are revealed. In the lower images, weak vascularization is observed along the periphery of the tumor with longitudinal and horizontal images on the ED.

The clinical complaints of a patient with lipoma (n=1) belonging to the group of benign neoplasms were painless and mild swelling in the left posterior mandibular region.

The USG revealed smooth and clear contours; the marginal areas are thinner relative to the middle part; the presence of linear-striped exopositive inclusions parallel to each other in the hypoechoic structure; avascularity in CD. With the help of sonoelastography, an image was obtained in the form of a mixture of red and green colors. The above signs are considered specific for the DDx of lipoma ($P<0.05$).

In the course of the study, we performed radiological differentiation between primary and secondary (metastases, relapses, etc.) processes in the malignant subgroup of the neoplastic group, as well as retrospectively and data from the literature. In our observations, mucoepidermoid carcinoma occurs in 25.0% (n=2; 50.0% in the parotid glands, 50.0% in the small salivary glands), adenocarcinoma in

25.0% (n=2; 50.0% in the submandibular gland, 50.0% in the small salivary glands), adenocystic carcinoma in 37.5% (n=3; 66.7% in the submandibular gland, 33.3% of patients in the small salivary glands) and 12.5% (N=1) of patients with lymphoma were evaluated initially. With the exception of lymphoma, there were no characteristic diagnostic signs among the noted malignant tumors. Of the patients included in the subgroup of malignant neoplasms, the average age index was calculated at 62.5±5 years, with 37.5% men (n=3) and 58.6% women (n=5.2).

The characteristic pathological description obtained in 7 patients (87.5%) was revealed in the form of hypervascular and heterogeneous solid tumors with irregular and fuzzy contours, developing from salivary glands, invaded and infiltrated into surrounding tissues, with a chaotic vascular pattern inside. There were pathological changes in the surrounding lymph nodes. These symptoms made it possible to make an accurate diagnosis of the malignancy of the process ($P<0.05$).

USG (n=8), CT (n=8) and MRI (n=5) images of malignant processes revealed fibrosis and calcifications inside tumors with a heterogeneous structure, as well as areas of necrosis in single or several units of different sizes. In 62.5% of cases, the tumor turned out to be hypoechoic (n=5), in 37.5% of cases of mixed echogenicity (n=3). In this subgroup, the characteristic DDx signs were the absence of acoustic amplification in the posterior part of large-sized tumors (n=6 - 75.0%), the presence of a weak acoustic shadow in small tumors (n=2-25.0%); erasure or serration of the edges of the tumor (87.5%); chaotic nature and hypervascularity of vascularization (87.5%).

On native CT, the parenchyma of malignant tumors had hypodens (n=6) in 75.0% of cases and hypo-isodens (n=2) images in 25.0% of cases. After contrasting, an active equal “gain” was observed in 37.5% of these patients, an uneven “gain” – in 62.5%. Images of 60.0% hypointensity, 40.0% hypo-isointensity were obtained in T1 weighted MRI mode, 20.0% iso-hypointensity, 80.0% hypointensity were obtained in T2 weighted MRI mode.

A weak signal in the T2 weighted MRI mode is considered a specific DDx sign of malignant tumors (Figure 3) ($p<0.05$). In the postcontrast T1 weighted MRI mode, 40.0% of uniform amplification of the pathological focus, 60.0% of uneven “amplification” were detected.

Based on our observations, the sensitivity of the results (USG, n = 30 - 100.0%) in determining the localization, nature, attitude to surrounding tissues and other features of neoplastic processes was 87.5 - 99.2%, specificity 90.9 - 97.0%, accuracy 90.0-95.5%. Thus, the sensitivity of ultrasound imaging of malignant tumors of the salivary glands was 97.5%, specificity 71.4%, accuracy 97.9%.

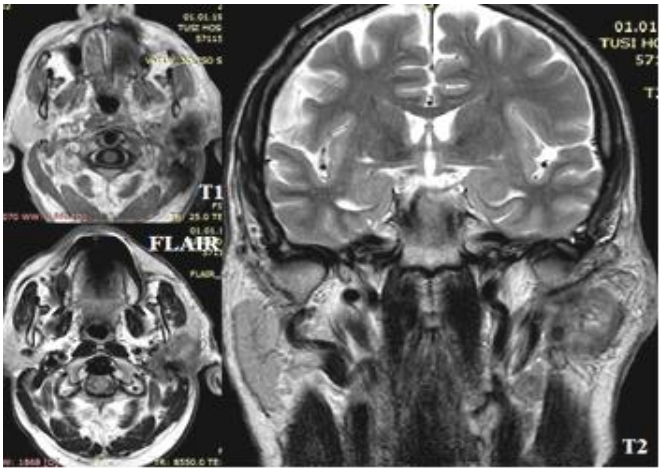


Figure 3. Patient M. R., male, 66 years old, a/c 0223. In the T2 weighted MRI mode, the isointensity of the tumor tissue is detected, inside the areas with T2-hyperintensive signal. On T1 weighted MRI has a hypointensive signal. There is an invasion of the surrounding fat tissue.

The informative value of USG in patients with a malignant subgroup was determined on the basis of metastatically altered lymph nodes and compared with postoperative indicators. Against the background of the inflammatory process in the salivary gland tissue in 2 patients who had metastatic changes and difficulties in diagnosing reactive lymph nodes, false negative results were noted.

Of the 42 patients who received the data, 38 had true positive results, and 6 had true negative results (including metastases to intraparenchymatous and regional lymph nodes). In our study, in 12.5% of cases with metastatic process of lymph nodes, unilateral lesion of the parotid and submandibular glands was also characteristic.

The exact outlines of the contours were 44.4%, the rounded shape was 100%, and the homogeneous structure of the lymph node was noted in 33.3% of cases. Thus, in our study, when determining the metastatic process in the lymph nodes, the sensitivity to tumors was 95%, specificity 100%, accuracy 95.6%, positive predicted result 100%, negative predicted result 75%.

In group II , the nature of intra - tumor blood supply to various tumors of the salivary glands was determined in all patients. According to the number of vessels detected inside, tumors of the salivary glands are divided into 3 groups: avascular, hypovascular (1-4 vessels), hypervascular (5 or more vessels). By nature, they are divided into groups with hypo - and hypervascular tumors, with venous and arteriovenous blood flow.

Thus, hypervascular blood flow was characteristic of malignant tumors (52.3%), and hypovascular blood flow was characteristic of many malignant tumors (90.2%). Arteriovenous (34.5%) in primary malignant tumors, venous blood supply (8.3% and 2.2%) in metastatic and lymphoproliferative tumors were determined. Arteriovenous blood supply was obtained in the blood supply of many benign tumors (33.3%). While in most malignant tumors, the shape of the arrangement of intratumor blood vessels was chaotic; in malignant tumors, non-chaotic (linearity) was determined.

A quantitative analysis of spectral parameters (maximum systolic velocity and pulsation index), which are of the greatest importance for the characteristics of the intratumoral vascular form in tumors with arteriovenous type of blood supply, was carried out. In malignant tumors, these indicators: the maximum systolic velocity of 20.0 cm/sec and the pulsation index were greater than 1.0 (in malignant tumors, these indicators were lower). This feature is considered an important differential diagnostic feature ($R<0.001$ and $R<0.05$).

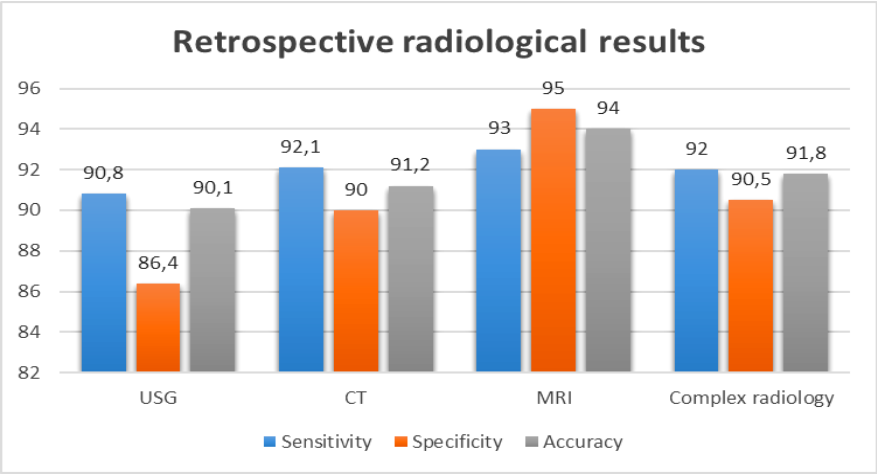
When comparing the data of US elastography and B-mode USG in the second group, elastography established 100.0% indistinctness of tumor contours, proved the presence of tumor infiltration into surrounding tissues, which is one of the important signs of differential diagnosis of malignant tumors. According to our observations, the accuracy of mechanical elastography was 100.0%, accuracy 88.9%, accuracy 94.7%. In B-mode, specificity compared to mechanical elastography was 66.7%, sensitivity 93.8%, accuracy 89.5%. In terms of accuracy and specificity, the results of mechanical elastography exceeded the data of the B-mode ($P < 0.05$).

When comparing between subgroups of malignant and benign tumors of group II USG (n=30) results were: sensitivity 87.5 - 99.2%, specificity 90.9 - 97.0%, accuracy 90.0 - 95.5%; CT (n= 19) results: sensitivity 100.0%, specificity 90.9 - 99.6%, accuracy 94.7 - 99.8%; MRI (n=11) results: sensitivity 100.0%, specificity 83.3 - 98.5%, accuracy 90.9 - 99.6%. Malignant tumors by specific differential diagnostic signs make it possible to differentiate them from malignant tumors and make an accurate diagnosis ($R < 0.05$).

Based on the data obtained, USG results compared between neoplastic and non-neoplastic groups (n=100) – sensitivity was 90.0 - 95.5%, specificity - 88.6 - 92.4%, accuracy-89.0-92.1%. USG results in determining the metastatic process in the lymph nodes: sensitivity 95%, specificity 100%, accuracy 95.6%, positive predicted result 100%, negative predicted result 75%. When comparing CT (n=32) and MRI (n=18) results among the main groups, CT sensitivity is 89.5-96.5%, specificity 76.9-88.6%, accuracy 84.4-90.8%; MRI sensitivity was 90.9 - 99.6%, specificity 85.7 - 98.9%, accuracy 88.9 - 96.3%.

In the framework of group II of the benign subgroup, a comparison was made between pleomorphic adenoma and Worthin's tumor and obtained by USG results (n=21) sensitivity 88.2 - 96.0%, specificity 75.0 - 96.7%, accuracy 85.7 - 93.3%; CT results (n=11) sensitivity 87.5 - 99.2%, specificity 66.7 - 93.9%, accuracy 81.8 - 93.4%; sensitivity according to MRI results (N=7) was 83.3 - 98.5%, specificity 100.0%, accuracy 85.7 - 98.9%.

Sensitivity, specificity and accuracy were calculated in the study based on the results of radiological and pathological diagnostics of retrospective patients. According to the results of USG (n=85), it was shown that sensitivity is 90.8%, specificity is 86.4%, accuracy is 90.1%; according to CT results (n=21) sensitivity is 92.1%, specificity is 90.0%, accuracy is 91.2%; according to MRI results (n=15) sensitivity is 93.0%, specificity-95.0% and accuracy-94.0%. According to the complex radiological results, the sensitivity was 92.0%, the specificity was 90.5%, and the accuracy was 91.8% (Fig. 4).



Fiqure 4. Retrospective radiological results.

Based on the results of prospective patients in 100 patients with salivary gland pathologies, USG sensitivity and specificity were 95.5% and 92.4%, respectively; in 33 patients, CT sensitivity and specificity were 96.5% and 88.6%; in 18 patients, MRI sensitivity and specificity were 99.6% and 98.9%. The total cost (accuracy) of the test was 92.1% for USG; 90.8% for CT; 96.3% for MRI. Based on complex radiological results, sensitivity was 97.2%, specificity 93.3%, and accuracy 93.1% (Fig. 5).

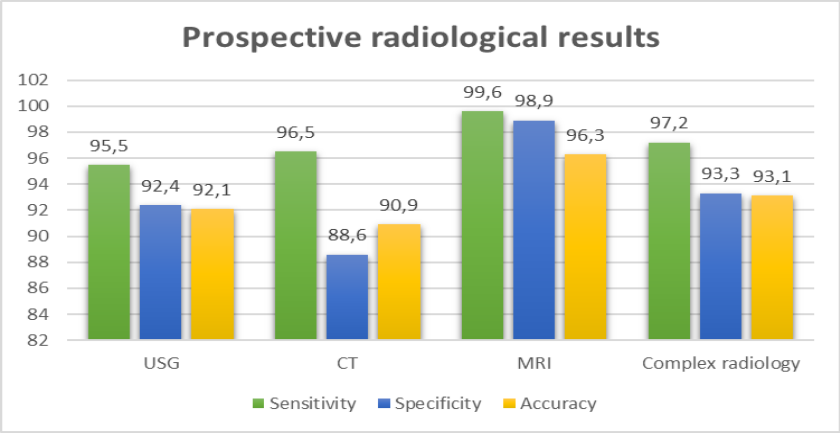


Figure 5. Prospective radiological results.

To confirm the data of USG, CT and MRI studies, cytological analysis was performed after fine needle aspiration biopsy under USG control in 26.7% of group II patients. Based on the results of complex radiological studies (10% of which were cytologically confirmed), surgical intervention was performed in 83.3% of patients. After the operation, the results of the next histological examination confirmed the data of a comprehensive radiological examination (USG (n=30) 90.0%, CT (n=19) 100.0% and MRI (n=11) 100.0%) in all observations.

The clinical picture of non-neoplastic and neoplastic pathology of the salivary glands is similar in many cases, so that during our observation of the leading symptom, the presence of a local swelling in the projection of the salivary glands (unilateral or bilateral) was assumed, and on the basis of this symptom, the course of further decisions was built. Other symptoms were obtained from the history of the disease, clinical complaints and laboratory results. The algorithm developed by us, based on clinical and radiological DDx signs of non-neoplastic and neoplastic pathology of the salivary glands, is shown in Figure 4 and has been confirmed on the basis of statistical data.

Unlike simple cysts, CT and MRI are more informative than USG in the diagnosis of cysts that have undergone secondary changes and carry lipid tissue. The mobility of the cyst contents is observed

only on USG. Using various imaging modes (T1, T2, FLAIR, STIR, DWI) on MRI, it is possible to obtain accurate information about the nature of the pathological substrate inside the cyst, so the DWI MRI mode is indispensable for the nosological diagnosis of epidermoid cysts. When optimizing the differential diagnosis of neoplastic and non-neoplastic processes, it is recommended to use the presented algorithm (Fig.6).

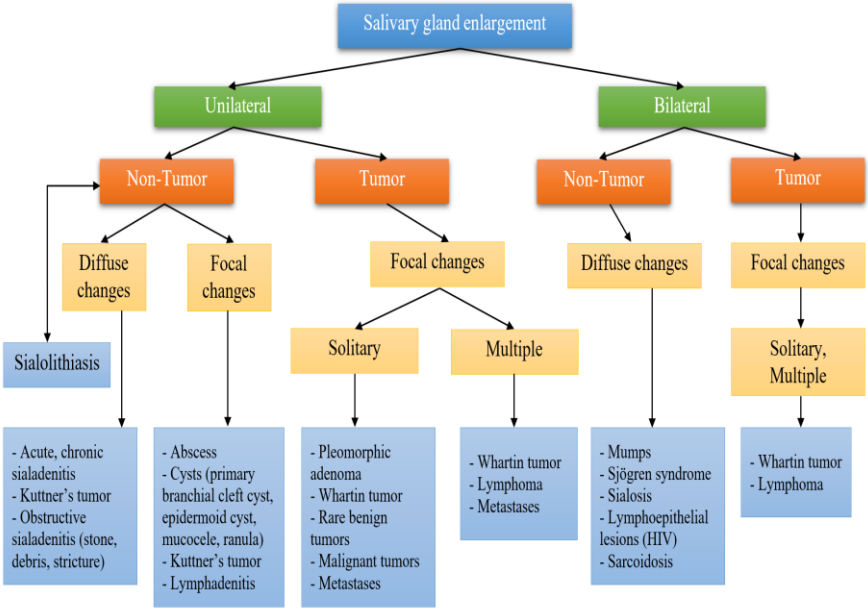


Figure 6. Diagnostic algorithm.

MRI is more sensitive to determine intraparenchymal edema and morphological changes, the connection of the tumor with the facial nerve and the boundaries of the process. While T1 weighted MRI accurately shows the contours and spread of the tumor, T2 weighted MRI gives more accurate information about the internal architectonics.

USG sensitivity in salivary gland pathologies is more than 95.0%, specificity is less than 93.0% since it is not possible to clearly

distinguish between neoplastic and non-neoplastic pathologies in all cases.

Sensitivity to contrast CT studies in salivary gland pathologies is more than 96.0%, specificity is less than 90%. At the same time, the sensitivity of MRI exceeds 99.0%, and the specificity is 98.0%.

When using complex radiological diagnostics, the diagnostic error did not exceed 2.0%. The data from the complex application of USG, CT and MRI methods and subsequent histological verification showed an accuracy of 98.3%.

RESULTS

1) The exact nature and pathognomonic signs of the process in nonneoplastic and neoplastic pathologies of the salivary glands were determined in ultrasound (n=100) 95.5%, CT (N=33) 96.3% and MRI (n=18) 99-100,0% [1, 10].
2) Comparative analysis of the results of retrospective and prospective observation revealed that: mobility of cystic fluid and tumor vascularization is USG competence; morphological character of tissue structure is most accurate in MRI; CT is the most accurate method for calcifications; CT and MRI methods in differentiation of “simple” and complicated cysts are more informative than USG; in the determination of PA, MR T2 FAT SAT mode is basic; in the determination of Kuttner’s tumor, the use of every 3 methods complements one; for early postoperative control, USG should be used first [2, 3, 4, 5, 7, 9, 12].
3) Based on retrospective analysis, USG sensitivity and specificity were 95.5% and 92.4%; CT sensitivity and specificity 96.5% and 88.6%; MRI sensitivity and specificity 99.6% and 98.9%. The total value (accuracy) of the test was 92.1% for USG; 90.8% for CT; 96.3% for MRI. Based on complex radiological results, sensitivity 97.2%, specificity 93.3% and accuracy 93.1% were obtained [6].
4) In the prognostic differentiation of complex radiology diagnostic examinations, post-operative pathohistological examination verification with the obtained results was 98.3% identical [8, 10].

5) As a result of the dissertation work, the developed and used diagnostic algorithm has a high degree of accuracy in DDx (error 1 – 2%). The developed diagnostic algorithm raises DDx and can be considered satisfactory for the choice or correction of the treatment method [10, 11].

PRACTICAL RECOMMENDATIONS

1. USG should be selected as a primary method of examination in DDx of salivary glands pathologies, and complex USG modes should be used. In case of bone infiltration and spread to deep structures in large-sized tumors, evaluation of deep lymph nodes, visualization of USG is impossible (parapharyngeal area, pharyngeal mucosal area, retropharyngeal area, etc.) in cases, CT and MRI should be applied. In some cases, repeated USG after CT and MRI methods allows to realize additional ideas.
2. To optimize the DDx of nonneoplastic and neoplastic processes of the salivary glands, it is recommended to use the presented algorithm and diagnostic schemes.

List of published scientific works on the topic of dissertation

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11. Sadigov, E.M. Radiological differential diagnosis of neoplastic processes of the salivary glands // Collection of scientific-practical conference dedicated to the birthday of A.Aliyev: – Baku, – 2020, – p. 176-177.
12. Sadigov, E.M. The role of strain elastography in pathologies of the salivary glands // Azerbaijan Onkology Journal, – 2022, №1, – p. 57-61.

List of abbreviations

HRUS – high resolution ultrasonography
CT – computer tomography
MRI – magnetic resonance imaging
DDx – differential diagnostics
DWI – diffusion weighted imaging
T2 W FAT SAT – fat saturated
PA – pleomorphic adenoma
FNAB – fine needle aspiration biopsy
FLAİR – fluid-attenuated inversion recovery
STİR – short tau inversion recovery
CD – color Doppler
ED – energetic Doppler

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