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US in preoperative evaluation of parotid glans neoplasms

Badanie USG w diagnostyce przedoperacyjnej nowotworów ślinianek przyusznych

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
F Literature Search
G Funds Collection

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ABSTRACT

Salivary gland neoplasms account for only 3% of all tumors of the head and neck area, but as they represent a wide variety of histological types, they are a big diagnostic challenge. The cornerstone of salivary gland neoplasm treatment, both for the benign and malignant lesions, is surgery. The main goal of the therapy is not only to achieve complete surgical tumor resection, but also to preserve adjacent structures (facial nerve, parapharyngeal space structures). Ultrasonography is an examination commonly used in the preoperative diagnosis of the lesions localized within salivary glands. Very often it is the only diagnostic imaging method used in these cases.

The aim of the study was to establish diagnostic value of US examination and its parameters for the assessment of parotid gland tumors.

A prospective study was performed on a group of 51 patients with parotid gland neoplasms, who over a period of 3 years underwent surgery in Otolaryngology and Laryngological Oncology Department with Craniomaxillofacial Surgery Department of Central Clinical Hospital of Ministry of Defence in Warsaw. All the included patients underwent US examination in the preoperative period. The parameters selected for the assessment were: ill-defined tumor margins, tumor vascularity and the presence of enlarged regional lymph nodes. The results of imaging examination were compared to the final diagnosis based on pathological examination of the surgical specimen. The parameters of the US examination such as sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) for the evaluation of parotid gland tumors were established based on the examination results.

An analysis was performed and ill-defined parotid tumor margins turned out to be a US parameter with higher diagnostic value for differentiating benign and malignant lesions than increased tumor vascularity. The presence of enlarged regional lymph nodes with blurred echostructure on the US examination had little value for differentiating lesions. The sensitivity of the US examination in terms of detecting malignant parotid gland neoplasms increased significantly in the setting of simultaneous assessment of several parameters.

KEYWORDS: parotid glands, neoplasm, ultrasonography.

STRESZCZENIE

Nowotwory gruczołów ślinowych stanowią jedynie 3% nowotworów rejonu głowy i szyi występujących u człowieka, ale ze względu na bogactwo form histologicznych, w jakich występują, stanowią duże wyzwanie diagnostyczne. Podstawową metodą leczenia zarówno nowotworów łagodnych, jak i złośliwych ślinianek, jest leczenie operacyjne. Zasadniczym celem tego leczenia jest nie tylko uzyskanie radykalności, ale również zachowanie struktur sąsiadujących (nerw twarzowy, struktury przestrzeni przygardłowej). Ultrasonografia jest badaniem powszechnie wykorzystywanym w przedoperacyjnej ocenie zmian zlokalizowanych w obrębie gruczołów ślinowych, niejednokrotnie jedynym badaniem obrazowym, jakie jest wykonywane.

Celem pracy było określenie wartości diagnostycznej badania ultrasonograficznego oraz jego poszczególnych parametrów w ocenie charakteru nowotworów lokalizujących się w śliniankach przyusznych.

Badanie było badaniem prospektywnym na grupie 51 osób z nowotworem ślinianki przyusznej, które leczone były operacyjnie na przestrzeni 3 lat w Klinice Otolaryngologii i Onkologii Laryngologicznej z Klinicznym Oddziałem Chirurgii Czaszkowo-Szczękowo-Twarzowej Centralnego Szpitala Klinicznego MON w Warszawie. Wszyscy zakwalifikowani chorzy w okresie przedoperacyjnym poddani zostali badaniu USG. Parametrami ocenianymi było zatarcie granic guza, jego unaczynienie oraz obecność powiększonych regionalnych węzłów chłonnych. Uzyskane wyniki badania obrazowego, porównane były z ostatecznym rozpoznaniem postawionym w oparciu o wynik badania histopatologicznego materiału operacyjnego. Na tej podstawie oceniona została czułość, swoistość, dokładność, wartość predykcyjna dodatnia i ujemna badania USG w ocenie charakteru guzów ślinianki przyusznej.

Na podstawie przeprowadzonej analizy, zatarcie zarysów guza ślinianki w badaniu USG okazało się objawem o większej wartości diagnostycznej w odróżnianiu zmian łagodnych i złośliwych, niż wzmożone unaczynienie nowotworu. Obecność powiększonych, o zatartej echostrukturze regionalnych węzłów chłonnych było parametrem badania USG o małym znaczeniu w odróżnianiu charakteru zmian. Czułość badania USG w wykrywaniu nowotworów złośliwych ślinianek przyusznych znacznie wzrosła, kiedy ocenianych było kilka parametrów jednocześnie.

SŁOWA KLUCZOWE: ślinianki przyuszne, nowotwór, ultrasonografia.

INTRODUCTION

Salivary gland tumors represent 3% [10] of head and neck neoplasms. Tumors of parotid glands account for 80% of them. There is a useful 'eighty rule' in characterizing parotid gland tumors: 80% of neoplasms are located in the superficial lobe, 80% of them are benign, and 80% of them are pleomorphic adenomas [18]. Malignant neoplasms of salivary glands are rare, accounting for only 0.5% of human malignant tumors. However, they represent 5% of head and neck malignant neoplasms [7]. Most of them arise in small salivary glands.

Salivary gland neoplasms represent a wide variety of both morphology and growth pattern, and thus, the features of benign and malignant tumors are very often the same. The variety of types of salivary gland neoplasms and their rarity makes them one of the most difficult diagnostic areas in both pathology and radiology.

The cornerstone of parotid gland tumors treatment is surgery. Its main goal is not only to achieve complete surgical tumor resection, but also to preserve adjacent structures (facial nerve, parapharyngeal space structures). That is why diagnostic imaging in the preoperative period is so important [7]. Ultrasonography is widely recognized as a basic examination in the assessment of neck neoplasms, including salivary gland tumors. It allows to differentiate intraparenchymal and extraglandular lesions and to assess tumor morphology as well as the presence of lesions within local lymph nodes. High accessibility, low examination cost and small burden for the patient are the main advantages of ultrasonography [1,19]. Its limitations are as follows: difficult assessment of lesions located in the deep lobe of the parotid gland and in the deeper structures (such as parapharyngeal space, base of the cranium), [3,9] of possible involvement of the facial nerve or retropharyngeal lymph nodes, where metastases of parotid gland carcinoma can be present. There are also doubts concerning the usefulness of the examination for the assessment of parotid gland neoplasms [14]. The choice of certain parameters in US examination in diagnosing parotid gland neoplasms, which would allow a preliminary differentiation between benign and malignant lesions, is a very important goal to achieve.

The features of malignant lesions on US examination are: ill-defined tumor margins, inhomogenous echostructure, increased vascularity and pathological local lymph nodes [14,16]. However, some of the researchers claim that the tumor appearance is largely dependent on its size. Irrespective of the histological type, smaller tumors are described in US reports as more homogenous and well-defined, whereas larger ones are ill-defined and their structure is heterogenous, which is the effect of the presence of necrotic and hemorrhagic foci [2,14,19]. Low-grade malignant parotid gland neoplasms can also present as well-defined tumors with smooth outlines. This happens due to their growth pattern, leading to the formation of so called pseudocapsule of the tumor. As a result, they can be confused with common, encapsulated benign parotid gland tumors [5,8]. Pathological, increased vascularity is possible to reveal in US examination and it is one of the useful parameters in tumor assessment. However, existing research showed that it also does not allow a reliable detection of benign and malignant tumors, as features such as increased vascularity, mainly of marginal type, can also be present in benign lesions, such as pleomorphic adenomas [2,6]. There are also research studies

stating that this feature is more often found in the malignant lesions. For the reasons outlined above, tumor assessment based on US examination with simultaneous lack of apparent malignant features (facial nerve paresis, lymph node metastases, infiltration of adjacent tissues) is often difficult. Some researchers state that no diagnostic imaging method can provide information that would allow to assess whether the tumor is benign or malignant [6].

The study was conducted in order to assess diagnostic value of US examination parameters, such as ill-defined tumor margins, pathological, increased vascularity of the lesion and the presence of enlarged regional lymph nodes for the parotid gland tumor assessment.

MATERIAL AND METHODS

A prospective study was conducted. A total number of 51 patients with parotid gland tumors were included. All of them were qualified to surgery in Otolaryngology and Laryngological Oncology Department with Craniomaxillofacial Surgery Department of Central Clinical Hospital of Military Institute of Medicine in Warsaw. Patients who previously had surgery due to parotid gland tumor, pregnant women and underage patients, were excluded from the study. The study group comprised 20 women and 31 men aged 22 to 79, with the largest group of patients aged 51 to 80 years. Based on pathological examination of the surgical specimen, benign parotid gland neoplasms were diagnosed in 43 cases, and malignant - in 8 cases.

All the patients were informed about study character and signed a written informed consent. The study was accepted by Ethics Comitee of Central Clinical Hospital of Military Institute of Medicine.

All the included patients underwent in the preoperative period an interview and a physical examination, as well as an ultrasonographic examination of the salivary glands and neck.

The US examination was performed using Logic P7 ultrasound scanner with a linear probe transducer (7-12 MHz) and a standard protocol, by a radiologist from Ultrasonography Imaging Laboratory of Medical Radiology Department in Central Clinical Hospital of Military Institute of Medicine. The following tumor features were assessed: 1) tumor margins, 2) degree of vascularity compared to adjacent tissues, and 3) presence of enlarged regional lymph nodes (> 10 mm in the short axis). In all the cases the results of diagnostic imaging were compared to the final diagnosis based on pathological examination of the surgical specimen. It was assumed in keeping with research that ill-defined tumor margins and its pathological, increased vascularity suggest the presence of a malignant lesion. The analysis of obtained results was performed and parameters such as sensitivity, specificity, positive and negative predictive value were assessed separately. Similar analysis was performed for all three parameters combined.

RESULTS

In the study group consisting of 51 patients an analysis was performed, assessing the relationship between the degree of tumor vascularity and whether the lesion was benign or malignant. The results of the US examination are shown in the table.

Tab. 1. Parotid gland tumor vascularity on the US examination in the study group.

Tumor type based on the pathological examination	Tumor vascularity on the US examination		
	none	increased	marginal
Pleomorphic adenoma	14	1	3
Adenolymphoma	8	3	4
Other benign neoplasms	9	1	
Polymorphous low-grade adenocarcinoma	2		
Infiltrating partially keratinizing planoepithelial ca G-2 Ex pleomorphic adenoma	1		
Partially necrotic high-grade mucoepidermoid carcinoma	1		
Acinic cell carcinoma			1
Adenocarcinoma			1
Adenoid cystic carcinoma	1		
Invasive necrotic adenocarcinoma G2, NOS			1

In 3 out of 8 patients with malignant neoplasm of the parotid gland based on pathological examination, tumor vascularity was increased. Increased vascularity was also observed in 7 out of 43 diagnosed benign tumors. With respect to the obtained results, a diagnostic value of the degree of tumor vascularity on US examination was determined, taking into account benign and malignant lesions. The results of the assessment of sensitivity, specificity, accuracy, positive and negative predictive value for this parameter based on the performed examination are shown in the table.

Table 2. Diagnostic value of the degree of parotid gland tumor vascularity on the US examination

	rate	%
sensitivity	0.30	30.00
specificity	0.837	83.72
positive predictive value (PPV)	0.077	7.69
negative predictive value (NPV)	0.878	87.80
accuracy	0.765	76.47

The analysis revealed that the evaluation of the parotid gland tumor based on the degree of its vascularity on the US examination is a test characterized by high specificity and negative predictive value of 83.72% and 87.80% respectively. The accuracy of the examination was fairly high (76.47%), but its sensitivity (30.00%) and positive predictive value (7.69%) were very low.

The relationship between whether the tumor was benign or malignant and its margins on the US examination was evaluated in the same manner. Pooled data from the whole study group is shown in the table.

Table 3. Parotid gland tumor margins on the US examination in the study group.

Tumor type based on the pathological examination	**Tumor margins on the US examination**	
	ill-defined	well-defined
Pleomorphic adenoma		
Adenolymphoma		
Other benign neoplasms		
Polymorphous low-grade adenocarcinoma		
Infiltrating partially keratinizing planoepithelial ca G-2 ex pleomorphic adenoma		
Partially necrotic high-grade mucoepidermoid carcinoma		
Acinic cell carcinoma		
Adenocarcinoma		
Adenoid cystic carcinoma		
Invasive necrotic adenocarcinoma G2, NOS		

Based on the results, a diagnostic value of ill-defined lesion margins on the US examination for tumor assessment was determined. The results of the analysis are shown in the table.

Table 4. Diagnostic value of parotid gland tumor margins on the US examination.

	rate	%
sensitivity	0.375	37.50
specificity	0.860	86.05
positive predictive value (PPV)	0.333	33.33
negative predictive value (NPV)	0.881	88.10
accuracy	0.784	78.431

The results show high specificity (86.05%) and negative predictive value (88.10%) of the examination, and fairly high accuracy (78.431%). However, sensitivity and positive predictive value of the examination were low in the study group (37.50% and 33.33%, respectively).

In the summary of the statistical report of the US examination an analysis was performed, assessing diagnostic value of this diagnostic imaging method for differentiating between benign and malignant parotid gland tumors. Three tumor US features were evaluated in the study: margins, vascularity and the presence of enlarged regional lymph nodes. The results of the analysis are shown in the table.

Tab. 5. The evaluation of the US examination usefulness for differentiating benign and malignant parotid gland tumors.

	rate	%
sensitivity	0.50	50.00
specificity	0.674	67.44
positive predictive value (PPV)	0.222	22.22
negative predictive value (NPV)	0.879	87.88
accuracy	0.647	64.71

The analysis of the study results revealed that US examination is characterized by the highest negative predictive value (87.88%) and slightly lower specificity (67.44%) and accuracy (64.71%) for differentiating benign and malignant lesions of the parotid glands. Sensitivity was determined at 50.00% and positive predictive value was the lowest of all the parameters (22.22%).

DISCUSSION

In the preoperative diagnosis of salivary gland neoplasms, various types of examinations are used, such as fine-needle aspiration (FNA), US, MRI, and CT [12]. Due to high accessibility and limited contraindications, FNA and US are the most commonly performed examinations. The main goal of preoperative diagnosis is not only the evaluation of tumor local stage, but most of all the assessment whether it is benign or malignant. The choice of US examination parameters determining if the

lesion is benign or malignant is still questionable. This stems from the fact that both benign and malignant tumor can often look similar on US examination [11]. The features of malignant lesions on US examination are mostly: ill-defined tumor margins, increased vascularity, inhomogenous echostructure, and enlarged regional lymph nodes [13,15].

One of the parameters evaluated in the analysis was the degree of parotid gland tumor vascularity. Taking into account radiological classification of tumors by their vascularity (none, marginal, increased), malignant tumors were described as lesions with increased vascularity. The verification of obtained results was performed in respect of the final diagnosis based on the pathological examination of the surgical specimen. A total number of 7 cases (16%) of benign neoplasms and 4 cases (50%) of malignant lesions were included in the group. Based on the results, a diagnostic value of the degree of parotid gland tumor vascularity on the US examination for differentiation between benign and malignant lesions was determined. It was found that tumor assessment based on the degree of its vascularity is characterized by high specificity and negative predictive value (83.72% and 87.80%, respectively) and slightly lower, but comparable accuracy (76.47%). Sensitivity and positive predictive value were much lower (30.00% and 7.69%, respectively). The assessment of the degree of parotid gland tumor vascularity cannot clearly prove it is benign or malignant. However, a trend was observed that malignant lesions tend to have increased vascularity. The US examination in this case allows mainly to confirm the presence of a benign lesion (high specificity and NPV), whereas the evaluation of malignant lesions is less reliable (low sensitivity and PPV). Research findings confirm these results. Similarly, Białek et al and Gritzmann et al in their studies evaluated diagnostic value of the degree of salivary gland tumor vascularity for its assessment. The conlusion from their studies was that this feature does not allow to clearly diagnose a tumor as benign or malignant, as increased vascularity, mainly of marginal type, can also appear in benign lesions, such as pleomorphic adenomas. However, the authors point out that in spite of the lack of a strict relationship between the degree of salivary gland tumor vascularity and whether it is benign or not, malignant lesions tend to have increased vascularity. Kovačević et al emphasized as well that increased vascularity of a parotid gland tumor on US examination increased the probability of the presence of a malignant lesion. They also pointed out that the lack of flow in the central part of the lesion cannot exclude malignancy [8].

In the next analysis a relationship was assessed between tumor margins on the US examination and the final pathological diagnosis. The lesions were divided by their US appearance into well-defined and ill-defined ones. It was assumed in keeping with common knowledge that ill-defined tumor margins are a sign that can suggest its malignant potential. Among benign neoplasms, 6 (13.9%) were described as lesions with ill-defined margins and therefore qualified as suspicious. In the malignant tumor group, there were 2 such lesions (25%). In order to assess diagnostic value of this parameter in the parotid gland lesions, a statistical dependence was checked between tumor margins on the US examination and whether it was benign or malignant based on the pathological examination.

No relationship was found between the size of the tumor and the presence of well-defined or ill-defined margins. In the presented material there were both cases of small malignant tumors (acinic cell carcinoma - size of 15 mm), which appeared in the US examination as lesions with ill-defined margins, suggesting malignant potential, as well as big benign lesions (pleomorphic adenoma - size of 45 mm), which appeared as well-defined and therefore not suspicious lesions. This is a different observation than the one by Thoeny, Białek or Harish et al, who noticed a strong relationship between the presence of ill-defined tumor margins and the size, no matter if it is a benign or a malignant lesion [2,5,8,19].

Based on the results, a diagnostic value of tumor margin assessment with US examination for differentiating benign and malignant lesions was determined. The highest rated parameter was specificity (86.05%) and negative predictive value (88.10%), whereas accuracy was established at 78.431%. Sensitivity (37.50%) and positive predictive value (33.33%) were the lowest parameters. Therefore, it can be concluded that the evaluation of tumor margins on the US examination is - such as its vascularity - a parameter more useful in the setting of benign lesions. It is not sensitive for detecting malignant tumors, although it seems that ill-defined margins are more significant than vascularity. Kovačević et al presented similar findings - in their study, sensitivity was also lower than specificity (17% and 63%, respectively). Also Gritzmann et al pointed out that there were often well-defined malignant lesions present on the US examination [5,11].

The aim of the preoperative diagnosis of parotid gland neoplasms on the US examination is not only to assess tumor parameters, but also regional lymph nodes. In keeping with scientific reports, one of the signs supporting the diagnosis of parotid gland malignancy is the presence of enlarged regional lymph nodes, often with blurred echostructure [1,4]. The enlarged regional lymph nodes (≥ 10 mm in the transverse dimension) on the US examination were observed in 13 patients with the final diagnosis of benign neoplasm (30%). In the patients with parotid gland malignancy, the US examination revealed the presence of enlarged regional lymph nodes in 4 out of 8 cases (50%). The presence of lymph

nodes with heterogenous echostructure was observed in 1 out of 8 (12.5%) cases of malignant parotid gland tumors and in 1 out of 43 (2.3%) cases of benign lesions. In the summary of the statistical report of the US examination an analysis was performed, assessing the usefulness of this diagnostic imaging method for differentiating benign and malignant parotid gland tumors based on all three discussed parameters. The results of the analysis revealed that ultrasonography in the assessment of parotid gland tumors is characterized by the highest negative predictive value, which was 87.88% in the study group. Specificity (67.44%) and accuracy (64.71%) were slightly lower. It should be emphasized that through the assessment of all the parameters mentioned above, US examination had significantly higher sensitivity (50.00%) in detecting malignant lesions than through separate assessments of all the signs. However, positive predictive value of the study was still low, established at 22.22%. A diagnostic value of US examination for diagnosing parotid gland tumors was significantly higher in the study by Badea et al with sensitivity of 95% [1]. The authors stated that this diagnostic imaging method can detect and assess lesions even as small as 5 mm. The main drawback of the study is said to be its low specificity. There are also reports that assign to the US examination a higher positive predictive value than the one obtained in this study. Among them is the study by de Ru et al, in which PPV was established at 67%. The study was based on a group of patients with parotid gland tumors, treated between 1999 and 2003 [17].

To summarize the analysis, we can say that:

- Ill-defined tumor margins on the US examination is a parameter of higher diagnostic value for differentiating benign and malignant lesions than increased tumor vascularity.
- The presence of enlarged regional lymph nodes is a parameter of low usefulness for differentiating benign and malignant lesions.
- The sensitivity of US examination in detecting malignant neoplasms of parotid glands significantly increases in the setting of simultaneous evaluation of several parameters. It allows to decrease probability of obtaining false negative results, which are frequent in case of using only one study parameter.

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