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B-mode and color Doppler ultrasound features of salivary gland tumors

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Abstract

Aim. The goal of the study was to assess the role of 2D and Doppler ultrasonography in the diagnosis of salivary gland tumors.

Material and methods. The study group consisted of 57 patients presenting with salivary gland enlargement, as the main symptom. B-mode and color Doppler sonography (CDS) examinations were performed on each patient. The imaging features were compared with the pathology report, after surgical excision of the lesions. 51 salivary gland tumors were confirmed in 50 patients, the rest presenting other types of lesions, which created a pseudo-tumoral aspect on ultrasound.

Results. In this study group, 33 tumors were benign and 18 malignant, each category with several subtypes. Most benign tumors (87.8%) had sharp borders, but 39.9% of malignant tumors also presented sharp borders. Lobulation of the tumor was seen most frequently in the case of pleomorphic adenomas. The internal structure of the tumor was not a relevant indicator of malignancy. The CDS examination revealed that 60.6% of benign and 55.5% of malignant tumors were poorly vascularized; the well-vascularized category included all Warthin tumors, 15% of pleomorphic adenomas and 38.8% of malignant tumors.

Conclusion. Although ultrasound is very sensitive in identifying tumors of the salivary glands, there are no definite features to ensure a differential diagnosis between benign and malignant tumors.

Key words: ultrasound, Doppler, salivary glands

Introduction

Tumors of the salivary glands are not common, and represent only 2-4 % of all head and neck malignancies. Most of them (80%) are located in the parotid gland, 14% in the submandibular gland and the rest of them in the sublingual glands and the minor salivary glands [1]. The smaller the gland, the higher the proportion of malignant tumors: the rate of malignancy in the parotid is 20-25%; it increases to 40-50% in the submandibular gland and to 51-80% in the sublingual and minor salivary glands [2].

Ultrasound is the first imaging technique used in many countries to evaluate the nature of a suspicious mass of the salivary glands. Most segments of the salivary glands can

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be thoroughly evaluated with ultrasound. However, for the deep segment of the parotid gland, as well as for tumors arising in the minor salivary glands, ultrasound may not be enough. In such cases MRI is used, as it provides very precise information on the position, extension and nature of the mass [3]. In some centers MRI is the first imaging technique in salivary gland masses, but ultrasound is more widely available, therefore our intention was to define some bidimensional and color Doppler features of benign and malignant tumors.

Patients and methods

In order to determine which features are most helpful in the differential diagnosis between benign and malignant tumors, a retrospective study was performed on 57 patients who presented with enlargement of a salivary gland region and the clinical suspicion of a salivary gland tumor, over a period of 4 years (2002-2006). In this group, 21 of the patients were male, and 36 female. The ages of the patients ranged between 11 and 76, with a mean age of 44.2 years. Coincidentally, the age limits in both the female and male groups were the same with the overall extreme ages: 11 and 76. However, the mean ages differed: they were 39.3 years for females and 52.4 for males. US examination was performed on several machines, all provided with linear small footprint (3.5-4 cm) transducers operating at 7.5-10 MHz).

The patients included in the study group were those with an ultrasound diagnosis of a salivary gland tumor. All those with other types of ultrasound diagnoses (such as chronic or acute inflammation) were excluded.

The B-mode ultrasound examination included coronal and axial sections of the enlarged salivary gland, as well as the evaluation of the other major salivary glands and of the cervical lymph nodes. All salivary gland masses were described in terms of location, size, shape, borders, echogenity, structure and relations to important elements of the cervical region, such as the carotid arteries and jugular veins. The shape, borders and structure were noted for all of the tumors. Two categories were considered for borders: sharp and blurred. Similarly, depending on their structure, tumors were divided into homogeneous and non-homogeneous. In the non-homogeneous group, the presence of areas of necrosis or calcification was taken into consideration.

The grey-scale examination was followed by the color Doppler sonography (CDS) examination. The lowest wall filter value and highest color sensitivity available on the machine were used to depict intratumoral blood flow. Pulsed Doppler sonography (PDS) was not used constantly in this group of patients and therefore the information provided by it in some cases was not taken into consideration.

Depending on their vascularization, tumors were divided into three groups: those with absent vascularization (in which cases no vessels could be identified with CDS), poorly vascularized tumors and well vascularized tumors. The poorly vascularized category included all the tumors where only one or two vessels could be identified, either in the periphery or in the centre of the mass. Tumors with more than two vessels were considered well vascularized.

All patients underwent surgery, and the ultrasound report was correlated with the histopathologic one. Pathology confirmed 51 tumors in 50 of these patients, 49 located in the parotid gland and 2 in the submandibular. One patient presented two pleomorphic adenomas of the parotid gland. In this group of patients there were no tumors in the sublingual or minor salivary glands. Out of the 51 tumors, 33 (64.7%) were benign, and 18 (35.3%) were malignant.

The diagnoses for the seven patients for whom pathology did not confirm a tumor were, respectively: actinomycosis, Sjögren syndrome, multiple bacterial abscesses, ruptured salivary duct cysts with inflammatory reaction and enlarged lymph nodes.

Information about the distribution of tumors in our group is presented in table 1.

Table 1. The distribution of benign and malignant tumors, according to histological type.

Benign	**33**	64.70%
Parotid	33	
Submandibular	0	
Pleomorphic adenoma	20	60.60%
Warthin tumor	5	15.15%
Lymphoepithelial cyst	2	6.06%
Myoepithelioma	2	6.06%
Hemangioma	2	6.06%
Schwannoma	1	3.03%
Dermoid cyst	1	3.03%
Malignant	**18**	35.30%
Parotid	16	
Submandibular	2	
Adenoid cystic carcinoma	5	27.80%
Squamous cell carcinoma	3	16.60%
Adenocarcinoma	3	16.60%
Acinic cell carcinoma	3	16.60%
Mucoepidermoid carcinoma	2	11.10%
Salivary duct carcinoma	1	5.50%
Undifferentiated carcinoma	1	5.50%

Results

The ultrasound characteristics for benign and malignant tumors are presented in tables 2 and 3.

Because most of the tumors in this group were pleomorphic adenomas (20 cases), the ultrasound features observed for these are presented in a separate table 2 – table 4.

Most benign tumors (87.8%) and 39.9% of malignant tumors had sharp borders. Inside this group, we also looked for the presence of lobulations in the tumor contour. This aspect was not seen in any of the malignant tumors; 10 benign tumors presented lobulations and 8 of these were pleomorphic adenomas (40% of all pleomorphic adenomas).

The proportions of homogenous and non-homogeneous tumors were almost equal in both groups (tables 2 and 3).

Most of the tumors in both groups presented poor vascularization (60.6% of benign and 55.5% of malignant tumors). Nevertheless, an important proportion – 30.3% - of benign tumors were well vascularized; of the 10 well vascularized benign tumors, only 3 were pleomorphic adenomas; the other 7 benign tumors were Warthin tumors and myoepitheliomas.

It is important to note that all of the five Warthin tumors in our group had sharp borders and were well vascularized. One of them was homogeneous and the other four were not. Three of them presented cystic areas.

Table 2. Ultrasound features of benign tumors

Borders		
Sharp	29	87.80%
Blurred	4	12.20%
Structure		
Homogeneous	17	51.50%
Non-homogeneous	16	48.50%
Calcifications	1	
Cystic areas	6	
Vascularization		
Absent	3	9.09%
Poorly vascularized	20	60.60%
Well vascularized	10	30.30%

Table 3. Ultrasound features of malignant tumors

Borders		
Sharp	7	39.90%
Blurred	11	60.10%
Structure		
Homogeneous	9	50%
Non-homogeneous	9	50%
Calcifications	5	
Cystic areas	3	
Vascularization		
Absent	1	5.50%
Poorly vascularized	10	55.50%
Well vascularized	7	38.80%

Table 4. Ultrasound features of pleomorphic adenoma

Borders		
Sharp	18	90%
Blurred	2	10%
Structure		
Homogeneous	13	65%
Non-homogeneous	7	35%
Calcifications	1	
Cystic areas	1	
Vascularization		
Absent	1	5%
Poorly vascularized	16	80%
Well vascularized	3	15%

Discussion

Although, as previously stated, salivary gland tumors are by no means common, they form a very diverse group. Among them, the most common is the pleomorphic adenoma (benign mixed tumor). It represents about 80% of parotid tumors and 55-65% of all salivary gland tumors [4]. The second most common benign tumor is the Warthin tumor (cystadenolymphoma), which is located almost exclusively in the parotid gland. Other benign tumors are monomorphic adenoma, oncocytoma, myoepithelioma, as well as tumors which do not arise from glandular elements, such as hemangioma, lymphangioma and nerve sheath tumors.

Among malignant tumors, mucoepidermoid carcinoma is the most frequent, followed by adenoid cystic carcinoma, and other less common types, such as squamous cell carcinoma, adenocarcinoma, acinic cell carcinoma and salivary duct carcinoma [5].

Certain features of salivary gland tumors, such as the sharp border, reduced vascularization and several structural patterns are established ultrasound criteria for benign tumors [6]. It is important to know how much one may rely on ultrasound and also when other imaging techniques are indicated. In many centers, particularly in the USA, MRI is almost the only technique used in cases where a neoplastic enlargement of a salivary gland is suspected. CT is used mostly to detect salivary stones [7].

As MRI is not always readily available, ultrasound is frequently the first imaging technique used when salivary gland tumors are suspected. Ultrasound is able to establish the exact source of the enlargement, to appreciate the shape, borders and pattern of a tumor and to evaluate the vascularization of the mass [7]. All of the information about the tumor is to be correlated with the clinical information and with a proper evaluation of the cervical lymph nodes.

This study's objective was to see just how reliable ultrasound is, when the features of the primary tumor alone are taken into account. In this group of patients, 87.8% of benign tumors had sharp borders, more than malignant tumors (39.9%). However, if this criterion alone is considered, it becomes obvious that almost 40% of malignant tumors would be diagnosed as benign. When referring to borders, as mentioned above, special attention was paid to a lobulated, or polycyclic, pattern. No malignant tumors presented with this type of borders and 8 out of 10 benign tumors with this aspect were pleomorphic adenomas (fig.1) Therefore, this feature of a tumor border may be considered a potential indicator of a benign tumor, most likely a pleomorphic adenoma.

Out of the 4 benign tumors with blurred borders, two were hemangiomas. They both presented a heterogeneous structure; one of them contained large pseudo-cystic spaces and the other had areas of calcification. This aspect is consistent with the commonly accepted pattern for hemangiomas [5]. Contrary to literature, they did not appear to be hypervascularized, but this may also be due to the fact that both patients who presented them were adults and hemangiomas usually appear to be strongly vascularized in children [5, 6].

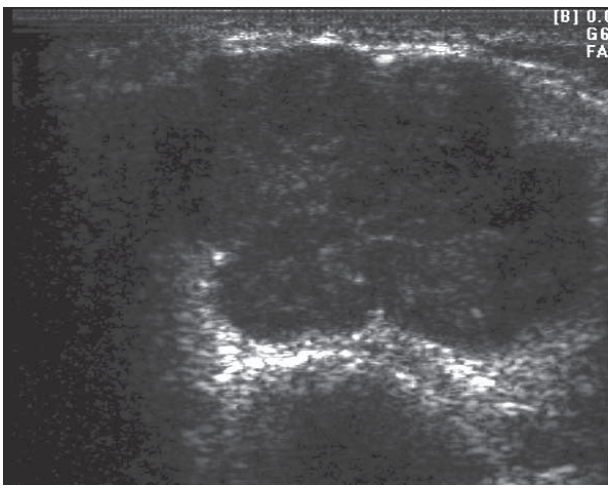

Fig.1. Grey-scale US: pleomorphic adenoma, presenting sharp borders and a polycyclic shape.

In this group of patients, 90% of pleomorphic adenomas and all Warthin tumors had sharp borders (fig.2 and fig.3). We found by comparison with other studies that this is a relevant feature for Warthin tumors, especially when correlated with other findings, which will be detailed further on.

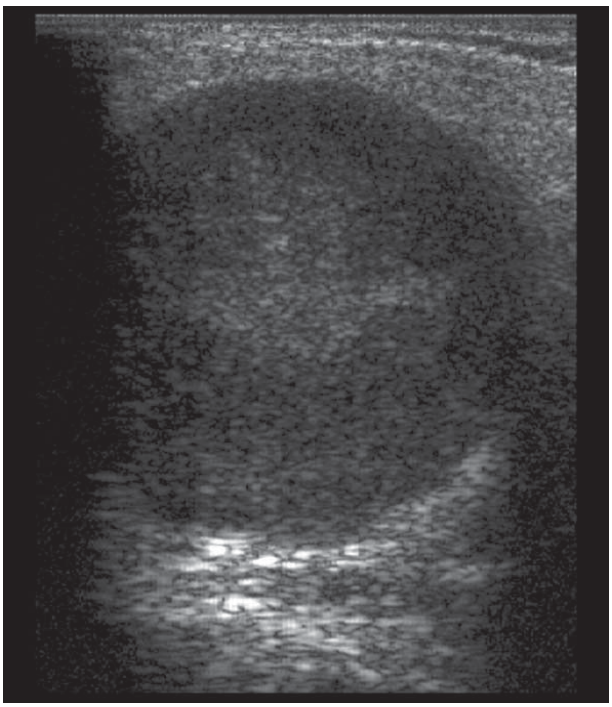

Fig.2. Grey-scale US: pleomorphic adenoma with sharp, regular borders.

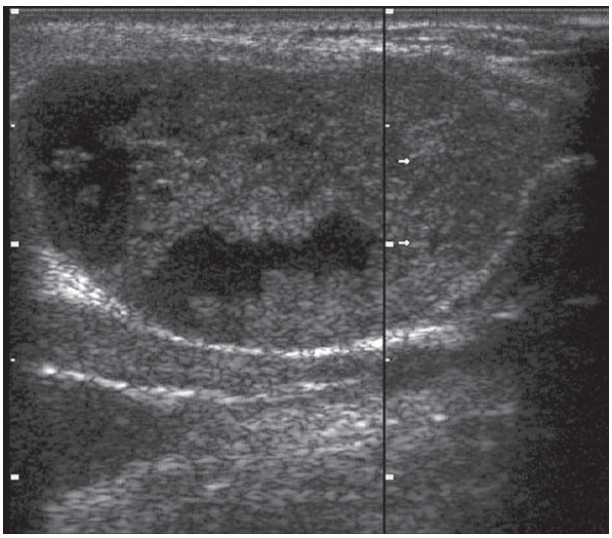

Fig.3. Grey-scale US: Warthin tumor with sharp borders and non-homogeneous structure, with multiple cystic areas.

As presented above, 60.1% of malignant tumors had blurred borders; 39.9% had sharp borders, but none of them were lobulated. There did not appear to be a certain histologic type with which this appearance of distinct borders might correlate. Out of the 7 malignant tumors with sharp borders, 2 were acinic cell carcinomas, 1 was an adenocarcinoma, 1 undifferentiated carcinoma and 1 salivary duct carcinoma. These findings did not correlate with those of other studies, which state that low-grade mucoepidermoid carcinoma (fig.4) is the one most commonly misinterpreted as benign, particularly because of its distinct borders and regular shape [2]. One possible explanation is that the falsely benign appearance is found mostly in mucoepidermoid carcinomas smaller than 2 cm [6], whereas the smallest tumor of this type in this group measured 2.5 cm in its shortest diameter.

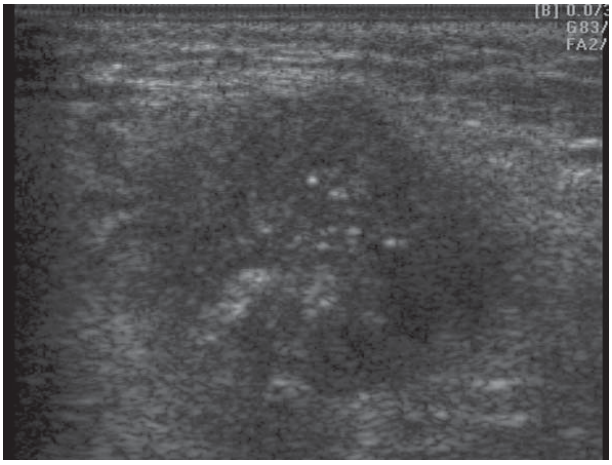

Fig.4. Grey-scale US: mucoepidermoid carcinoma – blurred borders, non-homogeneous structure, with multiple small calcifications.

According to the results, the echostructure of the tumor is not an indicator of malignancy. Whether a tumor is homogeneous or not, on the whole, gives no indication of its nature, since around 50% of both benign and malignant tumors were inhomogeneous.

The presence of calcifications or cystic-like areas was taken into consideration. Although other studies have found that calcifications appear most frequently in pleomorphic adenomas of all salivary gland tumors [5, 6], we found calcifications more frequently in malignant tumors (5, as compared to 1 in the case of benign tumors). Other studies state that calcifications are not an overall characteristic of pleomorphic adenomas, but only appear in those which have evolved over a long period of time (several years) [8].

In this study, pleomorphic adenomas were mostly homogeneous (65%) or presented a non-specific heterogeneous pattern, with no calcifications or fluid areas (25%). Only one of the pleomorphic adenomas presented calcifications. Some researchers [4, 9] have found a larger proportion of heterogeneous pleomorphic adenomas, but they were admittedly exceptions, since most studies confirm that pleomorphic adenomas are generally homogeneous [5].

Cystic areas were found in almost the same proportion in benign and malignant tumors (18.8% - benign and 16.6% - malignant). However, of the 6 benign tumors where cystic areas were found, only one was a pleomorphic adenoma. Three of them were Warthin tumors, one was a hemangioma and one a facial nerve schwannoma. This is consistent with literature, since most studies agree on the fact that Warthin tumors contain cystic areas more frequently than pleomorphic adenomas [5, 6]. Also, as in this case, it is not uncommon for tumors of neural origin to display cystic areas [5].

An equal number of malignant tumors were homogeneous and non-homogeneous (table 3). Of the 18 malignant tumors, 5 (27%) presented calcifications; there was not a particular histological type in which calcifications were more common. Also, three tumors presented cystic areas, which is not uncommon in malignant tumors, but is not a criterion for differential diagnosis [5] (fig.5-7).

The information regarding the vascularization of the tumors, which can be found in tables 2-4, reveals the fact that there were no significant differences between the percentages of tumors in each group. Most benign tumors presented poor vascularization, but a large proportion - 55.5% - of malignant tumors were also poorly vascularized. Only

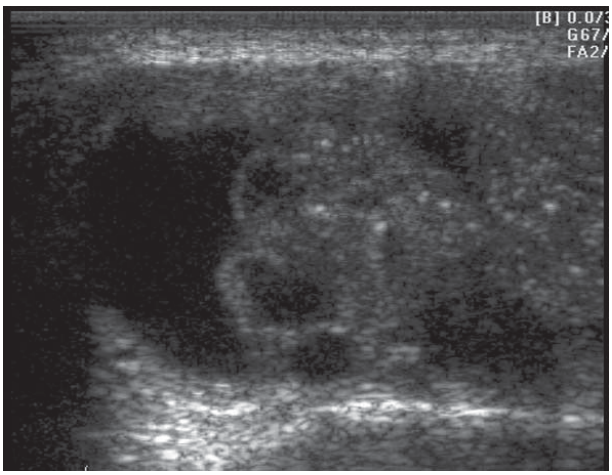

Fig.5. Grey-scale US: salivary duct carcinoma – non-homogeneous structure, with areas of calcification and necrosis.

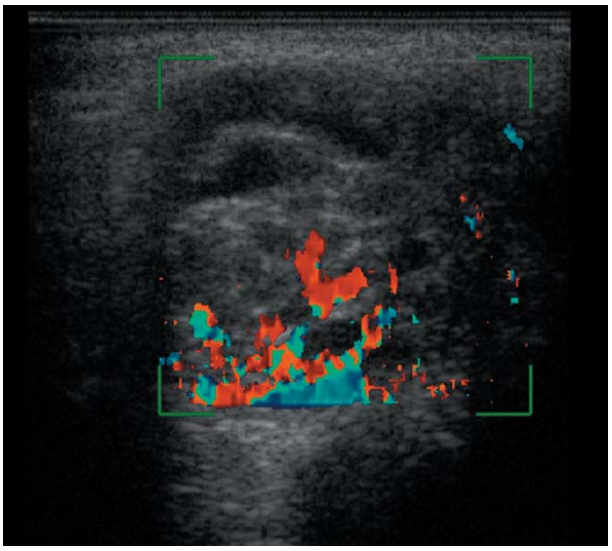

Fig.6. CDS: salivary duct carcinoma (same as fig. 5) – rich vascularization in the parenchymatous areas of the tumor.

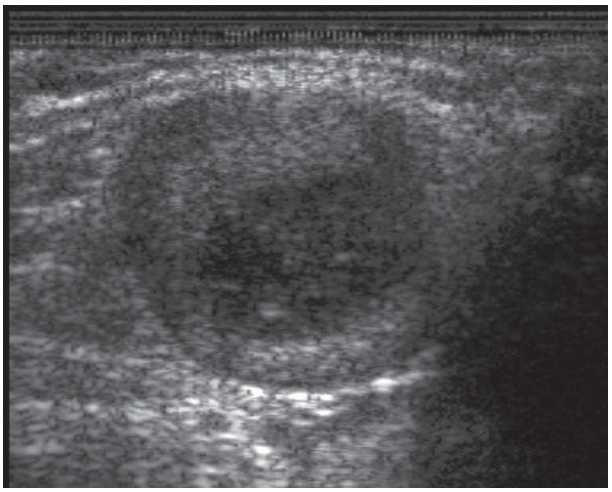

Fig.7. Grey-scale US: schwannoma in the parotid gland – sharp borders, non-homogeneous structure.

38.8% of malignant tumors could be included in the group of well-vascularized tumors; vascularization could not be demonstrated in only one malignant tumor, as opposed to 3 benign tumors. Ultimately, all of these numbers confirm the fact that vessel density, as appreciated by CDS, is not a reliable factor in the differential diagnosis between benign and malignant tumors. This is consistent with other studies, which also state that CDS is not enough, but that the measurement of peak flow velocity and, particularly, that of the resistance index (RI) and pulsatility index (PI) could be more useful [9-11].

Of the 10 benign tumors which were well vascularized, three were pleomorphic adenomas (fig.8); most of the pleomorphic adenomas in our group belonged to the category of poorly-vascularized tumors (fig.9) and in one case no vessels could be detected using CDS. All

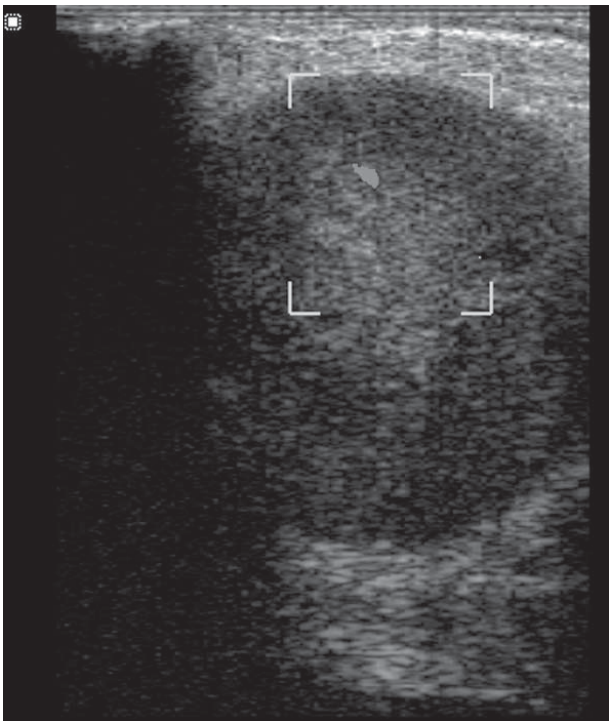

Fig.8. CDS: well vascularized pleomorphic adenoma.

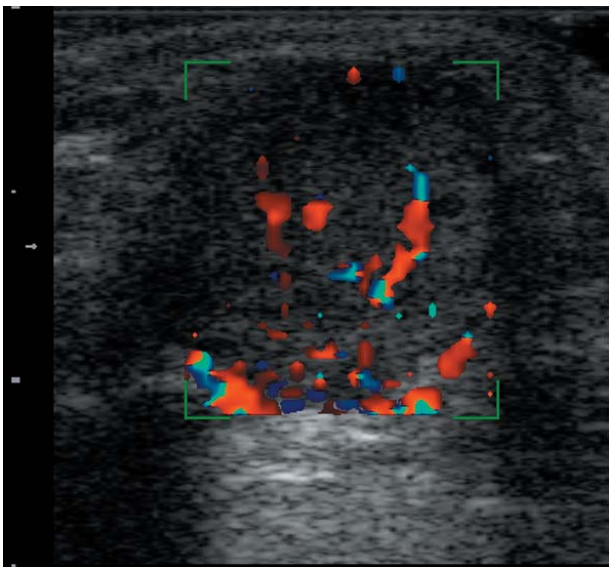

Fig.9. CDS: reduced vascularization in pleomorphic adenoma (same as fig.2).

five Warthin tumors encountered in this group of patients were very well vascularized (fig.10) and displayed a different pattern of vascularization than that found in pleomorphic adenoma: the vessels in Warthin tumors had an intratumoral disposition, whereas most pleomorphic adenomas showed the classic peripheral pattern, which has already been described as "basket-like" [8, 10]. The well-vascularized tumor group also included both of the myoepitheliomas in our study.

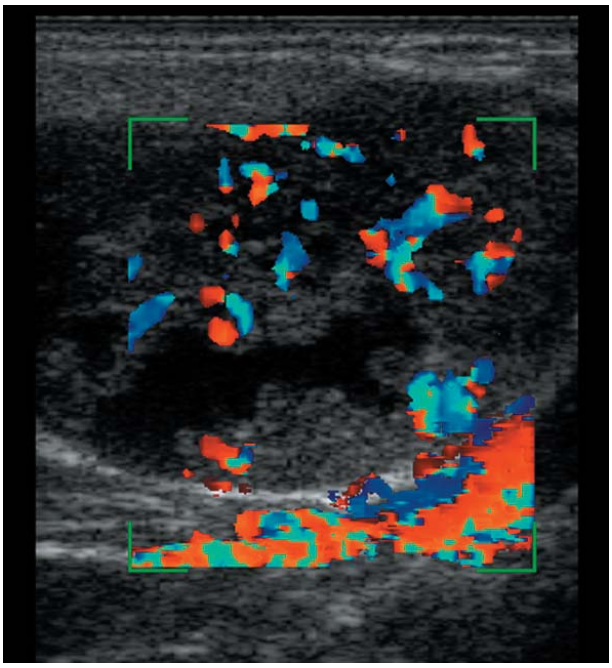

Fig.10. CDS: well vascularized Warthin tumor (same as fig.3).

Some of the features we studied were more distinctive than others. The lobulated shape was never encountered in malignant tumors and was found mostly in pleomorphic adenomas. The combination of well defined borders and rich vascularization was very specific to Warthin tumors, as were cystic areas. In this group, calcifications seemed to point more towards a malignant tumor than in other studies, where they appeared mostly in pleomorphic adenomas. A peripheral "basket-like" vascularization was seen more frequently in pleomorphic adenomas than in Warthin tumors. Malignant tumors did not display a specific pattern of vascularization.

Conclusion

Ultrasound is very useful in the description of many features of a salivary gland tumor, such as its exact location, size, shape, borders and structure. CDS can provide accurate information about the density of vessels in the mass. However, due to the large diversity of salivary gland tumors and to their non-specific features, 2D sonography and CDS are not reliable enough to exclude malignancy with certainty.

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