Evaluation of the Ultrasonographic Features of Salivary Gland Tumours

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Objective: *To evaluate the value of the ultrasonographic features for differentiation between benign and malignant tumours of salivary glands.*
Methods: *Eighty-four cases of salivary gland tumours were analysed. Sixty-five cases were benign and 19 were malignant. All cases were confirmed by histopathological examination. The ultrasonographic features analysed included the shape of the tumour, the boundary echo, the internal echo and the posterior echo. Each feature was graded into three ranks. For statistical analysis, they were ranked respectively 1, 2 and 3. Another 28 cases of salivary gland tumours were analysed to verify the diagnostic accuracy of the ultrasonography. All data were analysed using SPSS 16.0 for windows. The Mann–Whitney U test, the receiver operating characteristic (ROC) curve and Fisher's discriminant test were performed.*
Results: *The differences between benign and malignant tumours were statistically significant in the shape of the tumour ($P = 0.001$), the boundary echo ($P = 0.001$) and the posterior echo ($P = 0.000$). However, the difference in the internal echo was not statistically significant ($P > 0.05$). The diagnostic accuracy, sensitivity and specificity were 82.1%, 63.2% and 87.7%, respectively, while the predicting diagnostic accuracy was 85.7%.*
Conclusion: *The present study indicates that the shape of the tumour, the boundary echo and the posterior echo could be effective ultrasonographic criteria for differential diagnosis of benign tumours from malignant tumours in the salivary glands.*

Key words: *diagnosis, salivary gland, tumour, ultrasonography*

Tumour is one of the most common disorders of salivary glands. They make up 32.9% of all oral and maxillofacial tumours and 2% to 3% of all head and neck tumours[1,2]. Most tumours of major salivary glands are superficial, therefore more easily accessible for ultrasonography. In addition, ultrasonography is painless, non-invasive, free of ionising radiation, convenient and inexpensive. It has become one of the most important imaging modalities for the diagnosis of salivary gland tumours[1,3,4].

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There have been controversial reports on differentiation of salivary gland tumours by ultrasonography. The ultrasonographic features widely used for differential diagnosis include the shape of the tumour, the boundary echo, the internal echo and the posterior echo[1,5,6,7]. Martinoli et al[8] and Shimizu et al[9] reported that the homogeneous internal echo is a characteristic ultrasonographic finding of pleomorphic adenoma. However, some reports[1,3,6] indicated that the internal echoes of most pleomorphic adenomas and Warthin tumours are heterogeneous. The present study aimed to evaluate these ultrasonographic features for differentiation of malignant tumours from benign ones in the salivary glands.

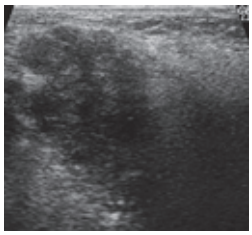

Fig 1 Ultrasonogram of an adenocarcinoma with irregular shape, unclear boundary echo, heterogeneous internal echo and attenuated posterior echo.

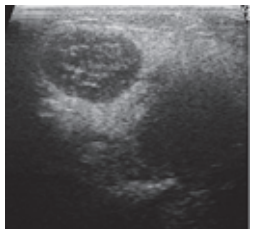

Fig 2 Ultrasonogram of a low malignant mucoepithelial carcinoma with regular shape, clear boundary echo, heterogeneous internal echo and slightly enhanced posterior echo.

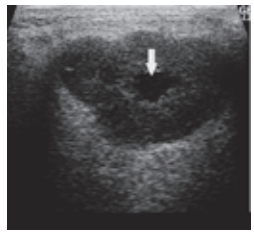

Fig 3 Ultrasonogram of a pleomorphic adenoma with lobulated shape, clear boundary echo, partly heterogeneous internal echo (arrow) and enhanced posterior echo.

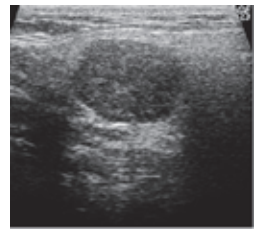

Fig 4 Ultrasonogram of a basal cell adenoma with regular shape, clear boundary echo, homogeneous internal echo and enhanced posterior echo.

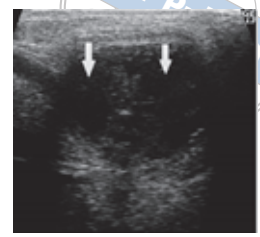

Fig 5 Ultrasonogram of a Warthin's tumour with regular shape, clear boundary echo, heterogeneous internal echo (arrow) and enhanced posterior echo.

Materials and methods

Patients

Group 1
Eighty-four cases of salivary gland tumours, obtained from Peking University Hospital of Stomatology from February 2008 to January 2010, were analysed. Among these patients, 35 were male and 49 female, aged from 16 to 78 years with a median age of 50 years. All cases were confirmed by histopathological examinations, with 65 benign tumours and 19 malignant tumours.

Group 2
A further 28 cases, obtained in the same hospital from February 2010 to March 2010, were analysed to verify the differential diagnostic accuracy. Fourteen patients were male and 14 were female, aged from 11 to 71 years with a median age of 46 years.

Scanning and analysis

Ultrasonography was performed using a real-time scanner (LOGIQ3 Expert, GE Healthcare, Chalfont St Giles, UK) with a transducer of 7–10 MHz.

The ultrasonographic features for analysis included the shape of the tumour, the boundary echo, the internal echo and the posterior echo. The shape was classified as regular, lobulated or irregular, and ranked as 1, 2 or 3, respectively. The boundary echoes were categorised as clear, partly clear or unclear, and ranked 1, 2 or 3, respectively. The internal echoes were classified as homogeneous, partly heterogeneous or heterogeneous, and ranked 1, 2 or 3, respectively. The posterior echoes were categorised as enhanced, slightly enhanced, or attenuated/with acoustic shadow, and ranked 1, 2 or 3, respectively (Table 1; Figs 1 to 5).

Statistical analysis

The data were analysed using SPSS 16.0 for Windows. The Mann–Whitney U test, the receiver operating characteristic (ROC) curve and Fisher's discriminant test were performed. The level of statistical significance was set at $P < 0.05$.

Results

Histopathological results were shown as in Table 2. Sixty-eight cases occurred in the parotid gland and 16 in the submandibular gland.

Ultrasonographic features

Ultrasonographic features of group 1 are shown in Table 3.

Statistical analysis

The Mann–Whitney U test was performed to compare the ultrasonographic features between benign and malignant tumours in the salivary glands. The differences were statistically significant in the shape of the tumour ($P = 0.001$), the boundary echo ($P = 0.001$) and the posterior echo ($P = 0.000$). There was no statistically significant difference in the internal echo ($P = 0.195$) (Table 4).

Table 1 Ultrasonographic features

Feature	Class	Rank
Shape of the tumour	Regular	1
	Lobulated	2
	Irregular	3
Boundary echo	Clear	1
	Partly clear	2
	Unclear	3
Internal echo	Homogeneous	1
	Partly heterogeneous	2
	Heterogeneous	3
Posterior echo	Enhanced	1
	Slightly enhanced	2
	Attenuated or with acoustic shadow	3

The ROC analysis was performed to evaluate the differential diagnostic power of the shape of the tumour, the boundary echo and the posterior echo. The areas under the ROC curve were 0.732, 0.647 and 0.760 respectively (Fig 6 and Table 5).

The results of Fisher's discriminant test are shown in Tables 6, 7 and 8. The diagnostic accuracy for group 1 was 82.1%, the sensitivity 63.2% and the specificity 87.7% (Table 7). The predicted diagnoses of group 2 using the coefficients in Table 6 are shown in Table 8. The predicting diagnostic accuracy was 85.7%.

Discussion

For tumours of salivary glands, 80% occur in the parotid gland, with 80% of the parotid tumours being benign[1,3,10]. In the present study, the tumours located in the minor salivary gland and sublingual gland were not included. Among the 112 cases with tumours of major salivary glands, 95 cases (84.8%) were tumours in the parotid gland and 84.2% of them were benign (80 cases);17 cases (15.2%) occurred in the submandibular gland, with 12 cases benign (70.6%). Among the benign tumours, pleomorphic adenoma and Warthin tumour were most common (79/92, 85.9%). Although higher malignant tendency has been reported in tumours of the submandibular gland, the present data did not show this tendency.

Previous studies reported that the ultrasonographic features of benign tumours of salivary glands are mostly of regular or lobulated shape with a clear boundary, homogeneous internal echo, and enhanced posterior

Table 2 Histopathological diagnosis (group 1)*

Diagnosis	Number of cases
Benign	
Pleomorphic adenoma	44
Warthin tumour	14
Basal cell adenoma	7
Malignant	
Mucoepidermoid carcinoma	5
Adenoid cystic carcinomas	3
Adenocarcinoma	8
Lymphoma	2
Myoepithelial carcinoma	1
Total	84

*Data of the 84 cases for analysis

Table 3 Ultrasonographic results of tumours (group 1)

Feature/class	Benign	Malignant
Shape of the tumour		
Regular	37	5
Lobulated	22	4
Irregular	6	10
Boundary echo		
Clear	60	12
Partly clear	4	5
Unclear	1	2
Internal echo		
Homogeneous	33	7
Partly heterogeneous	15	4
Heterogeneous	17	8
Posterior echo		
Enhanced	56	7
Slightly enhanced	8	7
Attenuated or with acoustic shadow	1	5

Table 4 Statistical difference between benign and malignant tumours*

Analysis	Shape of the tumour	Boundary echo	Internal echo	Posterior echo
P value **	0.001***	0.001***	0.195	0***

*Grouping variable: nature of tumours; ** (Asymp. Sig. [2-tailed]); ***$P < 0.01$

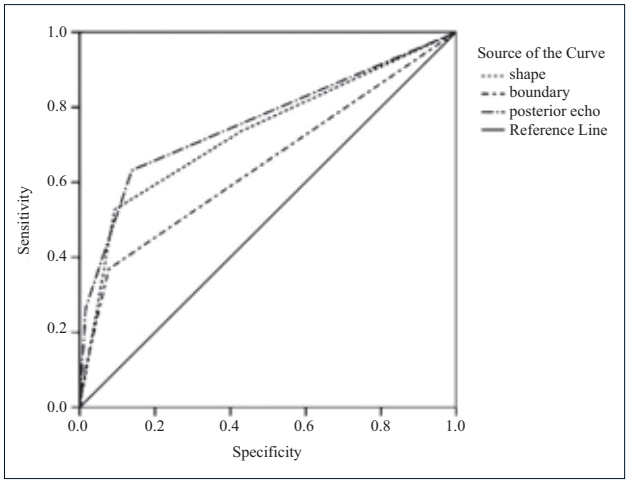

Fig 6 ROC curve.

echo, while the features of the malignant tumours are mostly of irregular shape with unclear boundary, heterogeneous internal echo, and attenuated posterior echo[1,5,7]. However, some benign tumours can show lobulated shapes and partly unclear boundary echoes, for example pleomorphic adenomas[5,7]. Some small or low-grade malignant tumours, such as mucoepidermoid carcinoma, can show regular shapes, clear boundary echoes, homogeneous internal echoes, and enhanced posterior echoes[11-13]. Certain malignant tumours, such as lymphoma, generally show benign features[14].

In the present study, there were no statistically significant differences in internal echoes between benign and malignant tumours. Some benign tumours showed heterogeneous internal echoes. Pleomorphic adenoma is composed of a diversity of components of epithelial, chondral and mucous tissues[15]. Cystic change or calcification in pleomorphic adenomas can account for its ultrasonographic features of internal echo. In Warthin tumours, as the cyst changes and epithelial papillae projecting into cystic space are common, the ultrasonographic features of Warthin tumours show characteristic heterogeneous internal echoes[3,6,9,12,13]. In contrast, the internal echoes of low-grade malignant tumours can be homogeneous or slightly heterogeneous. Well-differentiated mucoepidermoid carcinomas show homogeneous internal echoes and are difficult to differentiate from the benign tumours[16]. Therefore, the internal echo may not be an effective ultrasonographic criterion for differential diagnosis between the benign and malignant tumours.

Most benign tumours of salivary glands grow slowly, and generally show a regular or lobulated shape and a clear boundary echo. Malignant tumours of salivary

Table 5 Area under the ROC curve

Test result variable(s)	Area
Shape of the tumour	0.732
Boundary echo	0.647
Posterior echo	0.760

Table 6 Classification function coefficients*

	Benign	Malignant
	1**	2**
Shape	2.075	3.557
Boundary	2.381	2.68
Internal echo	1.931	2.187
Posterior echo	4.565	7.486
(Constant)	-7.901	-16.03

* Fisher's linear discriminant functions
** Coefficients of equations for discriminant functions

Table 7 Classification results*

Histopathological diagnosis	Predicted group membership		Total (%)
	Benign (%)	Malignant (%)	
Benign	57 (87.7)	8 (12.3)	65 (100)
Malignant	7 (36.8)	12 (63.2)	19 (100)

* 82.1% of original grouped cases correctly classified

Table 8 Histopathological diagnosis of cases in group 2*

Diagnosis	Number of cases
Pleomorphic adenoma	14
Warthin tumour	7
Basal cell adenoma	2
Neurinoma	2
Fibroma	1
Monomorphic adenoma	1
Mucoepidermoid carcinoma	1

*Data of the 28 cases of group 2

glands grow rapidly and often have an irregular shape and an unclear boundary echo[17]. Regarding the shape of the tumour, the present data showed that most benign tumours (91.3%) were regular or lobulated, and more than half (55%) of the malignant tumours were irregular. Moreover, 27 of 58 (46.6%) cases of pleomorphic adenomas were lobulated. For Warthin tumours, the majority (17/21, 81.0%) were regular. The shape of the tumour is useful for differential diagnosis between benign and malignant tumours ($P < 0.01$).

With regard to the boundary echo, the present data showed that 88.0% of the benign tumours and 60.0% of the malignant tumours were well demarcated. The boundaries of 12.0% of the benign tumours and 40.0% of the malignant tumours were partly clear or unclear, which was correlated with the presence of an incomplete capsule or absent capsule at histopathological examinations. Some pleomorphic adenomas growing rapidly can show unclear boundaries[14]. However, small malignant tumours or some low-grade malignant tumours usually show clear boundaries, similar to the benign tumours[3,18,19].

The posterior echo is an effective ultrasonographic criterion for differential diagnosis between benign and malignant tumours. In the present study, almost all of the benign tumours (97.8%) showed enhanced or slightly enhanced posterior echoes. The posterior echoes of most malignant tumours (65.0%) were slightly enhanced or attenuated or with acoustic shadow. By means of ROC analysis, the posterior echo was a more powerful ultrasonographic criterion than the shape of the tumour and the boundary echo.

In previous studies, the accuracy of differential diagnosis was between 56% and 80%[9]. In the present study, the diagnostic accuracy using ultrasonographic features was 82.1%, the sensitivity was 63.2%, and the specificity was 87.7%; the predicting diagnostic accuracy was 85.7%. Therefore, these ultrasonographic features could provide useful information for differential diagnosis between benign and malignant tumours in the salivary gland. However, the present results may have some bias considering that there was only one case of malignancy in group 2.

Although ultrasonography is one of the most important imaging modalities for diagnosing salivary gland tumours, it still has some disadvantages. It cannot show the tumours located in the deep lobe of the parotid gland and it hardly reveals the relationship between the tumour and blood vessel. It is necessary to integrate the ultrasonographic features with other imaging examinations and the clinical information of a patient for an accurate diagnosis of salivary gland tumours.

Conclusions

The present data indicate that the shape of the lesion, the boundary echo and the posterior echo were effective ultrasonographic criteria for differential diagnosis between benign and malignant tumours of salivary glands.

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