

# Utility of fine-needle aspiration biopsy (FNAB) in parotid pleomorphic adenoma diagnosis and management

Alzbeta Fikova<sup>1</sup>, Stepan Novak<sup>1</sup>, David Kalfert<sup>1</sup>, Martin Kuchar<sup>2</sup>, Michal Zabrodsky<sup>1</sup>, Lucie Dostalova<sup>1</sup>, Jan Balko<sup>3</sup>, Jan Plzak<sup>1</sup>

**Purpose.** Pleomorphic adenoma (PA), the most common benign tumour of the parotid gland, requires accurate pre-operative diagnosis owing to its capacity for malignant transformation. The aim of this study was to evaluate our experience with ultrasound-guided fine-needle aspiration biopsy (FNAB) in the diagnostic algorithm for patients with PA and to assess clinical outcomes for those with different surgical approaches.

**Material and Methods.** We carried out a retrospective analysis of patients treated for parotid gland mass between 2010 and 2016. These had had preoperative FNAB and had undergone subsequent surgery.

**Results.** 165 patients had FNAB with the result of PA and the definitive histology confirmed PA in 159 cases (96.4%). On the other hand, in 179 patients, the definitive histology showed PA and the preoperative FNAB result corresponded in 159 cases (88.9%). The measured sensitivity, specificity and accuracy of ultrasound-guided FNAB in the diagnosis of PA were, respectively, 88.83%, 96.23% and 92.31%. Most of the patients underwent superficial or partial superficial parotidectomy, followed by extracapsular dissection which was associated with statistically lower risk of facial nerve injury ( $P=0.04$ ).

**Conclusion.** Ultrasound-guided FNAB is simple, accurate and valuable in the diagnosis of PA and provides results that can lead to the choice of less invasive operative treatment.

**Key words:** pleomorphic adenoma, fine-needle aspiration biopsy, ultrasound, parotid gland tumours

Received: March 23, 2023; Revised: April 28, 2023; Accepted: June 13, 2023; Available online: July 10, 2023

<https://doi.org/10.5507/bp.2023.027>

© 2024 The Authors; <https://creativecommons.org/licenses/by/4.0/>

<sup>1</sup>Department of Otorhinolaryngology and Head and Neck Surgery, First Faculty of Medicine, Charles University and Motol University Hospital, Prague, Czech Republic

<sup>2</sup>Department of Otorhinolaryngology and Head and Neck Surgery, Bulovka University Hospital, Prague, Czech Republic

<sup>3</sup>Department of Pathology and Molecular Medicine, Second Faculty of Medicine, Charles University and Motol University Hospital, Prague, Czech Republic

Corresponding authors: Alzbeta Fikova, e-mail: [alzbeta.fikova@fnmotol.cz](mailto:alzbeta.fikova@fnmotol.cz); Stepan Novak, e-mail: [stepan.novak@fnmotol.cz](mailto:stepan.novak@fnmotol.cz)

## INTRODUCTION

Pleomorphic adenoma (PA) was long the most commonly encountered benign tumour of the salivary glands<sup>1</sup>. However, data from several countries show an increasing incidence of Warthin tumour (WT) in recent decades<sup>2,3</sup>. PAs are located mainly in the parotid gland (85%), where they frequently appear in the inferior pole of the superficial lobe<sup>4,5</sup>. They affect primarily women, typically occurring in the fourth and fifth decades of life<sup>6,7</sup>. They tend to grow slowly, are asymptomatic and do not involve the facial nerve<sup>8</sup>, but if left untreated, they can grow to extensive sizes<sup>9</sup>. Further, unlike WT there is a significant risk of malignant transformation (around 6%), with increasing incidence depending on the history of PA (from 1.5% after 5 years to 10% after 15 years) (ref.<sup>10,11</sup>). The precise etiopathogenesis remains unexplained though smoking, exposure to chemicals, genetic predisposition and simian virus are considered contributory factors<sup>4,12</sup>. Transcription factor gene *PLAG1* and *HMG2* alterations have been detected in a notable percentage of PA (ref.<sup>13</sup>). The tumour is composed of epithelial and myoepithelial cells embedded in the stroma of mucoid, myxoid, chondroid or osteoid origin. The proportion of parenchyma

and stroma is inconstant, and they are divided into several subtypes<sup>14,15</sup>. The adenoma is encapsulated by capsules of variable thickness and density that can be discontinuous and even penetrated by the tumour<sup>16</sup>. For this reason, the minimal surgery for PA which is extracapsular dissection and enucleation with a high recurrence rate has become obsolete<sup>17</sup>. After recurrence, there is a higher risk of further recurrence and also an increased risk of malignant transformation<sup>18</sup>.

Ultrasound is a simple, accessible and quick method of evaluating parotid gland pathologies. Fine-needle aspiration biopsy (FNAB) is a widely accepted and reliable method for the preoperative diagnosis of salivary gland lesions<sup>19</sup>.

The objective of this study was to assess the utility of ultrasound-guided FNAB in the preoperative diagnosis of PA and to evaluate clinical outcomes in patients with different surgical approaches.

## MATERIAL AND METHODS

This retrospective study was conducted at the Department of Otorhinolaryngology and Head and Neck

Surgery, First Faculty of Medicine, Charles University and University Hospital Motol, Prague, Czech Republic.

Patients treated for PA of the parotid gland between 2010 and 2016 were retrospectively included in the analysis. Only patients with preoperative ultrasound-guided FNAB followed by surgery were considered. FNABs were performed by 5 doctors of our department. These were divided into two partially overlapping groups. The first group consisted of patients with preoperative FNAB showing PLA and a correlation with definitive histology was found. The second, comprised patients with definitive PLA histology compared to preoperative FNAB.

All patients had a clinical examination followed by an ultrasound evaluation with ultrasound-guided FNAB before surgery. Facial nerve function was assessed using House-Brackmann classification before and after surgery. In terms of postoperative complications, we focused on Frey's syndrome, sensory impairment, inflammatory complications and healing disorders.

The extent of the surgery, which varied from extracapsular dissection to total parotidectomy, was also taken into account.

All statistical analyses were performed with IBM SPSS Statistics (version 22.0; SPSS, IBM, Armonk, NY, USA). The mean, median, standard deviation, and range were determined. The data were then processed using Fisher's exact test (two-tailed); *P*-values equal to or less than 0.05 were considered significant. Sensitivity and specificity, positive predictive value (PPV) and negative predictive value (NPV), positive likelihood ratio (LR+) and negative likelihood ratio (LR-) were measured with corresponding 95% confidence intervals (CI).

## RESULTS

In the 6-year monitored period (2010–2016), our retrospective survey identified 165 patients using FNAB with PA [53 men (32.1%) and 112 women (67.9%)], mean age 47 years and median 46 years (20–88 years) at the time of the surgical procedure.

The definitive histology confirmed PA in 159 cases (96.4%). Six patients (3.7%) had another histological type of tumour. Two patients (1.2%) were diagnosed with basal cell adenoma. Surprisingly, 4 definitive histologies (2.4%) turned out to be malignant, 3 cases (1.8%) of adenoid cystic carcinoma and 1 case (0.6%) of mucoepidermoid carcinoma (Table 1). On the other hand, 179 patients

were operated with definitive PA histology in the same period of time [57 men (31.8%), 122 women (68.2%)]. At the time of the surgery, their mean age was 47 years and median age also 47 years (19–87 years). The FNAB result corresponded to definitive PA histology in 159 patients (88.8%). In 20 cases (11.2%) preoperative FNAB showed a different result than PA. Ten patients (5.6%) were suspected of having a malignant tumour or a tumour of uncertain biological behaviour (4 adenoid cystic carcinomas, 3 epithelial tumours of uncertain biological behaviour, 1 adenocarcinoma, 1 carcinoma ex PA and 1 carcinoma not otherwise specified; NOS). Of the other 10 inconsistent FNABs, three results were non-diagnostic, 4 showed a myoepithelial tumour, 2 a mixed tumour and in 1 FNAB only salivary gland structures were found (Table 2). It is worth noting that no FNAB was evaluated as WT. Most of the patients underwent superficial or partial superficial parotidectomy (120, 67.0%). 32 patients (17.9%) were treated with extracapsular dissection of the tumour, 18 patients (10.1%) had subtotal parotidectomy, and in the remaining 9 cases (5.0%) total parotidectomy was performed. Criteria for decision making in surgical technique were tumour size ( $\leq 2$ cm, respectively  $> 2$ cm), tumour location, mobility of the tumour and distance from the surface of the parotid gland. Facial nerve palsy was observed in 43 cases (24.0%). 29 (16.2%) patients had HB II lesions, 8 patients (4.5%) HB III, 3 patients (1.7%) HB IV, 2 patients (1.1%) HB V and in one case (0.6%) HB VI lesion was observed. Of 29 cases of HB II lesion, we noted an improvement in facial nerve function to HB I in 15 patients (51.7%) in a year. One patient with an HB III lesion had complete recovery of facial nerve function (HB I) after a year and 2 patients had at least amelioration to HB II. One patient with HB IV and one with HB V showed improvement to HB III. In the HB VI case, the facial nerve had to be resected due to tumour infiltration (the preoperative FNAB showed an epithelial tumour of uncertain biological behavior), then a sural nerve reconstruction was performed, and the function recovered to HB IV after a year (Table 3). Extracapsular dissection was associated with a statistically significant lower risk of facial nerve injury ( $P=0.04$ ) and subtotal parotidectomy and total parotidectomy with a statistically significant higher risk of facial nerve injury ( $P=0.04$ , respectively  $P<0.01$ ).

Recurrence occurred in 4 cases (2.2%), 2 patients underwent superficial parotidectomy and 2 subtotal parotidectomy. All surgeries were initially radical (R0 resection), but in one case accidental rupture of the capsule

**Table 1.** Patients with preoperative FNAB result of PA, evaluation of the definitive histology, gender and age.

Definitive histology	FNAB result PA (165; 100%)		Gender		Age (years)		
	n	%	Female	Male	Median	Min	Max
PA	159	96.4	109	50	46	20	88
adenoid cystic carcinoma	3	1.8	1	2	54	47	55
mucoepidermoid carcinoma	1	0.6	1	0	50	-	-
basal cell adenoma	2	1.2	1	1	46	36	56

n, number of patients.

occurred. Subtotal parotidectomy was associated with statistically significant higher recurrence risk ( $P=0.05$ ). The mean recurrence time was 92.8 months, the median 87.5 months. We detected another 3 R0 resections with accidental capsular rupture, but no recurrence was observed. In addition, 6 patients had R1 resection (microscopic margins were positive for the tumour) with no apparent recurrence so far.

Forty-eight patients (26.8%) experienced temporary or permanent hyposensitivity of the earlobe and adjacent area after surgery due to damage to the great auricular nerve. Seven patients (3.9%) had Frey syndrome, one (0.6%) had pain in the temporomandibular joint and one (0.6%) had lymphedema. In 31 cases (17.3%) there was a local complication in the wound (19 seromas, 10 fistulas, 2 inflammations, 2 hematomas, 1 wound dehiscence, and 2 revision surgeries due to bleeding) (Table 4). The sensitivity, specificity and accuracy of ultrasound-guided FNAB in the diagnosis of PA were, respectively: 88.83% (CI 83.27–93.04 %), 96.23% (CI 91.97–98.6 %) and 92.31% (CI 88.93–94.91 %). The positive predicted value (PPV) was 96.36 % (CI 92.35–98.31 %) and the negative predictive value (NPV) was 88.44% (CI 83.49–92.05 %). Our data showed a positive likelihood ratio (LR+) of 23.54 (10.72–51.69) and a negative likelihood ratio (LR-) of 0.12 (0.08–0.18). All results are shown in Table 5.

## DISCUSSION

PA, along with WT, are the two most common tumours of the parotid gland<sup>20</sup>. Unlike WT, PA has a clear indication for its removal due to its possible malignant transformation<sup>21</sup>. Before parotid tumour surgery, it is advantageous to know the type of tumour, as it is then possible to adjust the scope of the operation accordingly. FNAB is a useful, safe, and cost-effective method in the diagnostic algorithm of major salivary gland pathologies with a wide range of sensitivities (67–92%) and specificities (82–99%) reported in the literature<sup>22,23</sup>. The high values for sensitivity and specificity (92.6% and 98.4%, respectively) of the cytological diagnosis of PA were reported by Viguer et al. in 1997 (ref.<sup>24</sup>). Carrillo et al. obtained similar results (97% and 98%, respectively) (ref.<sup>25</sup>). Our data show slightly lower values (sensitivity 88.83% and specificity 96.23%), but confirm that FNAB represents a reliable method in the diagnosis of PA. No PA was misdiagnosed as WT by FNAB (100% specificity, that it is not a WT). The calculated FNAB sensitivity for WT diagnosis in our previous study was remarkably higher (96.6%), but the specificity was similar (also 96.2%) (ref.<sup>26</sup>). This can be explained by various morphological features encountered in PA, which can cause diagnostic errors in the FNAB (ref.<sup>27</sup>). Some authors suggest the combination of cytology and MRI (ref.<sup>28,29</sup>). However, the availability of MRI in a reasonable time frame for all patients with parotid gland mass may pose difficulties. Another option

**Table 2.** Patients with definitive histology of PA, evaluation of the preoperative FNAB result, gender and age.

FNAB results	Definitive histology PA (179; 100%)		Gender		Age (years)		
	n	%	Female	Male	Median	Min	Max
PA	159	88.8	111	48	46	20	87
adenoid cystic carcinoma	4	2.2	1	3	60	46	75
epithelial tumour of uncertain biological behaviour	3	1.7	2	1	63	60	66
adenocarcinoma	1	0.6	0	1	75	–	–
carcinoma ex PA	1	0.6	1	0	59	–	–
carcinoma	1	0.6	0	1	79	–	–
myoepithelial tumour	4	2.2	2	2	46	32	51
mixed tumour	2	1.1	2	0	53.5	46	61
salivary structures	1	0.6	1	0	26	–	–
non-diagnostic	3	1.7	2	1	29	19	64

n, number of patients.

**Table 3.** Patients with definitive histology of PA, evaluation of the surgical approach and facial nerve palsy.

HB grading	Definitive histology PA (179; 100%)			Surgical approach			
	n	%	n after 1 year	Extracapsular dissection	Superficial PE	Subtotal PE	Total PE
HB I	136	76.0	152	31	95	9	1
HB II	29	16.2	16	1	19	6	4
HB III	8	4.5	7	0	4	2	2
HB IV	3	1.7	3	0	2	0	1
HB V	2	1.1	1	0	0	1	0
HB VI	1	0.6	0	0	0	0	1

n, number of patients; PE, parotidectomy.

**Table 4.** Patients with definitive histology of PA, evaluation of the surgical approach and other complications other than facial nerve palsy.

Complication	Definitive histology PA (179; 100%)		Surgical approach			
	n	%	Extracapsular dissection	Superficial PE	Subtotal PE	Total PE
None	98	54.7	23	60	10	5
Hyposensitivity	48	26.8	5	34	5	4
Seroma	19	10.6	3	14	2	0
Frey syndrome	7	3.9	0	5	2	0
Revision for bleeding	2	1.1	0	2	0	0
Fistula	10	5.6	2	8	0	0
Inflammation	2	1.1	0	2	0	0
TMJ pain	1	0.6	0	0	0	1
Hematoma	2	1.1	0	2	0	0
Wound dehiscence	1	0.6	0	1	0	0
Lymphedema	1	0.6	0	0	1	0

n, number of patients; TMJ, temporomandibular joint; PE, parotidectomy.

in preoperative diagnostics is a core needle biopsy. Some centres have better results with this method, and it can be proposed when the FNAB is inconclusive. However, beside FNAB, it is a more extensive procedure done under local anaesthesia and the risk of tumour seeding is controversial<sup>30-32</sup>.

Most of our patients with FNAB showing PA were treated with superficial or partial superficial parotidectomy (67.0%) followed by extracapsular dissection (17.9%), subtotal (10.1%) and total parotidectomy (5.0%). Facial nerve palsy and other complications were more frequent in more extensive surgeries such as subtotal or total parotidectomy. Extracapsular dissection was associated with a statistically significant lower risk of facial nerve palsy ( $P=0.04$ ) and subtotal parotidectomy and total parotidectomy with a statistically significant higher risk of facial nerve palsy ( $P=0.04$ , respectively  $P<0.01$ ). This is in agreement with other published findings<sup>33-35</sup>. Furthermore, extracapsular dissection had no higher recurrence rate. Other studies have confirmed low rates of recurrence after extracapsular dissection and partial superficial parotidectomies<sup>35-38</sup>. Generally, extracapsular dissection is recommended for smaller, easily accessible tumours (ideally less than 2 cm, possibly less than 4 cm) and should be performed only by more experienced surgeons<sup>39</sup>. This bias can influence postoperative complication outcome statistics. The risk of recurrence of PA is mainly associated with positive surgical margins, tumour spillage and capsule rupture<sup>4</sup>. However, recent studies indicate that intraoperative capsular rupture and tumour spillage are not related to a statistically significant higher recurrence rate and that PA recurrence is rather a multifactorial event<sup>16,40</sup>. Surgery for recurrent PA comes with a greater risk of facial nerve injury, but the risk can be reduced if previous treatment was more limited (extracapsular dissection or even partial superficial parotidectomy) (ref.<sup>16,41</sup>). Mantsopoulos et al. discovered a higher incidence of the hypocellular type of PA in younger patients and smaller lesions and the same subtype tends to have an incomplete capsule, pseudopodia, and satellite nodules. For this reason, they propose a larger surgical margin for PA resec-

**Table 5.** Sensitivity, specificity, LR+, LR-, PPV, NPV and accuracy of ultrasound-guided FNAB in the diagnosis of PA.

	Value	95%CI
Sensitivity	88.83	83.27-93.04
Specificity	96.23	91.07-98.60
LR+	23.54	10.72-51.69
LR-	0.12	0.08-0.18
PPV	96.36	92.35-98.31
NPV	88.44	83.49-92.05
Accuracy	92.31	88.93-94.91

tion in younger patients<sup>42</sup>. The mean recurrence time in our study was 92.8 months but the interval between the initial treatment and recurrence can be much longer, 15 years for example<sup>43</sup>.

For that reason, a follow-up longer than 5 years is recommended<sup>44</sup>. Ayoub et al. propose that a long-term follow-up can be replaced by patient education and self-examination<sup>45</sup>.

## CONCLUSIONS

Ultrasound-guided FNAB is an accurate, safe, and reliable method in the diagnosis of PA with high sensitivity, specificity and accuracy. However, the correlation with other clinical findings is important and the correct diagnosis depends on multiple factors, in particular the experience of the physician performing the FNAB, the cytopathologist and their cooperation.

For smaller tumours in favourable locations, extracapsular dissection is a safe and adequate surgical technique with minimal risk to the facial nerve or other local complications and without increased risk of recurrence. Due to the usual long interval between the initial operation and the recurrence, it is recommended to follow the patients with ultrasound examination once a year for more than 5 years.

**Acknowledgement:** The project “Center for Tumor Ecology – Research of the Cancer Microenvironment Supporting Cancer Growth and Spread” (reg. No. CZ.02.1.01/0.0/0.0/16\_019/0000785) is supported by the Operational Programme Research, Development and Education. The research was funded by the Ministry of Health of the Czech Republic (NU21-03-00223).

**Author contributions:** AF, SN, LD, DK: conceptualization, methodology, writing original draft; JP, MZ, MK: supervision, AF, DK, SN, LD, JB: investigation, data collection, validation; DK, SN: formal analysis; all authors edited the manuscript and approved the final version of the manuscript.

**Conflict of interest statement:** The authors have no relevant financial or non-financial interests to disclose.

**Ethical approval:** This article does not contain any animal studies conducted by the authors. The study was conducted in accordance with the guidelines of the Helsinki Declaration and its subsequent amendments. Retrospective study does not require approval by an ethical committee in our country.

## REFERENCES

1. Spiro RH. Salivary neoplasms: overview of a 35-year experience with 2,807 patients. *Head Neck Surg* 1986;8(3):177-84. doi: 10.1002/hed.2890080309
2. Mantsopoulos K, Iro H. Pleomorphic adenoma compared with cystadenolymphoma of the parotid gland: which is more common? *Br J Oral Maxillofac Surg* 2020;58(3):361-3. doi: 10.1016/j.bjoms.2019.12.014
3. Luers JC, Guntinas-Lichius O, Klusmann JP, Kusgen C, Beutner D, Grosheva M. The incidence of Warthin tumours and pleomorphic adenomas in the parotid gland over a 25-year period. *Clin Otolaryngol* 2016;41(6):793-7. doi: 10.1111/coa.12694
4. Almeslet AS. Pleomorphic Adenoma: A Systematic Review. *Int J Clin Pediatr Dent* 2020;13(3):284-7. doi: 10.5005/jp-journals-10005-1776
5. Zapletalová H, Kuchař M, Mrzena L. Surgical treatment of benign parotid gland tumors in the years 2014-2018 at the ENT department of Hospital České Budějovice, a.s. *Otorinolaryngol Foniatr* 2021;70(2):82-8. doi: 10.48095/ccorl202182
6. Andreasen S, Therkildsen MH, Bjørndal K, Homøe P. Pleomorphic adenoma of the parotid gland 1985-2010: A Danish nationwide study of incidence, recurrence rate, and malignant transformation. *Head Neck* 2016;38 Suppl 1:E1364-9. doi: 10.1002/hed.24228
7. Valstar MH, de Ridder M, van den Broek EC, Stuijver MM, van Dijk BAC, van Velthuisen MLF, Smeets LE. Salivary gland pleomorphic adenoma in the Netherlands: A nationwide observational study of primary tumor incidence, malignant transformation, recurrence, and risk factors for recurrence. *Oral Oncol* 2017;66:93-9. doi: 10.1016/j.oraloncology.2017.01.004
8. Sergi B, Limongelli A, Scarano E, Fetoni AR, Paludetti G. Giant deep lobe parotid gland pleomorphic adenoma involving the parapharyngeal space. Report of three cases and review of the diagnostic and therapeutic approaches. *Acta Otorhinolaryngol Ital* 2008;28(5):261-5.
9. Tarsitano A, Pizzigallo A, Giorgini F, Marchetti C. Giant pleomorphic adenoma of the parotid gland: an unusual case presentation and literature review. *Acta Otorhinolaryngol Ital* 2015;35(4):293-6.
10. Khanna D, Chaubal T, Bapat R, Abdulla AM, Philip ST, Arora S. Carcinoma ex pleomorphic adenoma: a case report and review of literature. *Afr Health Sci* 2019;19(4):3253-63. doi: 10.4314/ahs.v19i4.50
11. Di Palma S. Carcinoma ex pleomorphic adenoma, with particular emphasis on early lesions. *Head Neck Pathol* 2013;7 Suppl 1:S68-76. doi: 10.1007/s12105-013-0454-z
12. Martinelli M, Martini F, Rinaldi E, Caramanico L, Magri E, Grandi E, Carinci F, Pastore A, Tognon M. Simian virus 40 sequences and expression of the viral large T antigen oncoprotein in human pleomorphic adenomas of parotid glands. *Am J Pathol* 2002;161(4):1127-33. doi: 10.1016/S0002-9440(10)64389-1
13. Toper MH, Sarioglu S. Molecular Pathology of Salivary Gland Neoplasms: Diagnostic, Prognostic, and Predictive Perspective. *Adv Anat Pathol* 2021;28(2):81-93. doi: 10.1097/PAP.0000000000000291
14. Hernandez-Prera JC, Skalova A, Franchi A, Rinaldo A, Vander Poorten V, Zbären P, Ferlito A, Wenig BM. Pleomorphic adenoma: the great mimicker of malignancy. *Histopathology* 2021;79(3):279-90. doi: 10.1111/his.14322
15. Seifert G, Langrock I, Donath K. [A pathological classification of pleomorphic adenoma of the salivary glands (author's transl)]. *HNO* 1976;24(12):415-26.
16. Zbaren P, Vander Poorten V, Witt RL, Woolgar JA, Shaha AR, Triantafyllou A, Takes RP, Rinaldo A, Ferlito A. Pleomorphic adenoma of the parotid: formal parotidectomy or limited surgery? *Am J Surg* 2013;205(1):109-18. doi: 10.1016/j.amjsurg.2012.05.026
17. Psychogios G, Bohr C, Constantinidis J, Canis M, Vander Poorten V, Plzak J, Knopf A, Betz C, Guntinas-Lichius O, Zenk J. Review of surgical techniques and guide for decision making in the treatment of benign parotid tumors. *Eur Arch Otorhinolaryngol* 2021;278(1):15-29. doi: 10.1007/s00405-020-06250-x
18. Kanatas A, Ho MWS, Mucke T. Current thinking about the management of recurrent pleomorphic adenoma of the parotid: a structured review. *Br J Oral Maxillofac Surg* 2018;56(4):243-8. doi: 10.1016/j.bjoms.2018.01.021
19. Edizer DT, Server EA, Yigit O, Yildiz M. Role of Fine-Needle Aspiration Biopsy in the Management of Salivary Gland Masses. *Turk Arch Otorhinolaryngol* 2016;54(3):105-11. doi: 10.5152/tao.2016.1700
20. Colella G, Cannavale R, Flamminio F, Foschini MP. Fine-needle aspiration cytology of salivary gland lesions: a systematic review. *J Oral Maxillofac Surg* 2010;68(9):2146-53. doi: 10.1016/j.joms.2009.09.064
21. Hellquist H, Paiva-Correia A, Vander Poorten V, Quer M, Hernandez-Prera JC, Andreasen S, Zbären P, Skalova A, Rinaldo A, Ferlito A. Analysis of the Clinical Relevance of Histological Classification of Benign Epithelial Salivary Gland Tumours. *Adv Ther* 2019;36(8):1950-74. doi: 10.1007/s12325-019-01007-3
22. Shetty A, Geethamani V. Role of fine-needle aspiration cytology in the diagnosis of major salivary gland tumors: A study with histological and clinical correlation. *J Oral Maxillofac Pathol* 2016;20(2):224-9. doi: 10.4103/0973-029X.185899
23. Dostalova L, Kalfert D, Jechova A, Koucky V, Novak S, Kuchar M, Zabrodsky M, Novakova Kodetova D, Ludvikova M, Kholova I, Plzak J. The role of fine-needle aspiration biopsy (FNAB) in the diagnostic management of parotid gland masses with emphasis on potential pitfalls. *Eur Arch Otorhinolaryngol* 2020;277(6):1763-9. doi: 10.1007/s00405-020-05868-1
24. Viguer JM, Vicandi B, Jimenez-Heffernan JA, Lopez-Ferrer P, Limeres MA. Fine needle aspiration cytology of pleomorphic adenoma. An analysis of 212 cases. *Acta Cytol* 1997;41(3):786-94. doi: 10.1159/000332705
25. Carrillo JF, Ramirez R, Flores L, Ramirez-Ortega MC, Arrecillas MD, Ibarra M, Sotelo R, Ponce-De-León S, Oñate-Ocaña LF. Diagnostic accuracy of fine needle aspiration biopsy in preoperative diagnosis of patients with parotid gland masses. *J Surg Oncol* 2009;100(2):133-8. doi: 10.1002/jso.21317
26. Jechova A, Kuchar M, Novak S, Koucky V, Dostalova L, Zabrodsky M, Kalfert D, Plzak J. The role of fine-needle aspiration biopsy (FNAB) in Warthin tumour diagnosis and management. *Eur Arch Otorhinolaryngol* 2019;276(10):2941-6. doi: 10.1007/s00405-019-05566-7
27. Handa U, Dhir N, Chopra R, Mohan H. Pleomorphic adenoma: Cytologic variations and potential diagnostic pitfalls. *Diagn Cytopathol* 2009;37(1):11-5. doi: 10.1002/dc.20951
28. Masmoudi M, Hasnaoui M, Guizani R, Lahmar R, Jerbi S, Mighri K. Performance of the magnetic resonance imaging in parotid gland tumor histopathology. *Pan Afr Med J* 2021;39:10. doi: 10.11604/pamj.2021.39.10.27813
29. Heaton CM, Chazen JL, van Zante A, Glastonbury CM, Kezirian EJ, Eisele DW. Pleomorphic adenoma of the major salivary glands: diagnostic utility of FNAB and MRI. *Laryngoscope* 2013;123(12):3056-60. doi: 10.1002/lary.24247
30. Walsh E, Allan K, Brennan PA, Tullett M, Gomez RS, Rahimi S. Diagnostic accuracy of ultrasonography-guided core needle biopsy of parotid gland neoplasms: A large, single-institution experience

- in United Kingdom. *J Oral Pathol Med* 2022;51(1):1-4. doi: 10.1111/jop.13260
31. Cengiz AB, Tansuker HD, Gul R, Emre F, Demirbas T, Oktay MF. Comparison of preoperative diagnostic accuracy of fine needle aspiration and core needle biopsy in parotid gland neoplasms. *Eur Arch Otorhinolaryngol* 2021;278(10):4067-74. doi: 10.1007/s00405-021-07022-x
  32. Heidari F, Heidari F, Rahmaty B, Jafari N, Aghazadeh K, Sohrabpour S, Karimi E. The role of core needle biopsy in parotid glands lesions with inconclusive fine needle aspiration. *Am J Otolaryngol* 2020;41(6):102718. doi: 10.1016/j.amjoto.2020.102718
  33. Ciuman RR, Oels W, Jaussi R, Dost P. Outcome, general, and symptom-specific quality of life after various types of parotid resection. *Laryngoscope* 2012;122(6):1254-61. doi: 10.1002/lary.23318
  34. Barca I, Cristofaro MG. Surgical approach to parotid pleomorphic adenoma: a 15-year retrospective cohort study. *Br J Oral Maxillofac Surg.* 2020;58(6):659-62. Epub 2020/04/21. doi: 10.1016/j.bjoms.2020.03.020
  35. Bonavolonta P, Dell'Aversana Orabona G, Maglitter F, Abbate V, Committeri U, Salzano G, Improta G, Iaconetta G, Califano L. Postoperative complications after removal of pleomorphic adenoma from the parotid gland: A long-term follow up of 297 patients from 2002 to 2016 and a review of publications. *Br J Oral Maxillofac Surg* 2019;57(10):998-1002. doi: 10.1016/j.bjoms.2019.08.008
  36. Uyar Y, Caglak F, Keles B, Yildirim G, Salturk Z. Extracapsular dissection versus superficial parotidectomy in pleomorphic adenomas of the parotid gland. *Kulak Burun Bogaz Ihtis Derg* 2011;21(2):76-9. doi: 10.5606/kbbihtisas.2011.003
  37. Witt RL. Minimally invasive surgery for parotid pleomorphic adenoma. *Ear Nose Throat J* 2005;84(5):308,10-1.
  38. Fukushima M, Miyaguchi M, Kitahara T. Extracapsular dissection: minimally invasive surgery applied to patients with parotid pleomorphic adenoma. *Acta Otolaryngol* 2011;131(6):653-9. doi: 10.3109/00016489.2010.543148
  39. Psychogios G, Bohr C, Constantinidis J, Canis M, Vander Poorten V, Plzak J, Knopf A, Betz C, Guntinas-Lichius O, Zenk J. Author's response to the letter of the editor regarding the "Review of surgical techniques and guide for decision making in the treatment of benign parotid tumors". *Eur Arch Otorhinolaryngol* 2020;277(12):3539-40. doi: 10.1007/s00405-020-06359-z
  40. Mantsopoulos K, Iro H. Tumour spillage of the pleomorphic adenoma of the parotid gland: A proposal for intraoperative measures. *Oral Oncol* 2021;112:104986. doi: 10.1016/j.oraloncology.2020.104986
  41. Johnson JT, Ferlito A, Fagan JJ, Bradley PJ, Rinaldo A. Role of limited parotidectomy in management of pleomorphic adenoma. *J Laryngol Otol* 2007;121(12):1126-8. doi: 10.1017/S0022215107000345
  42. Mantsopoulos K, Thimsen V, Gostian AO, Muller SK, Sievert M, Iro AK, Agaimy A, Iro H. Histopathology of Parotid Pleomorphic Adenomas: A "Pleomorphic Approach" to a Demanding Lesion. *Laryngoscope* 2022;132(1):73-7. doi: 10.1002/lary.29726
  43. Abu-Ghanem Y, Mizrahi A, Popovtzer A, Abu-Ghanem N, Feinmesser R. Recurrent pleomorphic adenoma of the parotid gland: Institutional experience and review of the literature. *J Surg Oncol* 2016;114(6):714-8. doi: 10.1002/jso.24392
  44. Iro H, Zenk J, Koch M, Klintworth N. Follow-up of parotid pleomorphic adenomas treated by extracapsular dissection. *Head Neck* 2013;35(6):788-93. doi: 10.1002/hed.23032
  45. Ayoub OM, Bhatia K, Mal RK. Pleomorphic adenoma of the parotid gland: is long-term follow-up needed? *Auris Nasus Larynx* 2002;29(3):283-5. doi: 10.1016/s0385-8146(02)00013-5