A 10-year experience in preoperative ultrasound imaging for parotid glands' benign neoformations

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Salivary gland neoplasms represent less than 4% of all head and neck lesions, being 80% in the parotid gland and usually benign. Imaging plays a key role in the evaluation of parotid gland masses. Ultrasound is cheap, with an excellent resolution and a safe real time assessment making it an ideal first evaluation option. Conversely, MRI is considered a second-line pre-surgery exam used to determine the location, the extension and the signal features of a parotid lesion. Both US and MRI are poorly reliable for predicting histology, therefore a fine-needle aspiration cytology (FNAC) is usually needed.

In our retrospective study, we examined 263 patients with parotid diseases and a FNAC positive for a benign neoplasm, who underwent surgery between 2010 and 2020, in the departments of Otorhinolaryngology and Maxillofacial surgery in Verona. We compared a group of 126 patients preoperatively evaluated with ultrasound and a control group of 137 patients studied through third level imaging (usually MRI).

In our case series, both third level imaging and US were used in equal measure, despite the lesion size. We found the recurrence rate to be almost the same between the two diagnostic methods and we saw that the patients studied through third level preoperative imaging had a higher complication rate and a worse facial nerve outcome.

In our opinion, for patients with a FNAC positive for benign lesion the exclusive use of ultrasound imaging provides enough information to study the neoplasm while allowing for a faster and cheaper preoperative evaluation.

Salivary gland neoplasms are uncommon, representing less than 4% of all head and neck tumours, with a site distribution of approximately 80% within the parotid gland and 10% within the submandibular and minor salivary glands respectively. Most parotid gland tumors are benign, while tumors in the submandibular and sublingual glands have a higher risk of being malignant.

Pleomorphic adenomas (PAs) and Warthin tumors (WTs) are the most common benign parotid tumors, making up 75% to 90% of all neoplastic diseases. Even though these tumors are benign, preoperative

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knowledge of tumor pathology affects the treatment strategy, the surgical procedure, and morbidity (1). PAs are associated with a 2% to 25% risk of malignant transformation over time, and recurrence rates have been shown to be higher in patients who undergo enucleation. Conversely, WTs usually do not recur, and a malignant transformation has not been observed; WTs are multicentric or bilateral in up to 20% of cases (2).

Epithelial tumors account for the majority (95%) of malignant parotid gland neoplastic diseases, but are infrequently encountered, with an overall incidence in the western world of approximately less then 10 cases per million per year (3, 4).

The surgical treatment of malignant tumors includes the removal of the salivary gland, with or without a neck dissection, according to the stage of the disease.

Imaging plays a key role in the evaluation of salivary gland masses, both as a diagnostic tool and for the surgical planning. Ultrasound (US) has several qualities including wide availability, low cost, safety, excellent resolution, real-time assessment and image guidance for needle biopsies, making it an ideal first line technique for parotid gland evaluation (5). Moreover US provides excellent localization of tumors and it allows for a differential diagnosis with cystic masses. Furthermore, through color and spectral Doppler analysis the tumor vascularity pattern can be studied.

PAs typically appear as well-circumscribed, smooth, round, or lobulated hypoechoic masses with a posterior acoustic enhancement. They usually appear as hypo vascular, with a peripheral distribution on power Doppler if compared to WTs and malignant neoplasms (6). WTs are typically well-circumscribed, oval or round, hypoechoic, solid or partially cystic masses with a slightly heterogeneous echo pattern. WTs have a prominent vascularity on power Doppler with a central or mixed distribution.

Primary salivary malignancies' sonographic features are more varied than the ones of benign tumors, partially reflecting the range of histologic grades. High-grade malignancies have irregular or ill-defined margins, while in low grade malignancies smooth margins are more common. Other malignant features, although less reliable, include a heterogeneous echotexture, a chaotic and increased vascularity, and high resistive vascular indexes on spectral Doppler (7).

In the last decades many US advanced techniques have been developed which may significantly increase US accuracy in differentiating salivary gland pathologies. Microvascular sonography shows micro vessels with a slow flow in small salivary gland tumors that are not generally seen on conventional Doppler sonography. Recent studies have proved that the diagnostic accuracy of microvascular sonography in differentiating between pleomorphic adenomas and Warthin tumors is higher than the one of Doppler sonography (8).

Contrast-enhanced ultrasound (CEUS) uses microbubble agents as acoustic signal enhancers to describe the micro vascularity of the lesion and provide more objective qualitative and quantitative diagnostic data for a clinical diagnosis. Different studies have proved that the score based on combined CEUS and Color Doppler is a useful means to differentiate benign from malignant focal lesions in major salivary glands (9).

Ultrasound elastography (USE) is a non-invasive technique that measures and displays tissue elasticity evaluating the responses recorded by the probe to the mild transient deformations produced by mechanical or acoustic impulses. Many studies about USE in parotid and submandibular neoplastic diseases have been published, most of which suggest that salivary malignancies have higher mean stiffness indexes then benign neoplasms, although there is still marked overlapping (10).

MRI is considered as a second-line exam for the assessment of salivary gland pathologies, and it is usually performed for a pre-operative evaluation to determine the deep or superficial location of a parotid lesion, to describe the tumor extension and signal features and to establish the relationship between the tumor and the facial nerve (11).

Both US and MRI techniques are not precise for predicting the histology, with a considerable overlapping between the various salivary lesions. Therefore, the pre-operative examination of parotid masses usually includes a fine-needle aspiration

cytology (FNAC). FNAC is widely used as a first-line technique for the diagnosis of salivary gland diseases, but many studies have highlighted its limitations, including a high rate of false-negative results and poor accuracy in distinguishing the various types of malignant tumors (12, 13). A recent publication reported a 6% false-negative rate and a 10% false-positive rate (out of 138 cases), a sensitivity for malignancy of 73% and a specificity of 87% (14). A meta-analysis showed that ultrasound-guided core needle biopsy (USCB) has higher levels of accuracy and reduced non-diagnostic rates if compared to FNAC, in addition to good patient tolerability (15). A degree of caution should, however, be exercised because of the potential for tumor seeding.

In our study, we analyzed the role of US in the pre-surgical evaluation of parotid gland tumors in order to understand if it can be considered a sufficient tool, considering surgical complications and recurrence rates.

MATERIALS AND METHODS

In our retrospective study, we examined patients with parotid diseases who underwent surgery between 2010 and 2020. Two departments took part in this study, the department of Otorhinolaryngology and the one of Maxillo-facial surgery of the University of Verona.

The first one examined patients treated between 2014 and 2020 while the second one examined patients who underwent surgery between 2010 and 2020. We created a multi-parameter retrospective database for patient evaluation with a total of 402 patients. We then selected only the ones with a benign pathology for a total of 278 patients, of these 15 were lost during the follow up, thus obtaining a final number of 263 patients actually included in the present study.

Among all the patients in our retrospective database, we selected the ones who had undergone surgery after being evaluated only through preoperative ultrasound imaging for a benign pathology after FNAC (126 altogether). As a control group we used the patients who had undergone surgery for benign pathologies after FNAC, preoperatively studied through third level imaging, more frequently MRI (all in all 137 patients).

5 researchers performed either a partial or a total parotidectomy; 3 of them collected data and devoted to text-processing; 1 of them helped with text-processing and edited the bibliography; 1 of them made the ultrasound and radiological evaluation.

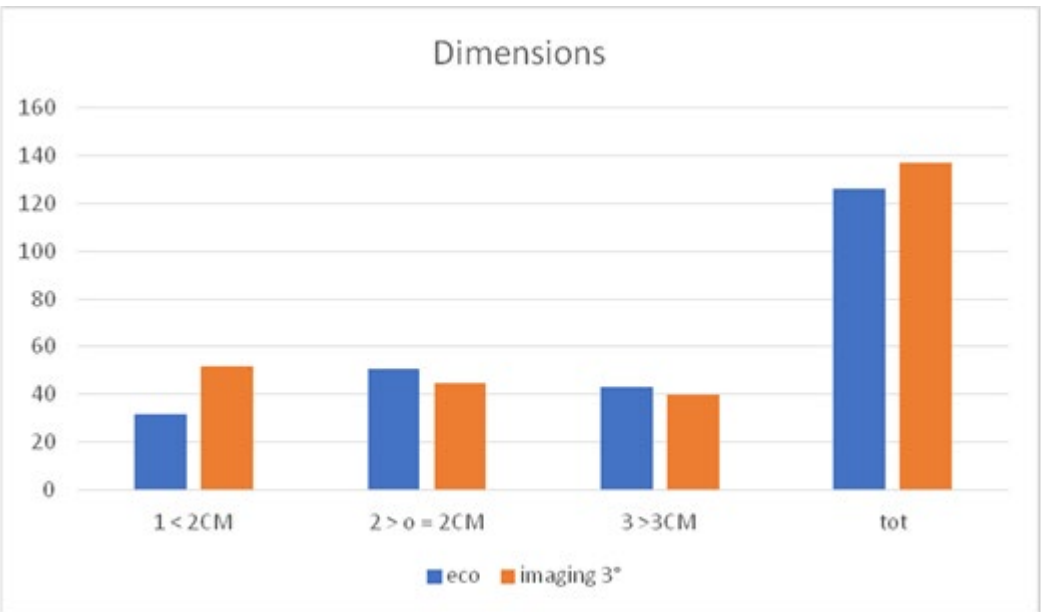

Fig 1. *Dimensions*

RESULTS

We subdivided the total number of patients according to the dimension of their lesion into three groups, below 2 cm of size, between 2 and 3 cm and bigger than 3 cm. The largest group was the one with lesions sized between 2 and 3 cm. For all groups both US and third level imaging were used as diagnostic means. While in the first group the most widely used diagnostic method turned out to be the third level one (38% vs 25.4% of the US), in the other two dimensional groups US was slightly more frequent (74.6% vs 62%) (Fig. 1).

We then examined the relapse rate of patients studied with ultrasound and those studied with third-level exams. In this case, as can be seen in Fig. 2, the results don't have a clear statistic relevance. In 97,6% of the patients (123) studied with ultrasound there wasn't any kind of recurrence while in the

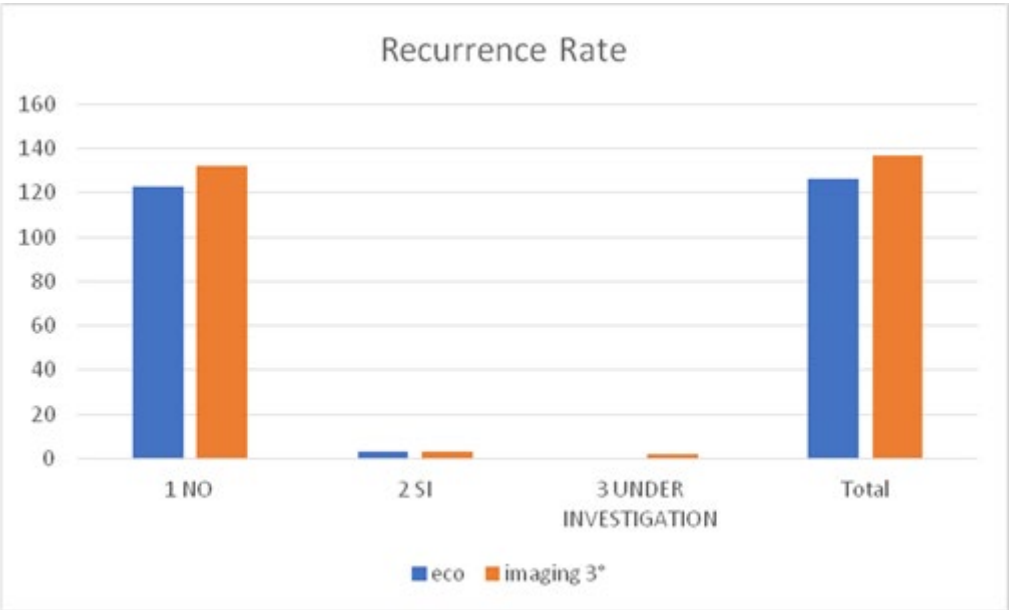

Fig. 2. *Recurrence rate*

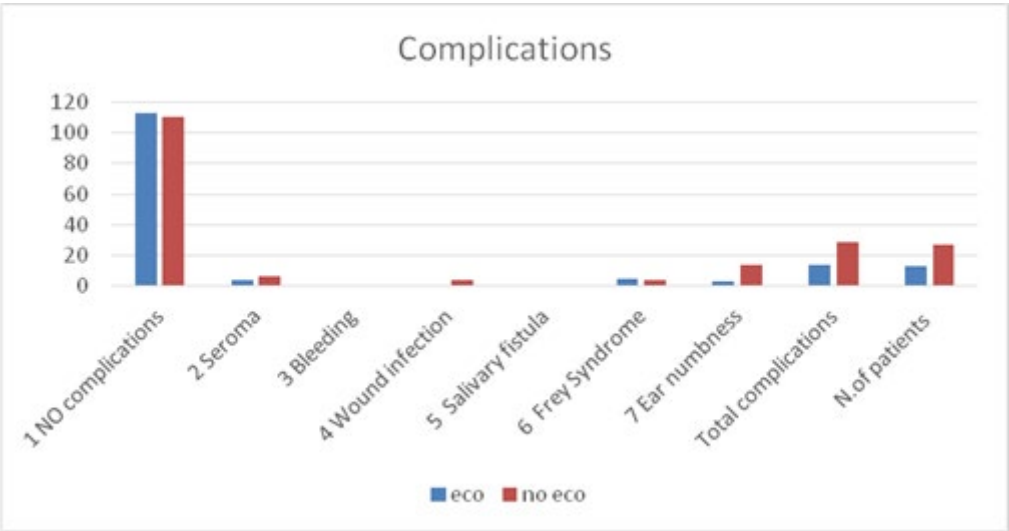

Fig. 3. *Complications*

remaining 2,4% (3 patients) we had a recurrence. Conversely, while examining the patients who had undergone third-level imaging we found that the rate of patients without recurrence was 96,3% (132); 2,2% patients had a recurrence (3) and in 1,5% of cases investigations were being carried out at the time of writing (2). Therefore, the statistics of the patients studied with the ultrasound technique was better than the one of the patients studied with third-level imaging.

For sure the most interesting evaluation was the one about postoperative complications reported in Fig. 3. In this case the incidence of complications was unexpectedly lower for the patients studied with exclusively preoperative ultrasound imaging (only 10,3%) while the patients with third-level imaging exams had a higher incidence of complications (19,7%).

Last but not least, we took the outcome of the facial nerve into account in Fig. 4. For practical reasons, given the small number of patients, we divided them into two categories, those with a partial impairment and those with a complete one. The patients without any deficits after surgery studied with ultrasound preoperative imaging were 112 out of 126 while the patients studied with third-level exams without deficits were 110 on a total of 137. In the third level imaging group, the patients with a partial deficit were twice as many as the ones studied with US (25 vs 13). Only 3 patients out of the overall group of 263 who had undergone surgery for a benign lesion had a complete deficit of the facial nerve. So, also in this area there wasn't a relevant statistical difference between the two groups of diagnostic method.

DISCUSSION

Over the years a great debate has arisen among surgeons about the best choice in preoperative exams before major salivary gland surgery. Some schools are in favor of third level imaging while others prefer to combine FNAC with ultrasound and, when malignancy is suspected, MRI or CT scan for a more accurate investigation of the gland and a complete evaluation also of the neck nodes (16).

US is a valuable and useful method for diagnosis of salivary gland tumors, it offers information about the tumor localization and the pattern of vascularization using spectral Doppler and it is able to assess the cystic component of the lesion at hand (17).

MRI, the most commonly used third level diagnostic method in our case series, is normally seen as a second-line diagnostic evaluation for

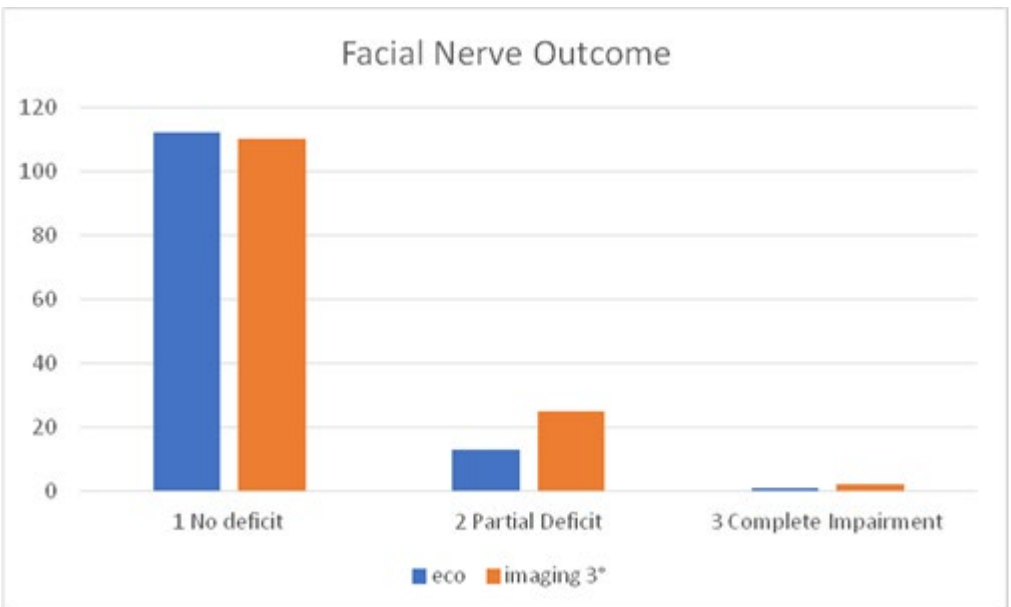

Fig. 4. *Facial Nerve Outcome*

salivary gland disease and it is usually chosen before surgery is carried out, in order to assess the tumor characteristics, deep or superficial location, signal features and extension. Moreover, MRI has proven to be particularly useful in determining perineural spread and in analyzing the relationship between the tumor and the facial nerve (18).

Considering our 10-year experience from 2010 to 2020 on 263 patients treated for a parotid gland benign neoplastic disease, we might say we obtained obtained some interesting results if compared to literature. As shown above, it is important to point out that we used both diagnostic methods (US and third level) in more or less equal measure, regardless of the dimension of the lesion, proving our results to be relevant for all size groups.

Interestingly, we found the recurrence rate to be almost the same whichever of the two diagnostic method was chosen, leading us to believe that US as the only imaging technique is not a risk factor for recurrence. Moreover, as far as the risk of postoperative complications is concerned, we saw that the patients studied through third level preoperative imaging generally had a worse outcome, even when the facial nerve result was concerned.

We therefore are led to believe that for patients with a parotid gland neoplastic disease with a FNAC positive for a benign lesion, the US as the sole diagnostic method of choice is enough to properly evaluate the lesion and plan the surgical treatment even for neoplasms of big dimensions (>2-3 cm), while allowing for a faster, cheaper and safer preoperative evaluation that may speed up the assessment of the patient and shorten the length of time before surgery.

In keeping with literature, the last ten years of our experience have shown that patients who have to undergo surgery for lesions involving the parotid glands must be tested through FNAC. In our study no difference in the incidence rate, whatever the lesion dimension, was found between ultrasound evaluation and a third level imaging technique, in addition the recurrence rate and the rate of complications were comparable between the two methods analyzed, with lower values in the complication rate for the US.

In the opinion of the current authors, for patients with a FNAC positive for benign lesion and in patients without clinical sings of neck adenopathies, the exclusive use of ultrasound imaging provides enough information to study the neoplasm and plan the surgical treatment while allowing for a faster preoperative evaluation and a consequent quicker access to the operating room.

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