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Evaluation of parotid and submandibular salivary glands by ultrasonography in patients using antidepressants: a case control study

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ORIGINAL RESEARCH

EVALUATION OF PAROTID AND SUBMANDIBULAR SALIVARY GLANDS BY ULTRASONOGRAPHY IN PATIENTS USING ANTIDEPRESSANTS: A CASE CONTROL STUDY

Running Title: Salivary Glands and Ultrasonography

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Abstract

Background: Antidepressants are widely prescribed group of medications frequently associated with xerostomia. Although alterations in salivary flow among antidepressant users have been extensively investigated, there is a paucity of data regarding the structural and vascular ultrasonographic characteristics of the major salivary glands. This study aimed to evaluate the echogenicity, parenchymal structure, margin characteristics, blood supply characteristics, and dimensions of the parotid and submandibular glands in antidepressant users compared with systemically healthy controls using ultrasonography (USG).

Methods: In this study, both right and left parotid and submandibular salivary glands of 102 individuals (51 healthy and 51 antidepressant users) were examined by USG. Data normality was evaluated using the Kolmogorov–Smirnov test. Group comparisons were performed using independent samples *t*-tests or Mann–Whitney U tests, as appropriate, and categorical variables were analyzed using the chi-square test. A *p*-value < 0.05 was considered statistically significant.

Results: There is no significant differences between antidepressant users and healthy individuals in terms of echogenicity, parenchymal structure, margin and blood supply characteristics of the submandibular and parotid salivary glands. However, the mean supero-inferior dimension of the right submandibular gland was significantly higher in the patient group than in the control group. The median medio-lateral dimension of the left submandibular gland was significantly lower in patients compared with controls. Additionally, the mean medio-lateral dimensions of both the right and left parotid glands were significantly lower in the patient group than in the control group.

Conclusions: The ultrasonographic appearance of the major salivary glands did not differ significantly between antidepressant users and healthy controls in terms of tissue characteristics and vascularity, despite limited dimensional differences. These findings suggest that antidepressant use does not markedly alter the ultrasonographic appearance of the salivary glands. Further studies with larger sample sizes, incorporating salivary flow measurements and elastography, are warranted to elucidate the functional and biomechanical effects of antidepressant use on the salivary glands.

Keywords: Ultrasonography, submandibular gland, parotid gland, antidepressants

Introduction

Ultrasonography (USG) is an imaging method that allows the examination of soft tissue and parenchymal organs using sound waves. As a non-ionising, non-invasive and dynamic imaging method, it has a wide range of applications in the head and neck region [1]. The main uses of USG in dentistry are the examination of salivary glands, periapical lesions, lymph nodes, intra-osseous lesions, temporomandibular joint, tongue and periodontal tissue

[2]. With the help of USG, salivary gland anomalies, location, shape, dimensions and blood supply can be determined. The homogeneity of the parenchyma and blood flow can be evaluated. [3].

In the salivary gland system, in addition to three large salivary glands in pairs, there are approximately 1000 small salivary glands located in the aerodigestive mucosa, which is the upper part of the respiratory and digestive tracts [4,5]. These glands play an important role in the execution of physiological functions such as chewing, tasting, speaking and in the protection of oral cavity health [6].

Xerostomia is defined as a subjective feeling of dry mouth and an important side effect of many commonly prescribed drugs. A substantial number of pharmacological agents, estimated at nearly 1,800 drugs within more than 80 therapeutic classes, have been identified as potential contributors to xerostomia. Among these, antidepressants are frequently implicated due to their pharmacological mechanisms, which may interfere with autonomic regulation of salivary secretion [7-9].

Antidepressant agents (particularly those with anticholinergic or serotonergic effects) may reduce parasympathetic stimulation of salivary acinar cells, leading to decreased salivary flow and glandular hypofunction [10]. Although alterations in salivary flow among antidepressant users have been extensively investigated, there is a paucity of data regarding the structural and vascular ultrasonographic characteristics of the major salivary glands [11]. A better understanding of these potential morphological changes is essential for elucidating the underlying mechanisms of drug-induced xerostomia and for guiding non-invasive imaging strategies in clinical practice. Therefore, in the current study we aimed to evaluate the echogenicity, parenchymal structure, margin characteristics, blood supply characteristics, and dimensions of the parotid and submandibular glands in antidepressant users compared with systemically healthy controls using USG.

Material Method

For this study, the approval of Aydın Adnan Menderes University, Faculty of Dentistry, Non-Interventional Clinical Research Ethics Committee was obtained with the decision

number 03 dated 25.10.2023. The study included a total of 102 individuals over the age of 18 who had applied to Aydın Adnan Menderes University, Faculty of Dentistry, Department of Oral, Dental and Maxillofacial Radiology for any reason, who signed the informed consent forms and stated that they agreed to be included in the study. As no comparable studies in the literature have evaluated the salivary glands using USG in patients using antidepressants, a power analysis was performed. Assuming a Type I error rate of 0.05 and a statistical power of 80% for a t-test, the required sample size was calculated as 102 to detect a moderate effect size (0.5).

Inclusion Criteria

- For the patient group; Individuals over 18 years of age and without systemic disease requiring the use of medication other than antidepressants
- For the control group; systemically healthy individuals without continuous drug use

Exclusion Criteria

- Individuals with mental and physical disabilities
- Individuals with a history of radiotherapy and chemotherapy
- Individuals with a history of salivary gland neoplasms
- Smokers

Detailed intraoral and extraoral examinations were performed to detect pathological findings in and around the mouth and to inform the patient. Imaging of the submandibular and parotid salivary glands was performed with a GE LOGIQ S8 withXDclear (SONY GE Ultrasound, Jungwon-gu, Seongnam- si, Gyeonggi-do, Korea) brand USG device in the Department of Oral, Dental and Maxillofacial Radiology, Faculty of Dentistry, Aydın Adnan Menderes University. All imaging and measurements were performed by the same observer to ensure standardisation during the evaluation of the patients and to prevent individual differences. All measurements and evaluations were repeated by the same observer after one month. Patients were positioned supine and measurements and evaluations were performed. Parotid gland imaging was performed perpendicular to the posterior edge of

the ramus (transversal) and parallel to the posterior edge of the ramus (longitudinal). Submandibular gland imaging was performed by positioning the probe parallel to the base of the mandible (transversal) and vertical to the base of the mandible (longitudinal). Imaging was performed in real-time B mode. For all measurements and evaluations in this study, the methodology described by Ozturk and Yalcin [12] was used as a reference. For the parotid gland, antero-posterior dimension was measured with the probe in the transversal position, medio-lateral dimension and infero-superior dimension were measured with the probe in the longitudinal position (Figure 1). In the submandibular gland, antero-posterior dimension and infero-superior dimension were measured with the probe in the transversal position, and medio-lateral dimension was measured with the probe in the longitudinal position (Figure 2).

In USG evaluation, the masseter muscle was taken as the reference for parotid gland echogenicity, while the mylohyoid muscle was used to benchmark the submandibular gland. The parotid gland was classified as hyperechoic when it appeared brighter than the masseter muscle, hypoechoic when it appeared darker, and isoechoic when it exhibited similar echogenicity. Similarly, the echogenicity of the submandibular gland was categorized as hyperechoic, isoechoic, or hypoechoic relative to adjacent mylohyoid muscle (Figure 3).

The margins of the glands were evaluated as regular, focally irregular and markedly irregular margins (Figure 4). If the borders of the examined gland were clearly visible, it was called regular margin, if there was loss of continuity in places, it was called focal irregular margin, and if there were completely irregular borders, it was called markedly irregular margin.

The parenchyma of the glands were evaluated as homogeneous, minimally heterogeneous and markedly heterogeneous (Figure 5). The examined gland was defined as homogeneous if the general echogenicity of the parenchyma was the same, as minimally heterogeneous if there were hyperechoic or hypoechoic areas, and as markedly heterogeneous if there were hyperechoic or hypoechoic areas spreading throughout the gland.

To assess glandular blood supply using colour Doppler USG, the Color Flow (CF) mode was activated, and the region of interest was adjusted on the monitor to encompass the area under examination. Vascularization of the submandibular and parotid glands was subsequently classified as hypervascularization, normal vascularization, or hypovascularization (Figure 6).

Statistical Method

Statistical Package for Social Science (SPSS) 19.0 programme was used for data evaluation. Compliance with normal distribution was evaluated by Kolmogorov-Smirnov test. Descriptive statistics are given as number and percentage, mean and standard deviation, median and minimum-maximum values. The relationship between categorical data between patient and control groups was evaluated by chi-square test. The relationship between the continuous data between the patient and control groups was analysed by independent samples t-test for the data fitting the normal distribution and Mann-Withney U test for the data not fitting the normal distribution. The relationship between age and measurement data was evaluated by Spearman correlation test. Type 1 error value was taken as 0.05.

Results

A total of 102 individuals, 51 (30 females, 21 males) in the patient group and 51 (30 females, 21 males) in the control group, were included in this study. The overall mean age of the study population was 36.6±12.8 years. The mean age of the patient group was 36.7±13.2, the mean age of the control group was 36.4±12.5, with no statistically significant difference between groups ($p = 0.91$). Among the patients using antidepressants, 38 were receiving Selective Serotonin Reuptake Inhibitors (SSRI) class medications and 13 were receiving Serotonin and Norepinephrine Reuptake Inhibitors (SNRI) class medications. In the medication group, the duration of antidepressant use ranged from 2 to 13 years.

Intra-observer reliability was assessed in all measurements and assessments. Intra-observer reliability was evaluated by Cohen's Kappa in categorical data and by intraclass correlation coefficient in measurement data and as a result of these evaluations, the measurements were found to be reliable. (Table 1)

Descriptive statistics of the dimensions of the right and left submandibular and parotid glands are shown in Table 2.

The comparison of right-left submandibular gland and right-left parotid gland dimensions between the control and the patient group is given in Table 3. The mean supero-inferior distance of the right submandibular gland in the patients (13.9±1,0 mm) was significantly higher than the mean value in the control group (13.4±1.0 mm) ($p=0.02$). However, no statistically significant difference was found between the median antero-posterior, medio-lateral values of the right submandibular gland ($p>0.05$). The mean medio-lateral distance of the left submandibular gland in patients (32.4±1,9 mm) was significantly lower than the mean value in the control group (33.2±1,1 mm) ($p=0.01$). However, there was no statistically significant difference between the median antero-posterior, supero-inferior values of the left submandibular gland ($p>0.05$). The mean medio-lateral distance of the right parotid gland in patients (15,0±1,3 mm) was significantly lower than the mean value in the control group (15.7±1.5 mm) ($p=0.007$). However, there was no statistically significant difference between the median antero-posterior, supero-inferior values of the right parotid gland ($p>0.05$). The mean medio-lateral distance of the left parotid gland in the patients (15,0±1,3 mm), was significantly lower than the mean value in the control group (15.6±1.6 mm) ($p=0.03$). However, no statistically significant difference was found between the median antero-posterior, supero-inferior values of the left parotid gland ($p>0.05$).

Descriptive statistics of the echogenicity, margin, parenchyma and blood supply characteristics of the right and left submandibular and parotid glands are given in Table 4.

The comparison of echogenicity, margin, parenchyma and blood supply parameters of the right and left submandibular glands between the patient and the control group is given in Table 5.

The comparison of echogenicity, margin, parenchyma, blood supply parameters of the right and left parotid glands between the control and the patient group is given in Table 6. There was no difference between the control and the patient group in the echogenicity, margin, parenchyma, blood supply parameters of the right-left submandibular gland and the right-left parotid gland ($p>0.05$).

Discussion

Depression is a common mood disorder that affects people individually or socially. Antidepressants, which are a group of drugs that play an important role in the treatment of depression, cause many side effects [13]. Dry mouth, which is among the side effects, occurs due to the effect of antidepressants on the salivary glands.

Navazesh et al. [14] researched the relationship between the use of antidepressant, antihypertensive, antiaggregant, antidiabetic and antihistaminic drugs and the dose of drug use with salivary flow rate. They reported that antidepressant and antiaggregant drug use decreased salivary flow rate and this effect was more pronounced in women than in men. In long-term studies, it was observed that antidepressant and daily aspirin use increased dry mouth in a period of 5-11 years [15,16].

The xerostomic effects of antidepressants have been well established in the literature [10,14,17]. Physiopharmacology for depression is considered as a rapidly changing and developing subject in the last fifty years. Antidepressant agents used from the past to the present stimulate serotonergic or noradrenergic mechanisms. Especially, tricyclic antidepressants cause dry mouth by blocking histaminic, cholinergic and alpha 1-adrenergic receptors [18]. Thomson et al. [19] researched the relationship between antidepressant drug use and dry mouth and reported that unstimulated salivary flow rate decreased in patients using antidepressant drugs. While changes in salivary flow in

individuals using antidepressants have been extensively studied, data regarding the structural and vascular characteristics of the major salivary glands are insufficient [11]. Various imaging modalities, including direct radiography, sialography, USG, computed tomography (CT), magnetic resonance imaging (MRI), and nuclear scintigraphy can be used to evaluate the salivary glands [20]. USG is a more practical, cost-effective, accessible, safe, non-ionizing, and non-invasive imaging modality compared with other methods [21,22]. Lee et al. [23] evaluated the diagnostic performance of different imaging methods in salivary gland neoplasms. They reported that when deep tissue extension is suspected or malignancy is confirmed by cytology, CT or MRI is necessary to assess tumor characteristics, local invasion, and perineural spread. However, USG was recommended for imaging superficial lesions and nodal involvement in the submandibular and parotid glands because of its high resolution and ability to provide tissue characterization. Similarly, Orloff et al. [24] investigated the success of USG in the diagnosis and treatment of salivary gland diseases and reported that qualified USG may eliminate the need for MRI and CT. They reported that inflammatory and neoplastic salivary gland disorders, as well as the ductal system and lymph nodes, can be diagnosed by evaluating them with ultrasound.

In dentistry, the use of USG to evaluate salivary glands is becoming increasingly common. Previous studies have employed USG to assess salivary gland alterations associated with diabetes mellitus, Sjögren's syndrome, and inflammatory conditions [3,25,26]. Ozturk and Yalçin [12] evaluated B-mode ultrasonography parameters, including the size, volume, and echogenicity of the bilateral parotid and submandibular salivary glands, as well as shear-wave elastography values and color Doppler features in patients with diabetes mellitus (DM) and healthy control groups. Kıranatlı et al. [27] investigated salivary gland homogeneity, resting salivary flow rates, and DMFT indices in patients with multiple sclerosis (MS), while Sahin and Kotanlı [28] examined the ultrasonographic characteristics of salivary glands in long-term smokers.

Decreased total salivary flow and xerostomia cannot be considered to be caused only by the parotid gland. It is known that submandibular glands play an important role in salivary flow

together with parotid glands. For this reason, consistent with previous studies [29,30], both parotid and submandibular glands were evaluated in the present study. The fact that the submandibular glands can be visualised more easily and comfortably than the parotid glands helps to measure their dimensions more clearly [30]. Although the deep lobe of parotid gland is less accessible and trying to measure the size and volume of the parotid gland as a whole with USG is not described as a correct method, the superficial lobe can be reliably assessed using USG, as demonstrated in many studies [25,29,30].

In a study conducted by Dost et al. [31] using USG in 50 healthy individuals without salivary gland disease, it was observed that the sizes of submandibular and parotid glands did not differ significantly depending on age and gender. In this study, the size and volume of the salivary glands measured by USG were compared with actual measurements in 16 cadavers and a statistically significant difference was found. They stated that trying to determine the actual volumes of salivary glands ultrasonographically may cause erroneous results, but it would not be erroneous to use USG to compare two different patient groups. They concluded that the measurements made with USG are not logical in terms of determining the actual dimensions, but the use of USG in comparing measurements made at different times in the same patients would not be a defect.

The literature reports an increase in salivary gland size in patients with diabetes mellitus [12] and marked glandular atrophy following radiotherapy [32]. In the present study, statistically significant differences in salivary gland dimensions were observed between individuals using antidepressants and healthy controls. The reduction in parotid gland size may be interpreted as a morphological correlate of medication-induced functional decline. Topak et al. [25] compared parotid gland dimensions in patients with type II diabetes mellitus (DM), with those of a healthy control group. In contrast to the findings of Ozturk and Yalcin [12], they reported no statistically significant differences in parotid gland dimensions between the groups and identified no correlation between diabetes duration and any measured parotid parameters. The authors suggested that these findings may be

attributable to the lack of consideration of autonomic neuropathy among the diabetic cohort.

In studies using USG [33-35], the echogenicity of the parotid glands was classified as hyperechoic, isoechoic and hypoechoic by comparing the echogenicity of the parotid glands with the adjacent masseter muscle and the echogenicity of the submandibular glands with the mylohyoid muscle. Homogeneity is a term used to express the same echogenicity in every region of the structure evaluated in USG. In healthy individuals, salivary glands are generally visualised homogenously. However, in some cases, it may have a heterogeneous appearance. In addition, hyperechoic lines and fibrosis-like spots are thought to cause a heterogeneous appearance [21]. When we examine the literature [29,34,36], it was seen that submandibular and parotid glands were evaluated as homogeneous and heterogeneous in terms of parenchyma structure.

Alyas et al. [37] and Howlett et al. [35] investigated the changes occurring in the glands in parotid and submandibular salivary gland diseases by USG. Parotid and submandibular glands, which are normally isoechoic or slightly hyperechoic and homogeneous, were observed as hypoechoic, homogenous parenchyma and irregular margins in pathologies such as sialadenitis, abscess, tuberculosis, sarcoidosis, Sjögren's syndrome, malignant and benign neoplasms of the salivary gland.

Sahin and Kotanlı [28] observed no statistically significant differences in echogenicity between smokers and controls; however, parenchymal heterogeneity and irregular gland margins were observed more frequently in smokers, and the volumes of both the submandibular and parotid glands were significantly higher in smokers compared with controls. In patients with diabetes mellitus, Ozturk and Yalcin [12] reported a higher prevalence of hypoechoic echogenicity, marked parenchymal heterogeneity, reduced perfusion, and hypovascularization in the bilateral parotid glands compared with healthy controls. Similarly, Açıkgöz et al. [38] demonstrated that, prior to radiotherapy, the submandibular glands predominantly exhibited hyperechoic echogenicity, homogeneous echotexture, and regular margins, whereas following radiotherapy, a distinct

transformation was observed, characterized by isoechoic to hypoechoic features, heterogeneous echotexture, and irregular margins, with a gradual tendency toward normalization of the parenchymal structure over time. Kıranatlı et al. [27] reported that the parenchyma of the major salivary glands in MS patients exhibited lower homogeneity than that of healthy controls, along with decreased salivary flow rates and increased DMFT indices in the MS group. The authors suggested that autonomic dysfunction and medications used for MS may contribute to salivary gland hypofunction and xerostomia.

In a study using USG to examine the vascular structure and anatomy of the salivary glands [39], major salivary glands were examined by colour doppler USG in a group of patients with chronic autoimmune diseases including salivary gland sarcoidosis and Sjögren's Syndrome and in a healthy control group. It was concluded that colour Doppler USG can be used to evaluate the vascularity of the salivary glands, to identify benign and malignant pathological conditions, and that colour Doppler USG can provide differential diagnostic information in patients with chronic inflammatory diseases or suspected malignant tumours.

In the present study, no statistically significant difference was observed between patients using antidepressants and healthy controls in terms of echogenicity, margin characteristics, parenchymal structure, and vascularization patterns of the salivary glands. This finding suggests that the pronounced ultrasonographic tissue alterations typically associated with systemic conditions such as diabetes mellitus, Sjögren’s syndrome, or post-radiotherapy status are not evident in individuals using antidepressant medications.

A major strength of this study is the absence of systemic disease in both groups and the matching of participants by age and sex. However, several limitations should be acknowledged. Body mass index was not evaluated, which may influence salivary gland dimensions. Ultrasonographic measurements are inherently operator-dependent and influenced by probe positioning, and the deep lobe of the parotid gland cannot be reliably visualized, limiting accurate volumetric assessment. Although the data were evaluated

twice by a single observer to enhance consistency, independent assessments by multiple experts are recommended in future studies to minimize potential observer bias.

Furthermore, the lack of objective salivary flow rate measurements represents an important limitation, as such data would provide quantitative functional assessment. All patients in the study group were using SSRI or SNRI-class antidepressants, which may be associated with bruxism; however, a history of teeth grinding was not assessed, potentially confounding the findings. Future investigations should include diverse antidepressant classes, longer treatment durations, dosage stratification, salivary flow measurements, and elastography to achieve a more comprehensive evaluation of salivary gland structure and function.

Conclusion: USG is a reliable and non-ionizing first-line imaging modality for the evaluation of the major salivary glands, providing highly useful data for examining parenchyma, echogenicity, and anatomical relationships. In this study, the ultrasonographic appearance of the major salivary glands did not differ significantly between antidepressant users and healthy controls in terms of tissue characteristics and vascularity, despite limited dimensional differences. These findings suggest that antidepressant use does not markedly alter the ultrasonographic appearance of the salivary glands. Further studies with larger sample sizes, incorporating salivary flow measurements and elastography, are warranted to elucidate the functional and biomechanical effects of antidepressant use on the salivary glands.

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Author Contributions

ST and SY: literature search and design of the work; ST: acquisition of data and writing of the manuscript; ST and SY: analysis and interpretation of data and drafting of manuscript and revisions.

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Data Availability

All data generated or analyzed during this study are included in this article. Further inquiries can be directed to the corresponding author.

Declarations

Ethics approval and consent to participate

For this study, the approval of Aydın Adnan Menderes University, Faculty of Dentistry, Non-Interventional Clinical Research Ethics Committee was obtained with the decision number 03 dated 25.10.2023.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the Institutional and/or National Research Committee and in alignment with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Additional informed consent was obtained from all participants included in the study.

Consent for publication

The informed consent forms obtained from the patients included explanatory text for personal or clinical details and identifying images to be published in this study, and written informed consent was obtained for their use.

Competing interests

The authors declare no competing interests

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Table 1. Intraobserver Agreement Values

	In-Class Correlation Coefficient
Right Parotid Anteroposterior	0,99
Right Parotid Mediolateral	0,99
Right Parotid Superoinferior	1,00
Right Submandibular Anteroposterior	1,00
Right Submandibular Mediolateral	1,00
Right Submandibular Superoinferior	0,99
Left Parotid Anteroposterior	1,00
Left Parotid Mediolateral	1,00
Left Parotid Superoinferior	1,00
Left Submandibular Anteroposterior	1,00
Left Submandibular Mediolateral	1,00
Left Submandibular Superoinferior	0,99
	Cohen'sKappa
Right Parotid Echogenicity	0,89
Right Parotid Margin	0,95
Right Parotid Parenchyma	0,95
Right Parotid Blood Supply	0,97

Right Submandibular Echogenicity	0,93
Right Submandibular Margin	0,93
Right Submandibular Parenchyma	0,96
Right Submandibular Blood Supply	0,96
Left Parotid Echogenicity	0,82
Left Parotid Margin	0,97
Left Parotid Parenchyma	0,98
Left Parotid Blood Supply	0,99
Left Submandibular Echogenicity	0,92
Left Submandibular Margin	0,98
Left Submandibular Parenchyma	0,90
Left Submandibular Blood Supply	0,82

Table 2. Size measurements of the submandibular and parotid glands

		Mean ± SD	Median (Minimum-Maximum)
Right Submandibular	Antero-posterior (mm)	34,4±2,1	34.3 (28.5-38.2)
	Medio-lateral (mm)	32,2±1,8	32,4 (25.3-35.9)
	Supero-inferior (mm)	13,6±1,1	13,7 (10,9-15,7)
Left Submandibular	Antero-posterior (mm)	34,8±2,0	34,7 (28,6-38,8)
	Medio-lateral (mm)	32,8±1,6	32,9 (25,6-36,1)
	Supero-inferior (mm)	13,8±0,9	13,7 (11,2-15,9)
Right Parotid	Antero-posterior (mm)	41,2±1,8	41,6 (36,0-44,5)
	Medio-lateral (mm)	15,3±1,5	15,2 (12,8-18,8)
	Supero-inferior (mm)	40,9±1,7	40,8 (36.9-44.1)
Left Parotid	Antero-posterior (mm)	41,2±1,9	41,4 (32,8-44,7)
	Medio-lateral (mm)	15,3±1,5	15,2 (12,6-19,8)
	Supero-inferior (mm)	41,2±1,7	41,0 (37,2-44,3)

independent samples t-test

Table 3. Relationship between Parotid and Submandibular Gland Sizes between Patient and Control Groups

	Group	
	Control	Patient

	Values	Mean ± SD	Median (Minimum-Maximum)	Mean ± SD	Median (Minimum-Maximum)	p
Right Parotid	Antero-posterior (mm)	41,1±1,8	41.0 (36.0-44.2)	41,3±1,8	41,6 (36,1-45,0)	0.46
	Medio-lateral (mm)	15,7±1,5	15.6 (13.2-19.0)	15,0±1,3	14.7 (13.0-18.0)	**0.007**
	Supero-inferior (mm)	41,0±1,6	40.9 (37.0-44.1)	41,0±1,8	40.6 (37.0-44.0)	0.91
Right Submandibular	Antero-posterior (mm)	34,2±2,1	34.2 (28.5-38.0)	34,5±2,1	34.5 (29.0-38.2)	0.47
	Medio-lateral (mm)	32,0±1,8	32.2 (25.3-35.4)	32,4±1,8	32.6 (25.5-35.9)	0.22
	Supero-inferior (mm)	13,4±1,0	13.4 (11,0-13.4)	13,9±1,0	14.0 (11.4-15.7)	**0.02**
Left Parotid	Antero-posterior (mm)	41,0±2,1	41.0 (33,0-44,0)	41,4±1,7	42,0 (37,0-45,0)	0.28
	Medio-lateral (mm)	15,6±1,6	16,0 (14.4-16,0)	15,0±1,3	15,0 (13,0-17.2)	**0,03**
	Supero-inferior (mm)	41,1±1,7	41.1 (38,0-44,0)	41,2±1,8	41.0 (37.2-44.2)	0.96
Left Submandibular	Antero-posterior (mm)	34,8±1,8	35,0 (31.1-39,0)	34,8±2,3	35,0 (29,0-39,0)	0,95
	Medio-lateral (mm)	33,2±1,1	33.1 (29,0-36,0)	32,4±1,9	33,0 (26,0-36.1)	**0.01**
	Supero-	13,6±0,8	14,0	13,9±1,1	14.0	0,13

	inferior (mm)	(11.3-16,0)	(11.2-16,0)

independent samples t-test

Table 4. Echogenicity, Margin, Parenchyma and Blood Supply Characteristics of Submandibular and Parotid Glands

		Right Parotid n (%)	Right Submandibular n (%)	Left Parotid n (%)	Left Submandibular n (%)
Echogenicity					
	Hyperechoic	86 (85,3)	13 (12,7)	87 (85,3)	16 (15,7)
	Isoechoic	15 (14,7)	84 (82,4)	15 (14,7)	80 (78,4)
	Hypoechoic	-	5 (4,9)	-	6 (5,9)
Margin					
	Regular margin	13 (12,7)	33 (32,4)	14 (13,7)	33 (32,4)
	Focal irregular margin	64 (62,7)	63 (61,8)	60 (58,8)	64 (62,7)
	Markedly irregular margin	25 (24,5)	6 (5,9)	28 (27,5)	5 (4,9)
Parenchyma					
	Homogenous	47 (46,1)	38 (37,3)	47 (46,1)	35 (34,3)
	Minimal heterogeneous	38 (37,3)	59 (57,8)	37 (36,3)	62 (60,8)
	Markedly heterogeneous	17 (16,7)	5 (4,9)	18 (17,6)	5 (4,9)
Blood Supply					
	Hypervascularization	32 (31,4)	54 (52,9)	31 (30,4)	56 (54,9)
	Normal	45 (44,1)	41 (40,2)	46 (45,1)	34 (33,3)
	Hypovascularization	25 (24,5)	7 (6,9)	25 (24,5)	12 (11,8)

chi-square test.

Tablo 5. The Relationship of Echogenicity, Margin, Parenchyma and Blood Supply Characteristics of Submandibular Glands

		Control n (%)	Patient n (%)	p
Right Submandibular	Echogenicity			0,86
	Hyperechoic	7 (13,7)	6 (11,8)	
	Isoechoic	41 (80,4)	43 (84,3)	
	Hypoechoic	3 (5,9)	2 (3,9)	
	Margin			0,51
	Regular margin	15 (29,4)	18 (35,3)	
	Focal irregular margin	34 (66,7)	29 (56,9)	
	Markedly irregular margin	2 (3,9)	4 (7,8)	
	Parenchyma			0,90
	Homogenous	18 (35,3)	20 (39,2)	
	Minimal heterogeneous	30 (58,8)	29 (56,9)	
	Markedly heterogeneous	3 (5,9)	2 (3,9)	
	Blood Supply			0,61
	Hypervascularization	28 (54,9)	26 (51,0)	
	Normal	21 (41,2)	20 (39,2)	
Left Submandibular	Echogenicity			1,00
	Hyperechoic	8 (15,7)	8 (15,7)	
	Isoechoic	40 (78,4)	40 (78,4)	
	Hypoechoic	3 (5,9)	3 (5,9)	
	Margin			0,23
	Regular margin	13 (25,5)	20 (39,2)	
	Focal irregular margin	36 (70,6)	28 (54,9)	
	Markedly irregular margin	2 (3,9)	3 (5,9)	
	Parenchyma			0,90
	Homogenous	18 (35,3)	17 (33,3)	
	Minimal heterogeneous	30 (58,8)	32 (62,7)	
	Markedly heterogeneous	3 (5,9)	2 (3,9)	
	Blood Supply			1,00
	Hypervascularization	28 (54,9)	28 (54,9)	
	Normal	17 (33,3)	28 (54,9)	

	Hypovascularization	2 (3,9)	5 (9,8)		Hypovascularization	6 (11,8)	6 (11,8)	

chi-square test.

Table 6. The Relationship of Echogenicity, Margin, Parenchyma and Blood Supply Characteristics of Parotid Glands

		Control n (%)	Patient n (%)	p			Control n (%)	Patient n (%)	p
Right Parotid	Echogenicity			1,00	Left Parotid	Echogenicity			0,86
	Hyperechoic	44 (86,3)	43 (84,3)			Hyperechoic	44 (86,3)	43 (84,3)	
	Isoechoic	7 (13,7)	8 (15,7)			Isoechoic	7 (13,7)	8 (15,7)	
	Hypoechoic	-	-			Hypoechoic	-	-	
	Margin			0,92		Margin			0,51
	Regular margin	7 (13,7)	6 (11,8)			Regular margin	8 (15,7)	6 (11,8)	
	Focal irregular margin	31 (60,8)	33 (64,7)			Focal irregular margin	29 (56,9)	31 (60,8)	
	Markedly irregular margin	13 (25,5)	12 (23,5)			Markedly irregular margin	14 (27,5)	14 (27,5)	
	Parenchyma			0,93		Parenchyma			0,90
	Homogenous	24 (47,1)	23 (45,1)			Homogenous	24 (47,1)	23 (45,1)	
	Minimal heterogeneous	18 (35,3)	20 (39,2)			Minimal heterogeneous	17 (33,3)	20 (39,2)	
	Markedly heterogeneous	9 (17,6)	8 (15,7)			Markedly heterogeneous	10 (19,6)	8 (15,7)	
	Blood Supply			0,8		Blood Supply			0,6

		1			1
Hypervascularization	17 (33,3)	15 (29,4)	Hypervascularization	16 (31,4)	15 (29,4)
Normal	23 (45,1)	22 (43,1)	Normal	24 (47,1)	22 (43,1)
Hypovascularization	11 (21,6)	14 (27,5)	Hypovascularization	11 (21,6)	14 (27,5)

chi-square test.

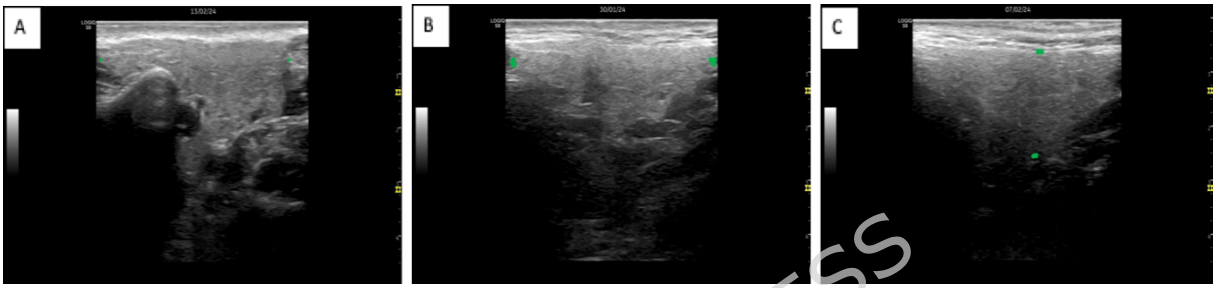

Figure 1. Measuring the size of the parotid gland **A.** antero-posterior dimension measurement with the probe in the transversal position (distance between two green dots) **B.** infero-superior dimension measurement with the probe in the longitudinal position (distance between two blue dots) **C.** medio-lateral dimension measurement with the probe in the longitudinal position (distance between two green dots).

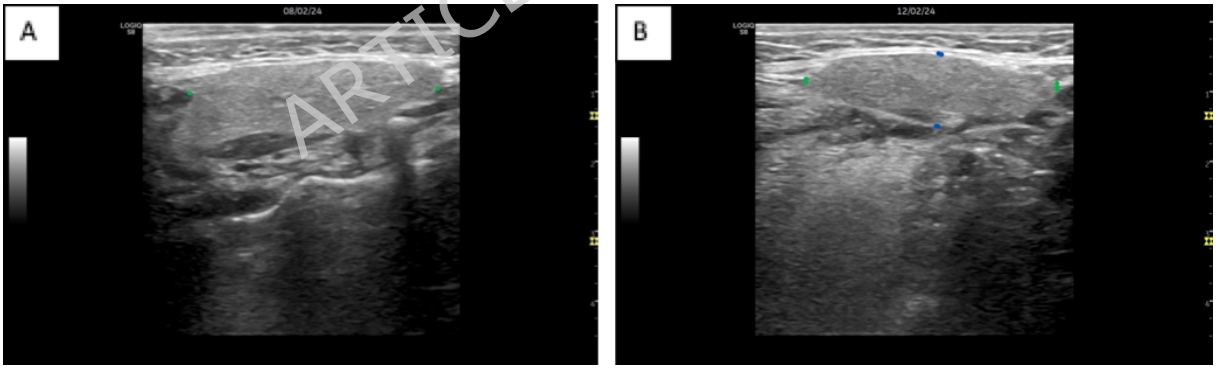

Figure 2. Measuring the size of the submandibular gland **A.** medio-lateral dimension measurement with the probe in the longitudinal position (distance between two green dots) **B.** Distance between two green dots: antero-posterior dimension measurement with the probe in the transversal position. Distance between two blue dots: infero-superior dimension measurement with the probe in the transversal position.

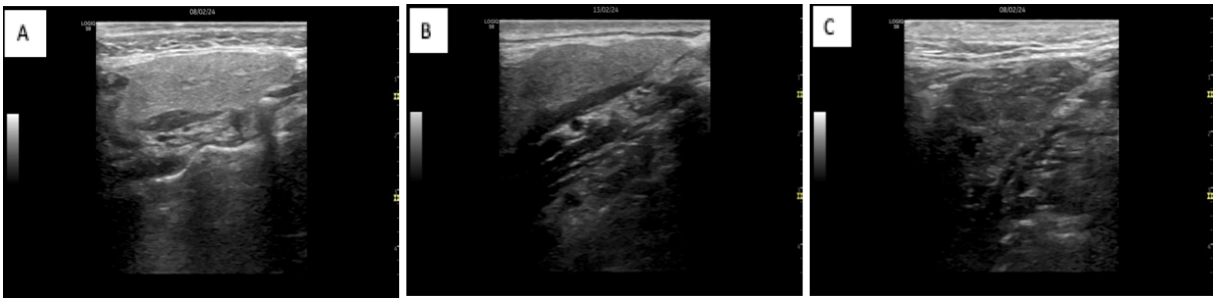

Figure 3. Echogenicity of submandibular salivary glands. **A.** hyperechoic **B.** isoechoic **C.** hypoechoic.

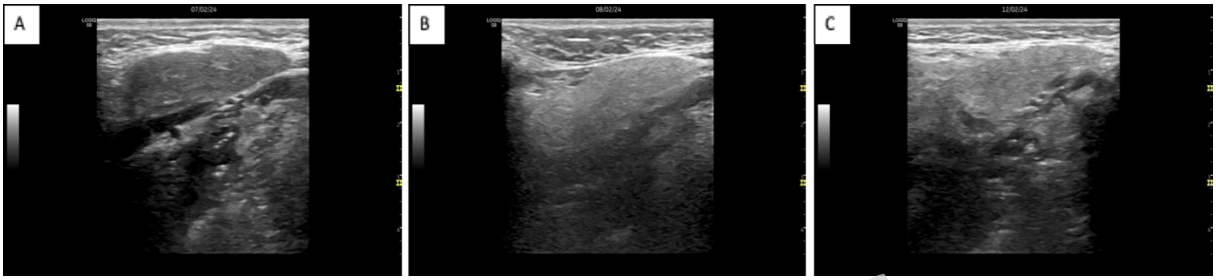

Figure 4. Margin assessment of the submandibular gland **A.** regular margin **B.** focal irregular margin **C.** markedly irregular margin.

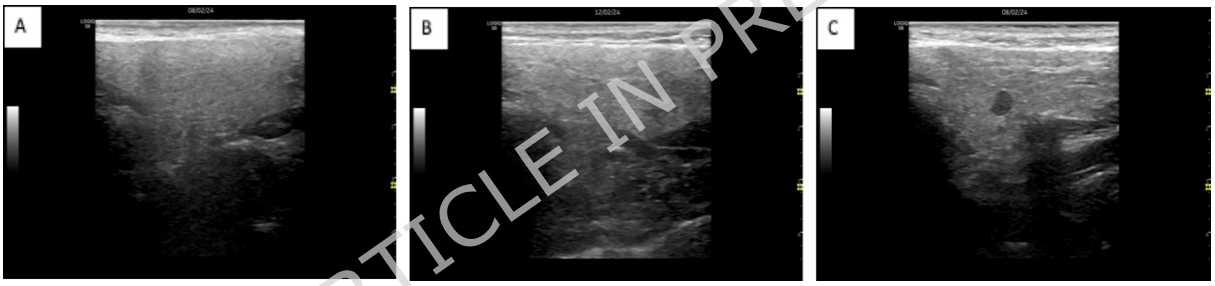

Figure 5. Parenchymal structure of the parotid glands **A.** homogeneous parenchyma **B.** minimal heterogeneous parenchyma **C.** markedly heterogeneous parenchyma.

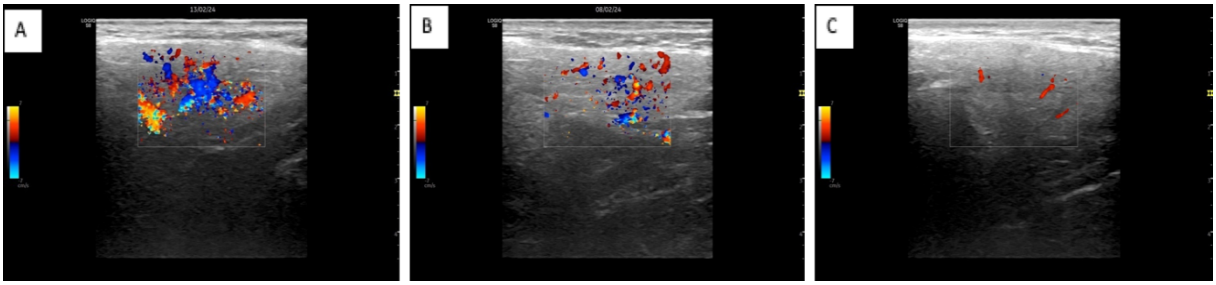

Figure 6. Blood supply to the parotid gland **A.** hypervascularization **B.** normal vascularization **C.** hypovascularization.