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EVALUATION OF ULTRASONOGRAPHIC FINDINGS OF SALIVARY GLANDS IN HEALTHY POPULATION

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ABSTRACT

Objective: *To investigate the ultrasonographic changes that may occur in the salivary glands in healthy individuals depending on age and gender.*

Material and Method: *In this study, the parotid and submandibular glands (240 parotid and 240 submandibular glands, right and left) of 120 patients of different age groups, who did not use alcohol or smoke, and did not have a history of continuous drug usage were examined by ultrasonography (USG). Changes in echogenicity, homogeneity, hyperechoic reflection, presence of hypoechoic area parameters depending on age, gender and Body Mass Index (BMI) were investigated.*

Result: *In healthy individuals, all parotid and submandibular glands were observed to be isoechoic. With age, the homogeneity of the submandibular and parotid glands deteriorated, becoming more heterogeneous. Hyperechoic reflection was more common in submandibular glands in males. In the parotid gland, hypoechoic area was observed more with aging. It was determined that the clearness of submandibular and parotid glands borders decreased with age and BMI.*

Conclusion: *Every ultrasonographic change that we see in the salivary glands of patients may not be an indicator of a pathological sign. There may be some physiological changes in the USG appearance of the salivary glands of healthy individuals depending on age and gender. In cases where salivary gland pathologies are suspected based on USG findings, the diagnosis can be confirmed with additional tests.*

Keywords: *Ultrasonography, parotid gland, submandibular gland.*

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SAĞLIKLI POPÜLASYONDA TÜKÜRÜK BEZLERİNİN ULTRASONOGRAFİK BULGULARININ DEĞERLENDİRİLMESİ

ÖZET

Amaç: Sağlıklı bireylerde yaş ve cinsiyete bağlı olarak tükürük bezlerinde oluşabilecek ultrasonografik değişiklikleri incelemektir.

Materyal ve Metot: Bu çalışmada, farklı yaş gruplarında, alkol ve sigara kullanmayan, sürekli ilaç öyküsü olmayan 120 hastanın parotis ve submandibular bezleri (sağ, sol 240 parotis ve 240 submandibular bez) ultrasonografi (USG) kullanılarak incelendi. Ekojenite, homojenlik, hiperekoik yansıma, hipoekoik alan varlığı parametrelerinin yaşa, cinsiyete ve Vücut Kitle İndeksi'ne (VKİ) bağlı olarak değişimleri araştırıldı.

Bulgular: Sağlıklı bireylerde tüm parotis ve submandibular bezlerin izoekoik olduğu gözlendi. Yaşla birlikte submandibular ve parotis bezlerinin homojenliği bozuldu ve daha heterojen olarak gözlendi. Hiperekoik yansıma erkeklerde submandibular bezlerde daha sıktı. Parotis bezinde yaşlanma ile birlikte daha çok hipoekoik alan gözlendi. Submandibular ve parotis bezlerinin sınırlarının netliğinin yaş ve VKİ ile azaldığı belirlendi.

Sonuç: Hastaların tükrük bezlerinde gördüğümüz her ultrasonografik değişiklik patolojik bir bulgu olmayabilir. Sağlıklı bireylerin tükürük bezlerinin USG görünümünde yaşa ve cinsiyete bağlı olarak bazı fizyolojik değişiklikler olabilir. USG bulgularına göre tükürük bezi patolojilerinden şüphelenilen durumlarda ek testler ile tanı doğrulanabilir.

Anahtar kelimeler: Ultrasonografi, parotis bezi, submandibular bezi.

INTRODUCTION

Ultrasonography (USG) is a noninvasive, easy-to-apply imaging method that does not involve the risk of ionizing radiation, and is used in the examination of muscles, tendons, joints, vessels and internal organs that do not remain behind the bone. It is one of the first preferred imaging techniques in the evaluation of salivary glands due to the superficial location of the salivary glands and appropriate homogeneous soft tissue densities.[1]

There are 3 pairs of major salivary glands in the body. These are the parotid, submandibular and sublingual salivary glands, one each on the right and left sides. In addition to these, there are nearly 600 minor salivary glands located in the lip, cheek, palate, molar and retromolar and tonsillar regions.[2]

The normal echogenicity of all major salivary glands is generally homogeneous and can vary from very hyperechoic to less hyperechoic compared to adjacent musculature. The echogenicity of the parotid gland varies depending on the adipose tissue in the gland. The echo structure of the submandibular gland is more hypoechoic compared to the parotid gland and has a triangular shape.[3]

The aim of this study was to investigate the ultrasonographic changes that may occur in the salivary glands in healthy individuals depending on age and gender.

MATERIAL AND METHOD

Study Design

This study was carried out in the Department of Oral and Maxillofacial Radiology, and the compliance of this study with scientific ethical rules was approved by the Ataturk University Faculty of Dentistry ethics committee's decision numbered 2020/17. A total of 120 patients between the ages of 15 and 81, who did not have any systemic disease, did not have a history of continuous drug use, did not smoke or drink alcohol, were included in this study. The patients were volunteered to participate in the study and signed written consent. Twenty patients from 6 age groups were included as 10 male and 10 female.

USG Procedures and Mesurements

Bilateral submandibular and parotid salivary glands of all patients who agreed to participate in the study were examined using the Toshiba Aplio 300 (Toshiba Corporation, Tokyo, Japan) USG device and a 12-MHz linear array transducer probe. In order to ensure standardization in the USG examination and to minimize mobility, the patient's head was fixed on the headrest. The sagittal plane was perpendicular and the occlusal plane was parallel to the floor in the parotid examination, and the head was positioned in the extension in the submandibular gland examination. USG examination was performed by moving the probe extraorally to the region of the submandibular and parotid glands in the transversal plane.

All measurements were made by the same observer with at least 3 years maxillofacial USG experience, and the reliability of the measurements was evaluated with the intra-observer correlation test.

The echogenicity, homogeneity, borders, presence of hypoechoic area, and hyperechoic reflections of the glands were evaluated according to the Hocevar score by USG. Hocevar *et al*. stated that the ultrasound score should be determined as 17 in patients with Sjögren's syndrome.[4] Hocevar *et al*. stated that setting the USG score to 17 for the diagnosis of the disease had the best specificity (98.7%) and sensitivity (58.8%).[4]

The findings were evaluated statistically, and the USG findings of the salivary glands were compared between the groups depending on age and gender.

Evaluation of echogenicity of salivary glands: The echogenicity was evaluated according to the Hocevar score and compared with the thyroid gland. A score of 0 was given if it had the same echogenicity as the thyroid gland (isoechoic). A score of 1 was given for decreased echogenicity (hypoechoic) compared to the thyroid gland.

Evaluation of the homogeneity of the salivary gland: 0: homogeneous, 1: mild inhomogeneous, 2: evident inhomogeneous, and 3: grossly inhomogeneous (Figure 1).

Hypoechoic areas in the salivary glands: 0: absent, 1: a few, scattered 2: several, 3: numerous areas (Figure 2).

Hyperechogenic reflection in the salivary glands: For parotid glands; 0: absent, 1: few scattered, 2: several; 3: numerous. For Submandibular glands; 0: absent, 1: present (Figure 3).

Clearness of salivary gland borders: 0: clear, 1: partly defines borders, 2: ill- defined borders, 3: borders not visible (Figure 4).

Statistical Analysis

IBM SPSS Statistics 20 package program (Armonk, NY: IBM Corp.) was used for statistical analysis. Mann-Whitney U test, one of the non-parametric tests, was used to evaluate the homogeneity, hyperechoic reflection, hypoechoic areas, and clearness of salivary gland borders parameters of the submandibular and parotid glands according to gender. When the *p* value was below 0.05 according to the Mann-Whitney U test, the result was considered statistically significant.

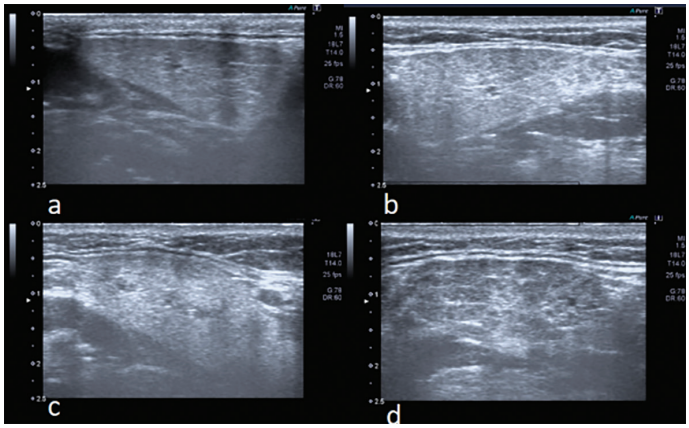

Figure 1. Evaluation of the homogeneity of submandibular glands.
a: homogeneous, **b:** mild inhomogeneous, **c:** evident inhomogeneous, **d:** grossly inhomogeneous.

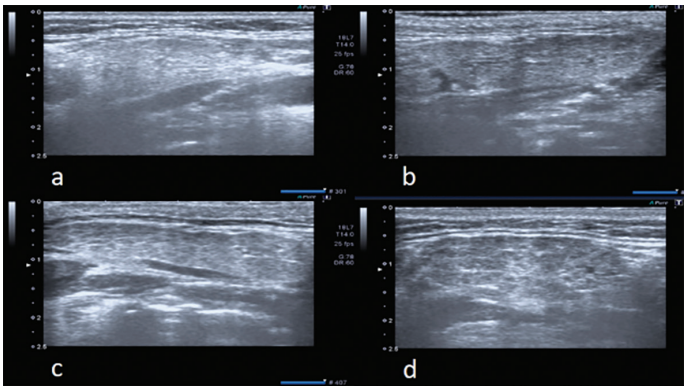

Figure 2. Evaluation of hypoechoic areas in the submandibular glands.
a: absent, **b:** a few scattered, **c:** several, **d:** numerous areas.

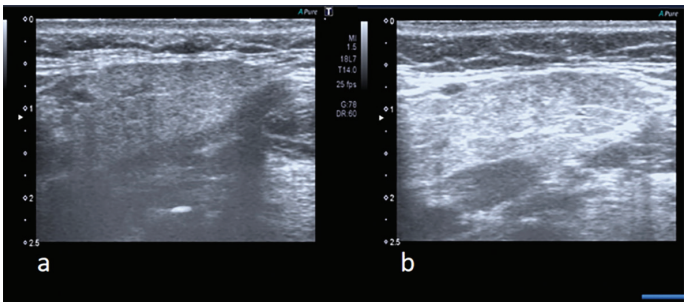

Figure 3. Hyperechogenic reflection in the submandibular glands.
a: absent, **b:** present

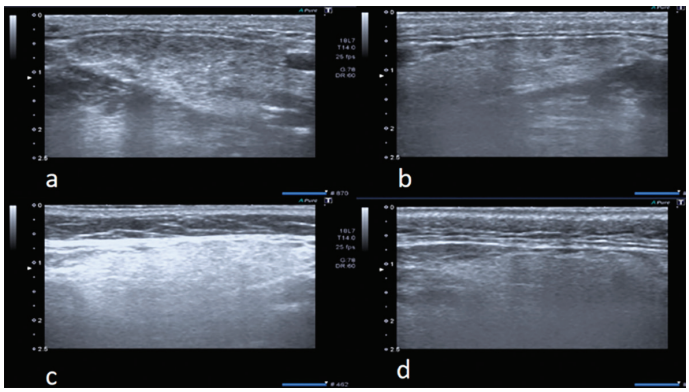

Figure 4. Clearness of submandibular gland borders.
a: clear, **b:** partly defines borders, **c:** ill- defined borders, **d:** borders not visible.

Table 1. The statistical evaluation of homogeneity, hyperechoic reflection, hypoechoic areas and clearness of salivary gland borders parameters of submandibular and parotid glands depending on gender.

		F, n	M, n	*p*	
Homogeneity (right submandibular)	homogeneous	8, 13.3%	5, 8.3%	0.296	
	mild inhomogeneous	36, 60%	36, 60%		
	evident inhomogeneous	15, 25%	14, 23.3%		
	grossly inhomogeneous	1, 1.7%	5, 8.3%		
Homogeneity (left submandibular)	homogeneous	8, 13.3%	4, 6.7%	0.336	
	mild inhomogeneous	34, 56.7%	36, 60%		
	evident inhomogeneous	17, 28.3%	16, 26.7%		
	grossly inhomogeneous	1, 1.7%	4, 6.7%		
Homogeneity (right parotid)	homogeneous	11, 18.3%	4, 6.7%	0.177	
	mild inhomogeneous	42, 70%	49, 81.7%		
	evident inhomogeneous	7, 11.7%	5, 8.3%		
	grossly inhomogeneous	0, 0%	2, 3.3%		
Homogeneity (left parotid)	homogeneous	11, 18.3%	5, 8.3%	0.250	
	mild inhomogeneous	42, 70%	48, 80%		
	evident inhomogeneous	7, 11.7%	5, 8.3%		
	grossly inhomogeneous	0, 0%	2, 3.3%		
Hyperechoic reflection (right submandibular)	absent	8, 13.3%	2, 3.3%	0.048*	M>F
	present	52, 86.7%	58, 96.7%		
Hyperechoic reflection (left submandibular)	absent	7, 11.7%	1, 1.7%	0.029*	M>F
	present	53, 88.3%	59, 98.3%		
Hyperechoic reflection (right parotid)	absent	9, 15%	7, 11.7%	0.953	
	few scattered	49, 81.7%	53, 88.3%		
	several	2, 3.3%	0, 0%		
	numerous	0, 0%	0, 0%		
Hyperechoic reflection (left parotid)	absent	9, 15 %	7, 11.7%	0.788	
	few scattered	49, 81.7%	52, 86.7%		
	several	2, 3.3%	1, 1.7%		
	numerous	0, 0%	0, 0%		
Hypoechoic areas (right submandibular)	absent	43, 71.3%	34, 56.7%	0.089	
	few scattered	15, 25%	23, 38.3%		
	several	2, 3.3%	1, 1.7%		
	numerous	0, 0%	2, 3.3%		
Hypoechoic areas (left submandibular)	absent	43, 71.3%	34, 56.7%	0.101	
	few scattered	15, 25%	24, 40%		
	several	2, 3.3%	1, 1.7%		
	numerous	0, 0%	1, 1.7%		
Hypoechoic areas (right parotid)	absent	56, 93.3%	53, 88.3%	0.345	
	few scattered	4, 6.7%	7, 11.7%		
	several	0, 0%	0, 0%		
	numerous	0, 0%	0, 0%		
Hypoechoic areas (left parotid)	absent	56, 93.3%	53, 88.3%	0.345	
	few scattered	4, 6.7%	7, 11.7%		
	several	0, 0%	0, 0%		
	numerous	0, 0%	0, 0%		
Clearness of salivary gland borders (right submandibular)	clear	34, 56.7%	22, 36.7%	0.210	
	partly defines borders	7, 11.7%	9, 15%		
	ill- defined borders	11, 18.3%	13, 21.7 %		
	borders not visible	8, 13.3%	16, 26.7%		
Clearness of salivary gland borders (left submandibular)	clear	33, 55%	22, 36.7%	0.270	
	partly defines borders	8, 13.3%	9, 15%		
	ill- defined borders	11, 18.3%	13, 21.7%		
	borders not visible	8, 13.3%	16, 26.7%		
Clearness of salivary gland borders (right parotid)	clear	32, 53.3%	19, 31.7%	0.110	
	partly defines borders	11, 18.3%	24, 40%		
	ill- defined borders	9, 15%	8, 13.3%		
	borders not visible	8, 13.3%	9, 15%		
Clearness of salivary gland borders (left parotid)	clear	32, 53.3%	19, 31.7%	0.110	
	partly defines borders	11, 18.3%	24, 40%		
	ill- defined borders	9, 15%	8, 13.3%		
	borders not visible	8, 13.3%	9, 15%		

F: Female **M:** Male, *$p<0.05$

The non-parametric Kruskal-Wallis test was used to evaluate the homogeneity, hyperechoic reflection, hypoechoic areas, clearness of salivary gland borders parameters of the submandibular and parotid glands according to age group. When the *p* value was below 0.05, Pairwise Comparisons test was used to determine between which groups the difference was. The non-parametric Kruskal-Wallis test was used to clearness of salivary gland borders of the submandibular and parotid glands according to BMI group. When the *p* value was below 0.05, Pairwise Comparisons test was used to determine between which groups the difference was.

RESULTS

The ages of the participants ranged from 15 to 81. The mean age of the participants was 39.73±17.345.

The USG score of 118 individuals participating in our study was below 17. Only 2 individuals had a USG score of 18.

Kappa value was 0.639 in the USG measurements, which was performed to evaluate the intra-observer agreement (95% Confidence Interval).

The echogenicity of the submandibular and parotid glands of all participants was observed isoechoic with the thyroid gland.

None of the individuals participating in our study were given a score of 3 for the presence of hyperechoic reflection in the parotid gland.

With age, submandibular and parotid glands were observed to be more heterogeneous with loss of homogeneity.

Hyperechoic reflection was more common in men in the submandibular gland.

In the parotid gland, hypoechoic area was observed more with age.

It was determined that the border clarity of the submandibular and parotid glands decreased with age and BMI.

The statistical evaluation of homogeneity, hyperechoic reflection, hypoechoic areas and clearness of salivary gland borders parameters of submandibular and parotid glands depending on age and gender is presented in Table 1, 2. Clearness of salivary gland borders depending on BMI is presented in Table 3.

Table 2. The statistical evaluation of homogeneity, hyperechoic reflection, hypoechoic areas and clearness of salivary gland borders parameters of submandibular and parotid glands depending on age group.

		1, n	2, n	3, n	4, n	5, n	6, n	*p*	*Significant differences*
Homogeneity (right submandibular)	homogeneous	4, 20%	5, 25%	3, 15%	1, 5%	0, 0%	0, 0%	<0,001	1-6;2-6;3-6
	mild inhomogeneous	14, 70%	12, 60%	15, 75%	13, 65%	11, 55%	7, 35%		
	evident inhomogeneous	2, 10%	3, 15%	2, 10%	6, 30%	9, 45%	8, 40%		
	grossly inhomogeneous	0, 0%	0, 0%	0, 0%	1, 5%	0, 0%	5, 25%		
Homogeneity (left submandibular)	homogeneous	4, 20%	4, 20%	3, 15%	1, 5%	0, 0%	0, 0%	<0,001	1-6;2-6;3-6
	mild inhomogeneous	14, 70%	12, 60%	14, 70%	12, 60%	11, 55%	7, 35%		
	evident inhomogeneous	2, 10%	4, 20%	3, 15%	7, 35%	9, 45%	8, 40%		
	grossly inhomogeneous	0, 0%	0, 0%	0, 0%	0, 0%	0, 0%	5, 25%		
Homogeneity (right parotid)	homogeneous	0, 0%	5, 25%	5, 25%	3, 15%	2, 10%	0, 0%	<0,001	1-6;2-6; 3-6; 4-6
	mild inhomogeneous	20, 100%	15, 75%	15, 75%	17, 85%	15, 75%	9, 45%		
	evident inhomogeneous	0, 0%	0, 0%	0, 0%	0, 0%	3, 15%	9, 45%		
	grossly inhomogeneous	0, 0%	0, 0%	0, 0%	0, 0%	0, 0%	2, 10%		
Homogeneity (left parotid)	homogeneous	0, 0%	6, 30%	5, 25%	3, 15%	2, 10%	0, 0%	<0,001	1-6;2-6; 3-6; 4-6
	mild inhomogeneous	20, 100%	14, 70%	15, 75%	17, 85%	15, 75%	9, 45%		
	evident inhomogeneous	0, 0%	0, 0%	0, 0%	0, 0%	3, 15%	9, 45%		
	grossly inhomogeneous	0, 0%	0,0%	0, 0%	0, 0%	0, 0%	2, 10%		
Hyperechoic reflection (right submandibular)	absent	2, 10%	4, 20%	2, 10%	1, 5%	0, 0%	1, 5%	0.301	
	present	18, 90%	16, 80%	18, 90%	19, 95%	20, 100%	19, 95%		
Hyperechoic reflection (left submandibular)	absent	2, 10%	3, 15%	1, 5%	1, 5%	0, 0%	1, 5%	0.514	
	present	18, 90%	17, 85%	19, 95%	19, 95%	20, 100%	19, 95%		
Hyperechoic reflection (right parotid)	absent	0, 0%	6, 30%	5, 25%	2, 10%	3, 15%	0, 0%	0.136	
	few scattered	20, 100%	13, 65%	14, 70%	18, 90%	17, 85%	20, 100%		
	several	2, 10%	0, 0%	0, 0%	0, 0%	0, 0%	0, 0%		
	numerous	0, 0%	0, 0%	0, 0%	0, 0%	0, 0%	0, 0%		
Hyperechoic reflection (left parotid)	absent	0, 0%	6, 30%	5, 25%	2, 10%	3, 15%	0, 0%	0.088	
	few scattered	20, 100%	13, 65%	14, 70%	18, 90%	17, 85%	19, 95%		
	several	2, 3.3%	0, 0%	0, 0%	0, 0%	0, 0%	1, 5%		
	numerous	0, 0%	0, 0%	0, 0%	0, 0%	0, 0%	0, 0%		
Hypoechoic areas (right submandibular)	absent	16, 80%	16, 80%	15, 75%	11, 55%	10, 50%	9, 45%	0.59	
	few scattered	4, 20%	3, 15%	4, 20%	9, 45%	9, 45%	9, 45%		
	several	0, 0%	0, 0%	1, 5%	0, 0%	0, 0%	2, 10%		
	numerous	0, 0%	1, 5%	0, 0%	0, 0%	1, 5%	0, 0%		
Hypoechoic areas (left submandibular)	absent	17, 85%	15, 75%	15, 75%	10, 50%	11, 55%	9, 45%	0.51	
	few scattered	3, 15%	4, 20%	4, 20%	10, 50%	9, 45%	9, 45%		
	several	0, 0%	0, 0%	1, 5%	0, 0%	0, 0%	2, 10%		
	numerous	0, 0%	1, 5%	0, 0%	0, 0%	0, 0%	0, 0%		
Hypoechoic areas (right parotid)	absent	20, 100%	20, 100%	20, 100%	20, 100%	17, 85%	12, 60%	<0,001	1-6;2-6 3-6; 4-6
	few scattered	0, 0%	0, 0%	0, 0%	0, 0%	3, 15%	8, 40%		
	several	0, 0%	0, 0%	0, 0%	0, 0%	0, 0%	0, 0%		
	numerous	0, 0%	0, 0%	0, 0%	0, 0%	0, 0%	0, 0%		
Hypoechoic areas (left parotid)	absent	20, 100%	20, 100%	20, 100%	20, 100%	17, 85%	12, 60%	<0,001	1-6;2-6; 3-6; 4-6
	few scattered	0, 0%	0, 0%	0, 0%	0, 0%	3, 15%	8, 40%		
	several	0, 0%	0, 0%	0, 0%	0, 0%	0, 0%	0, 0%		
	numerous	0, 0%	0, 0%	0, 0%	0, 0%	0, 0%	0, 0%		
Clearness of salivary gland borders (right submandibular)	clear	19, 95%	15, 75%	14, 70%	8, 40%	0, 0%	0, 0%	<0,001	1-6;1-5; 2-6; 2-5; 3-6; 3-5 4-6
	partly defines borders	0, 0%	1, 5%	2, 10%	6, 30%	6, 30%	1, 5%		
	ill- defined borders	1, 5%	3, 15%	3, 15%	4, 20%	6, 30%	7, 35%		
	borders not visible	0, 0%	1, 5%	1, 5%	2, 10%	8, 40%	12, 60%		
Clearness of salivary gland borders (left submandibular)	clear	19, 95%	15, 75%	14, 70%	7, 35%	0, 0%	0, 0%	<0,001	1-6;1-5; 2-6; 2-5; 3-6; 3-5 4-6
	partly defines borders	0, 0%	1, 5%	2, 10%	7, 35%	6, 30%	1, 5%		
	ill- defined borders	1, 5%	3, 15%	2, 10%	4, 20%	7, 35%	7, 35%		
	borders not visible	0, 0%	1, 5%	2, 10%	2, 10%	7, 35%	12, 60%		
Clearness of salivary gland borders (right parotid)	clear	18, 90%	15, 75%	12, 60%	6, 30%	0, 0%	0, 0%	<0,001	1-6;1-5 2-6; 2-5; 3-6; 3-5 4-6
	partly defines borders	2, 10%	5, 25%	4, 20%	11, 55%	11, 55%	2, 10%		
	ill- defined borders	0, 0%	0, 0%	3, 15%	3, 15%	5, 25%	6, 30%		
	borders not visible	0, 0%	0, 0%	1, 5%	0, 0%	4, 20%	12, 60%		
Clearness of salivary gland borders (left parotid)	clear	18, 90%	15, 75%	12, 60%	6, 30%	0, 0%	0, 0%	<0,001	1-6;1-5; 2-6; 2-5; 3-6; 3-5 4-6
	partly defines borders	2, 10%	5, 25%	4, 20%	11, 55%	11, 55%	2, 10%		
	ill- defined borders	0, 0%	0, 0%	3, 15%	3, 15%	5, 25%	6, 30%		
	borders not visible	0, 0%	0, 0%	1, 5%	0, 0%	4, 20%	12, 60%		

1: 15-19 years old; **2:** 20-29 years old; **3:** 30-39 years old; **4:** 40-49 years old; **5:** 50-59 years old; **6:** individuals over 60 years old shows.

Table 3. The clearness of the border regularity of the salivary glands according to the classification made according to BMI.

		1, n	2, n	3, n	4, n	*p*	*Significant differences*
Clearness of salivary gland borders (right submandibular)	clear	33, 58.9%	5, 8.9%	18, 32.1%	0, 0%	<0.001	1-4;2-4;2-3; 3-4
	partly defines borders	6, 37.5%	0, 0%	8, 50%	2, 12.5%		
	ill- defined borders	2, 8.3%	0, 0%	12, 50%	10, 41.7%		
	borders not visible	2, 8.3%	0, 0%	10, 41.7%	12, 50%		
Clearness of salivary gland borders (left submandibular)	clear	33, 60%	5, 9.1%	17, 30.9%	0, 0%	<0.001	1-4;2-4;2-3; 3-4
	partly defines borders	6, 35.3%	0, 0%	9, 52.9%	2, 11.8%		
	ill- defined borders	2, 8.3%	0, 0%	12, 50%	10, 41.7%		
	borders not visible	2, 8.3%	0, 0%	10, 41.7%	12, 50%		
Clearness of salivary gland borders (right parotid)	clear	32, 62.7%	5, 9.8%	14, 27.5%	0, 0%	<0.001	1-4;2-4;2-3; 3-4
	partly defines borders	7, 20%	0, 0%	21, 60%	7, 20%		
	ill- defined borders	2, 11.8%	0, 0%	6, 35.3%	9, 52.9%		
	borders not visible	2, 11.8%	0, 0%	7, 41.2%	8, 47.1%		
Clearness of salivary gland borders (left parotid)	clear	32, 62.7%	5, 9.8%	14, 27.5%	0, 0%	<0.001	1-4;2-4;2-3; 3-4
	partly defines borders	7, 20%	0, 0%	21, 60%	7, 20%		
	ill- defined borders	2, 11.8%	0, 0%	6, 35.3%	9, 52.9%		
	borders not visible	2, 11.8%	0, 0%	7, 41.2%	8, 47.1%		

1: (Low Weight) BMI below 18.5; **2:** (Normal weight) BMI 18.5-24.9; **3:** (Overweight) BMI 25-29.9; **4:** (Obese) BMI 30-40; **5:** (Extremely Obese) BMI 40+Extremely obese was not included in our study.

DISCUSSION

The most commonly used imaging methods in the diagnosis of salivary gland diseases are conventional radiographs, ultrasonography (USG), sialography, scintigraphy, computed tomography (CT) and magnetic resonance imaging (MRI). USG is a valuable and useful method for the diagnosis of salivary gland pathologies. Diagnostic ultrasound is a quick, inexpensive, harmless and easy method used to examine the salivary glands, especially the superficial lobe of the parotid. Our aim in this study was to investigate the echogenicity, homogeneity, hyperechoic reflection, hypoechogenic area, clearness of salivary gland borders of parotid and submandibular salivary glands with ultrasonography in healthy population. The reason for using USG in this study was to conduct research on more patients, since ultrasonography is a practical, non-invasive, inexpensive and radiation-free technique.

The salivary glands consist of three main salivary glands (parotid, submandibular, and sublingual) and minor salivary glands. The parotid and submandibular glands are easier to examine with ultrasound than the sublingual and minor salivary glands. In our study, ultrasonographic examination of the parotid and submandibular salivary glands was performed.

In the literature, there are various scoring systems to evaluate the severity of primary Sjogren's Syndrome based on ultrasonography of the salivary gland. Delli *et al*. identified 33 scoring systems used to evaluate the major salivary glands.[5] These scoring systems are quite different from each other and these differences are related to several factors such as different salivary glands examined and evaluated USG features. Hocevar *et al*. developed a new scoring system.[4] This method dates back to 2005 and is based on five components (echogenicity, homogeneity, presence of hypoechoic areas, presence of hyperechoic reflections and border clarity of glands) with precision. There are also researchers who state that simpler scoring systems should be preferred because this scoring system is time consuming.[6-9]

Besides the Hocevar scoring system, the most widely used systems have been developed by De Vita *et al*.[4,10] The oldest systems available in the literature are the scoring system found by Salaffi *et al*., Milic *et al*. and De Vita *et al*.[10-12] These systems date back to 1992 and were developed to describe parenchymal structural anomalies in a simplified manner based on scores from 0 to 3 (normal to marked parenchymal heterogeneity).

In 2008, Salaffi *et al*., modified the De Vita scoring system.[10,11] This scoring system summarizes the ultrasonographic changes in each of the right, left parotid and submandibular salivary glands and is scored according to changes in these ultrasound findings (parenchymal homogeneity, echogenicity, gland size, posterior glandular border). In 2019, the OMERACT ultrasound working group defined a Sjögren's syndrome USG score.[13] Hocevar scoring system was used in our study. Although this system is time consuming, it provides a more detailed assessment than other systems.

Inflammatory or neoplastic conditions will cause enlargement of the salivary glands, while sclerosing disease will lead to atrophy of the glands. The size and

function of the salivary glands are affected by diabetes, smoking, hypertension and consumption of alcoholic beverages.[14-17] All of these conditions have a potential impact on the size and function of the salivary glands. In this study, while performing ultrasonographic examination in the submandibular and parotid glands, the patient group was chosen from healthy, non-smoker and non-alcoholic persons in order to ensure standardization.

Normal glands generally have higher echogenicity than muscle and similar echogenicity to the thyroid; however, echogenicity may vary depending on physiological changes such as fat involution.[7] Katz *et al*. reported that the submandibular gland is more hypoechoic than the parotid gland, the normal parotid and submandibular glands are generally isoechoic and homogeneous with the healthy thyroid gland.[3] In the present study, the echogenicity of the submandibular and parotid glands of all 120 healthy patients who underwent USG examination was observed to be isoechoic when compared to the thyroid gland.

Although salivary glands are defined as homogeneous in healthy individuals, they can also be observed as heterogeneous. The reason for this is the arteries and veins passing through the glands.[18] In addition, hyperechoic lines and spots resembling fibrosis are thought to create a heterogeneous appearance.[19-21] In the present study, the right submandibular gland of 85 patients was observed as homogeneous and slightly inhomogeneous; and the left submandibular gland of 82 patients was observed in the same consequences. While the right parotid gland was observed as homogeneous and slightly non-homogeneous in 106 patients; the situation was the same in the left parotid gland.

Choi *et al*. investigated the normal echogenicity of salivary glands in adult patients and compared the echogenicity of the parotid and submandibular glands.[22] In their study of 969 patients, they could not find a gender difference in homogeneity in the submandibular and parotid glands. There was no statistically significant difference between male and female gender in homogeneity of submandibular and parotid glands in the present study also.

It was observed that the homogeneity of the right, left submandibular and parotid glands changed with age. Especially after the age of 60, it was determined that the homogeneity of both glands deteriorated and took a more heterogeneous appearance. The reason for this may be the changes seen in the major and minor salivary glands with advancing age. These changes include atrophy of acinar tissues, ductal proliferation and increase in fibroadipose tissue.[23] These changes may explain the heterogeneity of salivary glands with advancing age.

Takagi *et al*. compared the clinical findings with USG and MRI findings of the parotid and submandibular glands in their retrospective study on 90 patients with Sjögren's syndrome.[24] They found that the presence of hyperechoic reflections on USG is associated with the presence of fat areas on MRI and decreased salivary flow.

In our study, it was found that hyperechoic reflections in the submandibular glands were higher in males than females. The reason for this may be related to the presence of fat regions in the submandibular glands of the men participating in our study, as Takagi *et al*. stated.[24] However, we found that hyperechoic reflections in the parotid gland did not differ according to gender. This is Badarinza *et al*. supported the result.[18] We also found that hyperechoic reflections in the parotid and submandibular glands did not differ significantly with age.

Hypoechoic and anechoic areas draw attention in Sjögren's syndrome. In the later stages of Sjögren's syndrome, multiple small, oval, well-circumscribed, hypoechoic or anechoic areas surrounded by hyperechoic bands are seen.[25-28] It has been suggested that hypoechogenic areas consist of foci containing inflammatory cells.[29] The size and number of hypoechoic areas are important.

When the presence of hypoechoic areas in the submandibular gland was evaluated in our study, although there was no significant difference according to gender and age groups. It was found that the presence of hypoechoic area increased in the right and left parotid glands, especially after the age of 60. This may be due to the increase in fat and fibrous tissues of the parotid gland with aging. The presence of hypoechoic area of the right and left parotid glands did not show a statistically significant difference according to gender.

In our study, we obtained the result that clearness of salivary gland borders the right, left submandibular and parotid glands is lost with age. Especially after the age of 50, the visibility of the borders of both glands is lost. This may be due to changes in the salivary glands with aging. Among these changes, acinar atrophy, ductal proliferation and increase in fibroadipose tissue are the most common ones. In addition, with age,

the increase in the amount of fat in the surrounding tissues and the decrease in the water content may also affect the appearance of the border clarity of the glands. In adulthood, 25-30% loss of acinar cells is seen in the submandibular and parotid glands. These changes progress over time. Due to these changes in the parenchyma structure, the borders of the parotid and submandibular salivary glands may not be able to follow clearly, especially after the age of 50. However, there is no study in the literature investigating ultrasonographic changes in salivary glands associated with aging in healthy population. Current studies have generally focused on patients with Sjögren's syndrome.

In our study, we found that the border clarity of the submandibular and parotid glands was negatively correlated with BMI. According to the study conducted by Badarinza *et al*. on salivary glands and lacrimal glands between healthy population and diabetic obese individuals, they found that the clarity of the parotid and submandibular gland borders in obese and diabetic individuals was observed worse than in healthy individuals.[18] They suggested increased triglyceride and cholesterol levels in obese and diabetic individuals as the reason for this. This result supported the data we obtained.

Since our study was an ultrasonographic examination of the salivary glands in a healthy population, the ultrasound score of 118 patients was below 17 according to the Hocevar score. Only 2 patients had an ultrasound score of 18. These data are highly consistent with the study stating that patients with Sjögren's syndrome should have an ultrasound score of 17. Hocevar *et al*. stated that setting the USG score to 17 had the best specificity (98.7%) and sensitivity (58.8%).[4]

Lin *et al*. used 3 USG scoring systems created by Hocevar, Salaffi and Millic to evaluate bilateral parotid glands and submandibular glands.[30] Then stated that Hocevar's method had the best likelihood ratio and accuracy.

Among the limitations of the present study; it can be considered that healthy individuals participating in the study were included in the study by taking anamnesis. Ultrasonographic examination was performed on individuals who do not smoke, do not use drugs, and do not have any systemic disease. Healthy individuals were selected by taking anamnesis from the patients, and no medical screening was requested. It should also be taken into account that there may be individuals who are unaware of their undiagnosed disease.

CONCLUSION

In conclusion, according to the results we obtained from our study; when ultrasonographic examination of parotid and submandibular salivary glands are performed in healthy population, ultrasonographic findings of salivary glands may change depending on age, gender and BMI. Every ultrasonographic change that we see in the salivary glands of patients may not be an indicator of a pathological sign, but this situation has some limitations. In order to understand this situation, a good ultrasonographic examination should be performed and the degree of change should be measured using various scoring systems. In patients with suspected salivary gland pathology, USG is a very advantageous technique because there is no contain radiation and is easily accessible and simultaneous images can be obtained. In cases where salivary gland pathologies are suspected based on USG findings, the diagnosis can be confirmed with additional tests.

*The authors declare that there are no conflicts of interest.

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