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Ultrasound Examination of Normal Anatomic Variations of Major Salivary Glands

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ABSTRACT

Introduction: Accurate knowledge of anatomic characteristics and variations of sonographic view is important to better understand the imaging findings for a more precise examination. The present study therefore aimed to examine the variations in sonographic view of the normal anatomy of salivary glands and the important anatomical structures around them.

Material and Methods: In this study, 200 cases of parotid, submandibular, and sublingual salivary glands in 100 healthy volunteers were scanned using ultrasound. The variables studied included echogenicity and echo-pattern of all three pairs of salivary glands, borders of submandibular and sublingual glands, and the possibility of observing common tissues, which were evaluated in all examinations.

Results: Eighty-three female and 17 males were surveyed between the ages of 6 and 61. Echogenicity of the sublingual, submandibular, and parotid glands was hyperechoic in 94.5%, 92.5%, and 84.5%; and hypoechoic in 5.5%, 7.5% and 15.5%, respectively. Also, echo-pattern of the sublingual, submandibular, and parotid glands was homogeneous in 78.5%, 80.5%, and 92%; and heterogeneous in 21.5%, 19.5% and 8%, respectively. The border of sublingual glands was well, ill, and poor in 36.5%, 43.5%, and 20%, respectively. Also, the border of submandibular glands was well, ill, and poor in 56%, 24.5%, and 19.5%, respectively. In the possibility of observing sublingual gland-specific variables, the highest and lowest frequency was related to geniohyoid with 73% and genioglossus with 50.5%, respectively. In submandibular glands, the highest and lowest frequency was of posterior digastric belly with 69.5% and hyoglossus muscle with 60%, respectively. Also, in parotid gland, the highest and lowest frequency was related to lymph nodes with 56% and external carotid artery with 32%, respectively.

Conclusion: There were significant variations in the sonographic characteristics of all three pairs of salivary glands of healthy volunteers, indicating that accurate knowledge of the glands is necessary for reliable ultrasound examination.

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INTRODUCTION

Salivary glands are exocrine glands made up of different cell families, including stem, duct, acinar, and myoepithelial cells. They play the essential role in oral health by digesting starch, swallowing, and preserving teeth through the production of saliva and important biological processes (1). Salivary gland disorders are among of the most common complications which various imaging methods are used to evaluate them (2). For this purpose, ultrasound examination is a harmless, inexpensive, and easily-accessible imaging method (3). The method is widely used to evaluate lymph nodes and soft tissue diseases in the head and neck, and salivary glands (4-7). The superficial position of the major salivary glands allows them to be evaluated by ultrasound (8).

Basic errors may occur during ultrasound examination of salivary glands. It may be related to examiner or other factors. One of the important and common causes of errors in the interpretation of salivary gland ultrasound results is insufficient knowledge of the normal anatomy of these structures (9). A key factor for reliable examination of salivary glands region, lymph nodes and neck and face structures is the sufficient knowledge and understanding of normal anatomy. Studies have shown that these structures are not well recognized in many materials. The large number of anatomical structures in this region, their route and location, and their complex spatial relationship make it difficult to interpret the ultrasound image of this region. In addition, the insufficient knowledge of the anatomy of the region prevents ultrasound examination and the correct interpretation of the findings (10-12).

Due to the advantages of ultrasound, the complex anatomical structures in head and neck, the necessity of accurate knowledge of anatomical landmarks, typical view, and their possible variations in ultrasound and the spatial relationship between the structures for reliable ultrasound examination and its correct interpretation, the present study aimed to examine the normal-anatomical variations of the major salivary glands and the important adjacent anatomical structures using ultrasound.

MATERIALS AND METHODS

Sample size and study design

This cross-sectional study was conducted on 100 healthy volunteers (without a history of salivary gland disease) from June to March 2016 at Mashhad University of Medical Sciences. After a written informed consent was obtained from volunteers, they were entered the study and their parotid, submandibular, and sublingual salivary glands were examined. The sonographic images of all of the patients were evaluated by an expert radiologist in the field of sonography. Volunteers were excluded in case of illness or unwillingness to participate.

Work Process

Based on the scanning protocol, the examinations were begun with the sublingual salivary glands in the submental triangle, followed by the submandibular and right and left parotid glands. The scanning was begun with identifying the structures adjacent to the glands. For better observation, scanning and storage of the sublingual and submandibular glands were performed at transverse section and that of the parotid glands in vertical section. If necessary, scans were sometimes performed at other sections for further investigation (10).

By placing the probe transversely in the submental region, the sublingual salivary glands were identified. The key structures in the submental triangle included the anterior belly of the digastric muscle, the mylohyoid muscle, the genioglossus and the geniohyoid muscles, the sublingual salivary glands, and the lingual artery. The sublingual gland was observed around the genial and medial muscles and mylohyoid muscles. During the sublingual gland scan, the size of the right gland, the borders, echotexture and echogenicity of the parenchyma of the glands, and the possibility of observing surrounding structures such as the anterior digastric belly, mylohyoid muscle, and genial muscle was examined and the corresponding view stored (6,7). To scan the submandibular glands, the probe was moved in a transverse direction along the left and right sublingual glands. The superficial lobe of the submandibular gland was observed on the side and top of the mylohyoid muscle, and its deep lobe under the posterior free border of the mylohyoid muscle. During the submandibular gland scan, the border, echotexture and echogenicity of the parenchyma of the glands, and the possibility of observing surrounding structures such as the hyoglossus muscle, the femoral artery, the lymph node, and the posterior digastric belly was examined and the corresponding view stored.

To observe the overall anatomy of the parotid gland on either sides, the probe was first moved in a transverse direction from the front of the external ear hole to the submandibular region. To observe the gland, the probe was then placed in front of the ear in a transverse section. Also, the echotexture and echogenicity of the gland parenchyma and the presence of lymph nodes within the gland were examined. To observe the vascular plan within the gland, the probe was placed in a vertical direction behind the angle of mandible. Also, the possibility of observing the retromandibular vein, the posterior belly of digastric muscle, and the external carotid artery was examined. Due to the fact that most of the gland is located in the retromandibular fossa and the presence of mandibular bone is not identified by ultrasound, the border of the parotid gland was not examined (11). It should be noted that the examination was performed using a CTS-7700 ultrasound and a multi-frequency linear probe (5-10 MHz). During the scan, the participants was in a sitting position with a stretched neck.

Recording variables

In the end, the sum of each salivary gland and its surrounding structures was calculated in all participants, i.e. the total distribution of variables in 200 parotid glands, 200 submandibular glands, and 200 sublingual glands was separately examined. Before the examination, demographic information was recorded, including name, gender, age, the history of salivary gland and other diseases, and the medications used to assess any possible interference with the objectives of the present study.

Ethical considerations

The present study was approved by the Ethical research committee (code of ethics IR.mums.sd.REC.1394.175). Also, before the study, a written informed consent was obtained from volunteers and they were assured that their personal information and research results would be treated strictly confidential.

RESULTS

The present study investigated 100 healthy volunteers, including 83 females (83%) and 17 males (17%) between the ages of 6 and 61 years, with the mean age of 32 years.

Echogenicity of the sublingual, submandibular, and parotid glands was hyperechoic in 94.5%, 92.5%, and 84.5%; and hypoechoic in 5.5%, 7.5% and 15.5%, respectively. Also, echo-pattern of the sublingual, submandibular, and parotid glands was homogeneous in 78.5%, 80.5%, and 92%; and heterogeneous in 21.5%, 19.5% and 8%, respectively (Table 1).

Table 1: Echogenicity and echo-pattern of salivary glands

	echogenicity				echotexture			
	hyperechoic		hypoechoic		homogeneous		heterogeneous	
Types of glands	number	percent	number	percent	number	percent	number	percent
sublingual	189	94.5	11	5.5	157	78.5	43	21.5
Submandibular	185	92.5	15	7.5	161	80.5	39	19.5
Parotid	169	84.5	31	15.5	184	92	16	8

As shown in Table 2, the border of sublingual glands is well, ill, and poor in 36.5%, 43.5%, and 20%, respectively. Also, the border of submandibular glands was well, ill, and poor in 56%, 24.5%, and 19.5%, respectively.

Table 2: Borders of the studied glands

	well		ill		poor	
Type of gland	number	percent	number	percent	number	percent
Sublingual	73	36.5	87	43.5	40	20
Submandibular	112	56	49	24.5	39	19.5

In the possibility of observing sublingual gland-specific variables, the highest and lowest frequency was related to geniohyoid with 73% and genioglossus with 50.5%, respectively; in the other variables, including the anterior digastric belly, mylohyoid muscle, and the lingual artery, it was 62%, 71.5%, and 58%, respectively.

In the possibility of observing submandibular gland-specific variables, the highest and lowest frequency was of posterior digastric belly with 69.5% and hyoglossus muscle with 60%, respectively; in the other variables, including facial artery and lymph, it was 68.5% and 62.5%, respectively. Regarding the possibility of observing the parotid gland, the highest and lowest frequency was related to lymph nodes with 56% and the external carotid artery with 32%, respectively; in the other variables, including retromandibular vein and posterior digastric belly, it was 45.5% and 42.5%, respectively.

Table 3: The possibility of observing gland-specific variables

Type of gland	Geniohyoid	Genioglossus	Posterior belly	Posterior belly of digastric	Lingual artery	Mylohyoid muscle
Sublingual	73%	50.5%	62%	71.5%	58%	71.5%
	Posterior belly of digastric	Hyoglossus muscle	Facial veins	Lymph nodes		
submandibular	69.5%	60%	68.5%	62.5%		
	External carotid artery	Lymph nodes	Retromandibular cross-section	Posterior belly of digastric		
Parotid	32%	56%	45.5%	42.5%		

DISCUSSION

Although there have been several studies on echogenicity and echo-pattern variations in various salivary glands diseases (12-15), there is little studies on their possible variation in salivary glands of healthy individuals. In various sources, the sonographic view of normal salivary glands is generally introduced as echogenic and homogeneous structures with specific borders (11 and 12).

In the present study, the echogenicity of the sublingual, submandibular and parotid glands were in most cases hyperechoic. Also, echo-pattern of the studied glands were in most cases homogeneous. As a result, hypoechoic and heterogeneous cases may be considered as normal variations in healthy salivary glands. It is important to paying attention to hypoechoic and heterogeneous cases in examining echogenicity and echo-pattern variations of endocrine glands parenchyma in salivary glands lesions or systemic diseases such as Sjorgen, diabetes, sarcoidosis, lymphoepithelial lesion, in which there is a possibility of involvement of the endocrine glands (16-18).

In addition, the anterior belly of digastric, geniohyoid, genioglossus, and mylohyoid muscles were observed as hypoechoic structures in 62%, 73%, 50.5%, and 71.5%, respectively. The mylohyoid muscle is triangular and flat whose posterior fibers enter the hyoid bone to form the muscular floor of the mouth. This muscle is one of the key structures in the floor of the mouth and forms the lateral and inferior borders of the sublingual gland. The anterior and medial borders of the gland are also formed by the genioglossus and geniohyoid muscles. Identifying these muscles in sonographic view helps to detect the gland (19, 20, and 27).

In our study, the border of sublingual glands was well, ill, and poor in 36.5%, 43.5%, and 20%, respectively. In a study by Yasumoto et al., the border of sublingual glands was good in 93% of the cases (20). In many studies, the borders of the salivary glands, including the submandibular gland, have been clearly defined (10, 11, and 27).

The hyoglossus muscle, one of the external muscles of the tongue, originates on either sides of the greater horn of the hyoid bone and enters the sides of the tongue (19). In the ultrasound view, the hyoglossus muscle separates the submandibular gland from the tongue and tonsil. In the present study, the hyoglossus muscle was visible in 60% of cases. Also, the posterior belly of the digastric muscle, which originates from the mastoid appendage and enters the lesser horn of the hyoid bone, was visible in 69.5% cases in the submandibular scan and 42.5% cases in the parotid scan.

The branches of the lingual artery enter the body of the tongue either in a transverse or oblique direction and can be identified by their pulse. In the present study, lingual artery was visible in 58% of the cases, while in Yasumoto's study, it was reported 93% (20).

In this study, the facial artery was visible in 68.5% of cases in the submandibular gland scan. Previous studies have shown that the facial artery and veins, which pass anteriorly and posteriorly through the gland, may be observed as individual or multiple (10, 11, 21, and 22). Therefore, the accurate knowledge of the possibility of observation, the echogenicity variations, and clarity of these normal anatomic structures in ultrasound images is essential to prevent diagnostic errors. For example, the anterior belly of the digastric muscle in the transverse or oblique cross-sections is oval and may imitate the view of a local lesion with specific borders. Also, genioglossus muscle in transverse cross-sections at the junction of the mandibular bone may imitate the view of a local lesion and even a malignancy (9).

In case of lesion in the salivary glands, attention to the presence of muscular plans and normal vascular structures in the sonographic view, and the movement direction of these landmarks, may contribute to find the source of the lesion and its exact location (10, 23). For example, if the source of the lesion is the submandibular gland, the facial vein moves to the lateral side, and if the source is not the salivary gland, the landmark is located between the lesion and the salivary gland (23).

In the present study, retromandibular vein cross-section was observed in 45.5% of cases during the parotid gland scan. There is external carotid artery in the retromandibular vein medial artery, which was observed in 32% of cases. The previous studies have shown that because most imaging techniques are unable to display the nerve except that high-resolution MRIs, observing this venous cross-section in the parotid sonographic view is a good marker for determining the facial nerve plan passing through this salivary gland. It can also be thought of as a marker dividing the parotid gland into superficial and deep lobes. For parotid lesions, it is important to determine the location and extent of the involvement in relation to the facial nerve (26, 24, and 10). In a similar study by Thoron et al., all methods were able to show retromandibular venous plan in more than two-thirds (66%) of the cases. The use of Doppler and power Doppler methods increased the sensitivity and quality of the examination (25).

In our study, lymph nodes were observed in 62.5% and 56% of cases in submandibular region and inside the parotid gland, respectively. In the submandibular region, the presence of a small number of oval lymph nodes is always considered a normal finding, and if a large node lymph is not identified, it may be mistaken for a mass (10, 27).

Notably, the complex anatomical structures of the floor of the mouth may be mistaken for benign or malignant tumors. Parts of the correct anatomical structures (bones, arterial wall fibrosis, air bubbles in the mouth) can be mistakenly interpreted as deposits in the salivary gland or its excretory duct. Correct lymph nodes in the parotid glands may be known as pathological structures. One of the diagnostic limitations of ultrasound is small focal changes and permeable lesions, which makes the reliable detection of the diseases difficult.

CONCLUSION

Diagnostic problems in ultrasound examination may occur at any time, even if a modern device is used. However, the important thing is to completely eliminate the errors due to insufficient knowledge. As a result, it is important to keep up to date with new information, regardless of the level of knowledge available to experts. The results of this study showed that in echogenicity, echo-pattern, and border of all three pairs of salivary glands and the possibility of observing the anatomical structures around them in the sonographic images of healthy individuals, there are significant variations, indicating that knowledge of their presence is required to a reliable ultrasound examination.

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CONFLICT OF INTEREST

Declare that they have no conflict of interest. The author

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