

# Magnetic Resonance Imaging Assessment of Normal ADC Values of the Parotid Gland

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**Cite this article as:** Kazcı Ö, Ece B. Magnetic resonance imaging assessment of normal ADC values of the parotid gland. *Current Research in MRI*, 2023;2(1):16-18.

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**Received:** February 16, 2023 **Accepted:** March 15, 2023 **Publication Date:** April 27, 2023

DOI:10.5152/CurrResMRI.2023.23053



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## Abstract

**Objective:** The objective of this study is to determine the normal Apparent Diffusion Coefficient (ADC) values of the parotid gland in relation to age and gender.

**Methods:** Fifty female and 50 male patients of the same age were retrospectively analyzed. After inspecting the parotid glands of patients from the same age range, measurements were made using a 30 mm<sup>2</sup> Region of Interest (ROI) in the superficial region. The research was conducted by a single radiologist.

**Results:** There is no difference between average ages of men and women ( $P = .844$ ). There was no difference between mean ADC values of men and women ( $P = .715$ ). The average ADC for the entire group was  $1069.1 \pm 89.5 \text{ mm}^2/\text{s}$ .

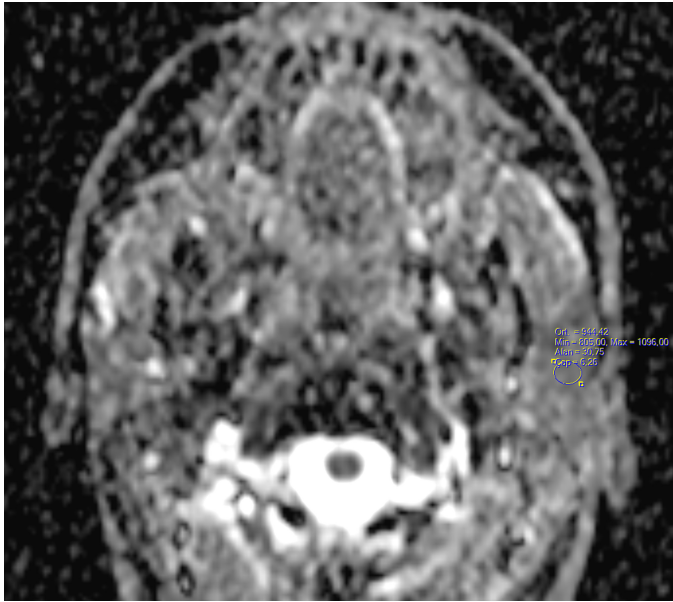
**Conclusion:** In our study, the average ADC for the entire group was  $1069.1 \pm 89.5 \text{ mm}^2/\text{s}$ . If these values are considered in accordance with the device, technique, age, and gender and used as a reference, hypocellular formations can be anticipated above this value and hypercellular formations below this value.

**Keywords:** ADC value, parotid, magnetic resonance imaging, normal

## INTRODUCTION

The parotid gland is the largest of the 3 pairs of major salivary glands in the human body. It is located in front of and just below the ear, and it produces saliva that is released into the mouth through the parotid duct. The parotid gland plays an important role in the digestive process, as it secretes enzymes that help break down food and also helps to lubricate the mouth and throat to aid in swallowing. However, the parotid gland can also be affected by various diseases, such as infections, tumors, and autoimmune disorders, which can cause swelling, pain, and other symptoms. There are various conditions that can be associated with parotid gland masses. The majority of parotid gland masses are benign tumors such as pleomorphic adenomas, Warthin tumors, or oncocytomas. These tumors are slow-growing, well-defined, and can be easily treated with surgical excision. Malignant tumors of the parotid gland are less common but can be more aggressive. They include mucoepidermoid carcinomas, adenoid cystic carcinomas, and acinic cell carcinomas. These tumors require a combination of surgery, radiation therapy, and sometimes chemotherapy for treatment. Infections of the parotid gland can cause swelling and pain, leading to the development of a mass. The most common cause of parotid gland infection is a viral infection, such as mumps. Bacterial infections can also occur, usually as a complication of a salivary duct stone or other obstruction. Sialolithiasis is a condition where a stone forms in the salivary gland or duct, causing obstruction and leading to swelling and pain. This can also lead to the development of a parotid gland mass. Sjogren's syndrome is an autoimmune disorder that can cause inflammation and destruction of the salivary glands, including the parotid gland. This can lead to the development of a mass and is typically treated with immunosuppressive therapy. Lymphoma is a type of cancer that can affect the lymphatic tissue in the parotid gland, leading to the development of a mass. Treatment typically involves a combination of chemotherapy and radiation therapy. In general, parotid gland masses can be associated with a wide range of conditions, and a thorough evaluation by a qualified healthcare provider is necessary to determine the underlying cause and an appropriate management plan.

A range of radiological imaging techniques can be used to assess the parotid gland. Ultrasonography is performed initially due to its low cost and accessibility. Afterward, if necessary, computed tomography (CT) and magnetic resonance (MR) scans are performed. Magnetic resonance imaging (MRI) lacks ionizing radiation and provides great resolution of soft tissue. It is one of the most prevalent methods. Dynamic series and multiparametric parotid MRI with diffusion can yield data that is nearly as precise as histology.<sup>1</sup> Diffusion Weighted Imaging (DWI)-MRI is a non-invasive imaging technique that measures the diffusion of water molecules in tissue, providing information about tissue cellularity, viscosity, and membrane integrity. ADC is a quantitative parameter derived from DW-MRI that reflects the rate and magnitude of water diffusion in tissue. ADC values have been shown to correlate with various pathological conditions in the parotid gland, such as inflammation, fibrosis, neoplasms, and radiation-induced changes. The classification of parotid tumors is essential. Measurements of ADC (appearance diffusion coefficient) vary in



**Figure 1.** A 17-year-old female patient's left parotid gland superficial segment was assessed for ADC using a 30 mm<sup>2</sup> ROI.

connection to various diseases and mass types. The objective of this study is to determine the normal ADC values of the parotid gland in relation to age and gender.

## METHODS

Since our investigation is retrospective, Bilkent City Hospital Ethics Committee (Date: July 28, 2022, No: E2-22-1105) has been obtained. Since this is a retrospective study, consent was not obtained from patients. Utilizing 1.5 Tesla (Magnetom Aera, Siemens Healthcare, Erlangen, Germany). In our database, neck MRI tests over the previous 5 years were reviewed retrospectively. Fifty patients of the same gender and age were studied. The parotid glands of the selected individuals are homogeneous, and no history of mass infection, radiation to the head and neck, or nontreatment is present. After inspecting the parotid glands of patients from the same age range, measurements were made using a 30 mm<sup>2</sup> ROI in the superficial region (Figures 1 and 2). The research was conducted by a single radiologist.

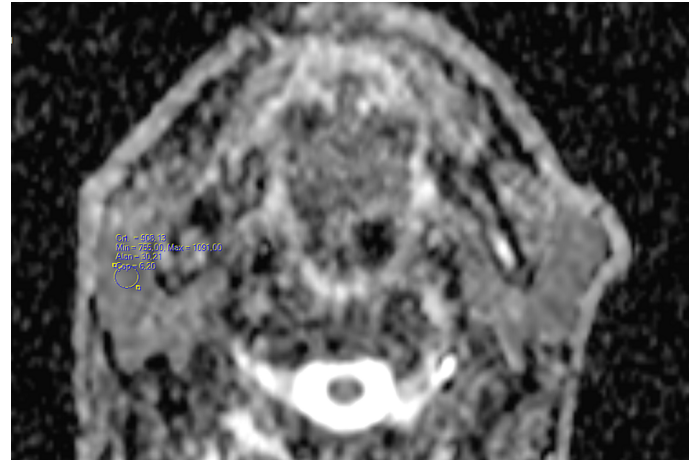
As final data, measurements of 50 female and 50 male patients' parotid gland ADC values were recorded and assessed.

## RESULTS

In the study, 50 women and 50 men were included. The ages of the female participants ranged from 16 to 87 years. The average age of women was  $44.4 \pm 17.1$  years. Male participation ranged in age between 17 and 88. The average age of males was  $45.1 \pm 17.5$  years.

### MAIN POINTS

- The aim of this study is to evaluate the normal ADC value and comparison with different parotid mass lesions.
- The normal ADC values vary by age, gender, and device characteristics.
- The average ADC for the entire group in our investigation was  $1069.1 \pm 89.5$  mm<sup>2</sup>/s.



**Figure 2.** A 58-year-old male patient's right parotid gland superficial segment was assessed for ADC using a 30 mm<sup>2</sup> ROI.

**Table 1.** Female and Male Patient Ages and ADC Values

	Total (n=100)	Female (n=50)	Male (n=50)	P
<b>Age</b>				
Mean $\pm$ SS	$44.8 \pm 17.2$	$44.4 \pm 17.1$	$45.1 \pm 17.5$	.844
Min.-Max	16-88	16-87	17-88	
<b>ADC</b>				
Mean $\pm$ SS	$1069.1 \pm 89.5$	$1072.4 \pm 89.4$	$1065.8 \pm 90.3$	.715

There is no difference between men's and women's average ages ( $P=.844$ ). There was no difference between men's and women's mean ADC values ( $P=.715$ ).

The average ADC for the entire group was  $1069.1 \pm 89.5$  mm<sup>2</sup>/s. The average ADC for the female group was  $1072.4 \pm 89.4$  mm<sup>2</sup>/s. The average ADC for the male group was  $1065.8 \pm 90.3$  mm<sup>2</sup>/s ( $P=.715$ ).

Table 1 displays all values stated in the previous paragraph.

## DISCUSSION

The largest of the salivary glands is the parotid gland. Due to its superior soft tissue contrast and ability to offer functional information, MRI is a popular method for examining the parotid gland. DWI, which assesses the diffusion of water molecules inside tissues, is one of the functional MRI techniques utilized to evaluate the parotid gland. ADC is generated from DWI and gives an indirect measurement of tissue cellularity and extracellular space.

The normal ADC value of the parotid gland has been reported to be in the range of  $1.5\text{--}2.5 \times 10^{-3}$  mm<sup>2</sup>/s.<sup>2,3</sup> However, the specific ADC values can vary depending on several factors, such as the imaging protocol, magnetic field strength, and software used for image analysis. For instance, a study by Vandecaveye et al<sup>4</sup> reported a mean ADC value of  $1.85 \times 10^{-3}$  mm<sup>2</sup>/s for the parotid gland at 3T, while a study by Lee et al<sup>5</sup> reported a mean ADC value of  $1.5 \times 10^{-3}$  mm<sup>2</sup>/s at 1.5 T.

Zhang et al.<sup>6</sup> report that the typical ADC value for the parotid gland is 0.94 (0.88–0.96) 103 mm<sup>2</sup>/s, as reported by Ali EL-Adalany et al.<sup>7</sup> and lower than the ADC values determined with readout-segmented procedures within malignant lesions in previous studies.<sup>8</sup>

The average ADC for the entire group in our investigation was  $1069,1 \pm 89.5 \text{ mm}^2/\text{s}$ .

If the parotid gland is affected by a disease, like inflammation or a tumor, this could change the ADC readings. Takagi et al<sup>9</sup> discovered that the ADC values of parotid glands with Sjogren's syndrome, an autoimmune illness that affects the salivary glands, were much lower than the ADC values of parotid glands with normal salivary gland function. In a separate study, Abdel Razek et al<sup>2</sup> found that the ADC values of normal parotid glands were much higher than those of tumors. Typically, pleomorphic adenomas show elevated ADC values, indicating that the tumor is hypocellular. Unlike carcinomas, which have low ADC values and are hypercellular,<sup>10</sup> this condition is characterized by high ADC values.

### Study Limitations

Although ADC values can provide useful information about the tissue characteristics of the parotid gland, their interpretation has several limitations, including technical variability, physiological factors, and pathological conditions. Therefore, the use of standardized imaging protocols, ROI placement, and clinical correlation is necessary for accurate and consistent ADC measurements.

In our study, the average ADC for the entire group was  $1069,1 \pm 89.5 \text{ mm}^2$ . If these values are considered in accordance with the device, technique, age, and gender and used as a reference, hypocellular formations can be anticipated above this value and hypercellular formations below this value.

**Ethics Committee Approval:** Ethics committee approval was received for this study from the ethics committee of Bilkent City Hospital (Date: July 28, 2022, Number: E2-22-1105).

**Informed Consent:** Due to the retrospective design of the study, informed consent was not taken.

**Peer-review:** Externally peer-reviewed.

**Author Contributions:** Concept – Ö.K.; Design – Ö.K.; Supervision – Ö.K.; Resources - B.E.; Materials – Ö.K.; Data Collection and/or Processing – Ö.K.; Analysis and/or Interpretation – B.E.; Literature Search – B.E.; Writing – Ö.K.; Critical Review – B.E.

**Declaration of Interests:** The authors have no conflict of interest to declare.

**Funding:** The authors declared that this study has received no financial support.

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