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Salivary glands of healthy children versus sialorrhea children, is there an anatomical difference? An ultrasonographic biometry

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ABSTRACT

Objectives: There is no literature about the average size of the salivary glands in the pediatric population with drooling (sialorrhea). Studies have shown that some pathologies affect the functionality of the salivary glands. We assessed via ultrasonography the sizes of the submandibular and parotid glands in 9 healthy children who were not suffering from local or systemic diseases that could affect the salivary glands. We also compared this group with a group of 9 patients with sialorrhea.
Methods: Volunteers were matched based on age, gender, and BMI. Body weight did not differ more than 20% from ideal weight. The parotid and submandibular glands of 9 patients with sialorrhea without any previous treatment were measured via ultrasound and matched to a healthy control. Children with various causes for drooling were included (neurological disorders, neuromuscular disorders, lack of oral motor control).
Results: Dimensions of the parotid glands in drooling and healthy patients were: surface area 2.96 cm^2 (SD ±0.90) and 2.81 cm^2 (SD ±0.54); in depth 1.68 cm (SD ±0.24) and 1.61 cm (SD ±0.27); in the axis longitudinal to the horizontal mandibular ramus 3.18 cm (±0.46) and 3.15 cm (SD ±0.45) in drooling and healthy groups respectively. The means of submandibular glands of drooling and healthy patients measured in surface area: 3.20 cm^2 (SD ±0.66) and 3.08 cm^2 (SD ±0.65); anterior–posterior length 1.55 cm (SD ±0.23) and 1.46 cm (SD ±0.23), medio-lateral length 3.07 cm (SD ±0.39) and 3.07 cm (SD ±0.32). There was no statistical significance in comparison with the healthy group control.
Conclusion: The parotid and submandibular salivary glands in the pediatric population do not differ in size in children with or without drooling. Measuring the glands at baseline and post treatment with botulinum toxin injections allows one to evaluate if there are changes in the gland related to the treatment.

1. Introduction

Saliva is mainly secreted by three major salivary glands: the parotid, sublingual and submandibular glands, as well as by minor salivary glands, spread along the aerodigestive tract [1]. Saliva production ranges between 0.5 and 1.5 L per day in adults and varies from person to person [2]

There are salivary gland changes with local or systemic diseases, usually not easy to identify on clinical examination only. For instance, there is parotid gland volume enlargement in patients with eating disorders [3] and there is a linear correlation found between adipose tissue and the size of the parotid glands [4]. Both parotid and submandibular glands can be visualized successfully via ultrasound [5]. Drooling (sialorrhea) is the unintentional loss of saliva from the mouth, usually defined as saliva beyond the lower lip margin. To date, there is no literature associating the size of the salivary gland with drooling. The purpose of our study was to rule out whether sialorrhea is associated with changes in either parotid or submandibular glands.

This project has received REB approval at our institution.

2. Materials and methods

2.1. Subjects selection

Patients between 4 and 18 years of age, presenting to our institution between October 2013 and May 2014 and that agree to

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participate in the study. Children with various causes for drooling were included (neurological disorders such as cerebral palsy, hypoxic ischemic encephalopathy, lack of oral motor control), having had previous scores of at least 6 on the drooling frequency and severity scales [6], without any surgical procedure nor medical treatment that could interrupt salivary flow or production. Healthy children were considered those without any systemic or salivary gland disorder in their lifetime and that were not taking any medication that could affect salivary flow. We recruited 9 drooling children that were matched by age, BMI no less than 20% different and gender with a group control of 9 healthy children. Patients were not matched by gender.

Ultrasound measurement: we measured the surface area of the superficial lobe, anterior–posterior (AP) diameter and the medial–lateral (ML) dimension or depth. Ultrasound images were taken in the sitting position with the neck hyperextended and the head slightly turned to the side opposite to the gland being examined. We used a HDI 5000 Ultrasound machine (Philips®) equipped with a linear VA 12–15 MHz probe with 15 MHz frequency presets. Both submandibular glands and parotid glands of each patient were scanned in two planes, transverse and longitudinal to the mandibular plane. For the submandibular gland, AP dimension was measured on a longitudinal view acquired parallel to the horizontal ramus of the mandible, being the maximum distance in the sagittal axis. The medial–lateral (ML) dimension or depth was measured on a perpendicular view obtained at half point of AP dimension, defined as the maximum distance in the coronal axis. The surface area was computed automatically based on the circumference. All ultrasound parameters were evaluated by the same physician, previously trained by an experienced pediatric radiologist.

2.2. Statistical analysis

For continuous variables, mean and standard deviation are reported. Means were compared using the Student's *t*-test, while categorical variables were compared using the Fisher's exact test. The salivary gland measurements (AP, ML, surface area) were compared between the drooling and the control group using a logistic linear regression analysis with adjusting for possible confounders: age, gender, and BMI. A *P*-value lower than 0.05 was considered to indicate statistical significance. All statistics were done using SPSS 17.0 (IBM©).

3. Results

We included 18 children (9 controls, 9 untreated drooling patients). In the control group, mean age was 6.5 years old (SD ±2.0) and 2 (22%) of those were female. In the drooling group, mean age was 6.5 years old (SD ±2.0) and all were male. The mean BMI was 17.2 (SD ±2.7) and 17.5 (SD ±2.3) for the control and drooling group respectively. Body weight did not show great variation by age. The relative distribution of each variable for the drooling and healthy group is shown in Table 1.

We combined results of both right and left parotids as well as right and left submandibular glands, after finding no statistical difference between right and left salivary glands respectively (*t*-test, each wise $P > 0.05$). Table 2 reports the mean salivary gland size and comparison in univariate analysis. We found no statistical difference for both parotid and submandibular glands.

3.1. Submandibular gland

Results of the submandibular biometry of the drooling and control groups are shown in Table 1, Figs. 1 and 2B. No statistical difference was found in dimensions of area, depth and AP dimension between both control and drooling groups. Age, gender and BMI were also not statistical significant at the 5% level. The average area was 3.20 cm^2 (SD ±0.66) and 3.08 cm^2 (SD ±0.65) in drooling and healthy groups respectively. The anterior–posterior dimensions were 1.55 cm (SD ±0.23) and 1.46 cm (SD ±0.23) and the medio-lateral dimensions 3.07 cm (SD ±0.39) and 3.07 cm (SD ±0.32) in drooling and healthy groups respectively.

Table 1
Patients baseline characteristics.

	Healthy Group	Drooling Group	*P* value
Gender			
Male	7 (78%)	9 (100%)	
Female	2 (22%)	0 (0%)	
Age (mean SD)	6.5 (±2.0)	6.5 (±2.0)	0.81
BMI (mean SD)	17.2 (±2.72)	17.5 (±2.34)	1.00

Age and BMI compared using the *t*-test. Gender Fischer's exact test.

3.2. Parotid gland

Results of parotid gland biometry separated by group drooling and control are also shown in Table 1, Figs. 1 and 2A. Dimensions of area, depth and AP dimension between both control and drooling groups showed no statistical difference. Age, gender and BMI were also not statistically significant ($P > 0.05$). The average area was 2.96 cm^2 (SD ±0.90) and 2.81 cm^2 (SD ±0.54) in drooling and healthy groups respectively. The anterior–posterior dimension were 1.68 cm (SD ±0.24) and 1.61 cm (SD ±0.27) and the medio-lateral dimensions 3.18 cm (±0.46) and 3.15 cm (SD ±0.45) in drooling and healthy groups respectively.

No differences in echotexture was observed in any drooling group and healthy control groups.

4. Discussion

Studies have shown that both parotid and submandibular glands are superficial structures well evaluated by ultrasonography with high frequency transducers that can delimit sonographically the anatomy and evaluate intra or extraglandular pathologies [7]. It is known that some pathologies can morphologically affect the salivary glands. These include inflammatory diseases; autoimmune diseases such as recurrent parotitis and acute episodes of Sjogren's syndrome [8]; granulomatous diseases; neoplastic (Whartin tumors, MALT lymphomas); congenital diseases (polycystic parotid disease) and human immunodeficiency virus (HIV) patients [9]. Significant parotid enlargement is also

Table 2
Mean glandular dimensions (cm) via ultrasound of the submandibular gland and parotid glands in drooling and healthy patients and comparison in univariate analysis.

Dimensions (cm)	Drooling patients	Healthy patients	Significance (*P*-value)
Area			
Parot	2.96 (±0.90)	2.81 (±0.54)	0.54
SMG	3.20 (±0.66)	3.08 (±0.65)	0.59
ML (depth)			
Parot	3.18 (±0.46)	3.15 (±0.45)	0.84
SMG	3.07 (±0.39)	3.07 (±0.32)	0.99
AP			
Parot	1.68 (±0.24)	1.61 (±0.27)	0.40
SMG	1.55 (±0.23)	1.46 (±0.23)	0.25

ML, medio-lateral dimension; AP, anterior–posterior length; PAROT, parotid gland; SMG, submandibular gland; area, dimension in cm^2.