CORRELATION BETWEEN CT SCAN FINDINGS AND DEGREE OF HYPERNASALITY IN VELOPHARYNGEAL INSUFFICIENCY PATIENTS

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Received: 27/1/2022
Accepted: 1/3/2022

Online ISSN: 2735-3540

ABSTRACT:

Background: *Velopharyngeal Insufficiency (VPI) is the most common seen disorder in children with associated craniofacial developmental anomalies of which cleft palate is the most common. Overt cleft palate, in both before and after repair, is by far the most common cause of VPI. Computerized tomography (CT scan) is used to assess mobility of the velum, lateral and posterior pharyngeal walls, but it needs a cooperative patient (>5years). Its advantages are the easy definition of measured parameters, the provision of automated numerical value regarding the size of velopharyngeal gap and the amount of displacement of each wall as well as the provision information about the vertical level of closure of the velopharyngeal port referring to surrounding structures.*

Aim of the work: *To analyze the CT findings and its correlation to severity of the hypernasality in velopharyngeal insufficiency patients.*

patients and methods: *This study was applied on 50 patients with age ranging from 20 - 60 years, from January 2017 to December 2020, diagnosed hypernasality caused by velopharyngeal insufficiency, from the outpatient Phoniatric clinic at Ain Shams University Hospitals. Each patient was subjected to the following:1-Auditory perceptual assessment (APA) to assess hypernasality presence and degrees. 2-Computrixed tomography (facial view) over the velopharyngeal valve to assess the valvular functions. To compare CT findings of the velopharyngeal port to the severity of the hypernasality in patients.*

Results*: It showed that mild degree hyper-nasality will be seen in CT as valve gap (while sustained vowel production) with mean of 1.914 mm gap ranging from (0.03 -5.23 mm) in 17 cases. While moderate degree hyper-nasality showed CT valve gap with mean of 5.75 range from (2.05-10 mm) in 16 cases. Moderately severe hyper nasality showed CT valve gap with mean of 7.09 range valve gap (3.45-11mm) in 12 cases. Severe degree hyper-nasality showed CT valve gap mean of 10.42 ranges from (7.05-13 mm) in 5 cases. The overlapping between ranges in different degrees of nasality was obvious*

Conclusion: *The present study showed that CT scan measurement suggestive of severity in moderate to severe degrees of hypernasality more than mild and mild to moderate degrees.*

Keywords: *Hypernasality, Radiology, Velopharyngeal Insufficiency.*

INTRODUCTION:

Velopharyngeal insufficiency (VPI) defined as incomplete closure of the velopharyngeal port during speech producing tasks that resutls in hyper-nasal speech, nasal air emission, compensatory misarticulating, lowered vocal intensity and facial grimacing[1].

Velopharyngeal incompetence is a common problem following the primary repair of cleft palate. A competent velopharyngeal mechanism is the goal in repair of soft palate [2].

The effect of VPI on speech and resonance ranges from mild speech distortion to catastrophic disruption of speech intelligibility, leading to breakdown of the ability to communicate verbally [3].

One of the most common causes of VPI is cleft palate even after being repaired. The frequency of hypernasality after cleft palate repair that may need secondary surgery varies in different literature between 15 and 45%. VPI occurs when the surgically repaired cleft palate is of inadequate mobility for elevation and achieving velopharyngeal closure and thus optimal speech, which is one of the primary goals of surgical repair [1].

Normal velopharyngeal closure is accomplished by the coordinated and perfectly timed actions of muscular parts of the velum, both lateral pharyngeal walls and the posterior pharyngeal wall. These structures are the ones who functions as a valve that serves to separate the nasal cavity from the oral cavity during speech as well as other functions as singing, blowing, swallowing, suckling, gagging and vomiting [4].

CT scan assess mobility of the velum, lateral and posterior pharyngeal walls, but it needs a cooperative patient (>5years) [5]. Its advantages are the easy definition of measured parameters, the provision of automated numerical value regarding the size of velopharyngeal gap and the amount of displacement of each wall as well as the provision information about the vertical level of closure of the velopharyngeal port referring to surrounding structures. On the other hand, it gives no information about the dynamic function during speech production. The effect of gravity in the supine position may alter the actual picture of velar function. Moreover, the amount of exposure of radiation cannot be overlooked[6].

The levator veli muscle help retract the velum (soft palate) to permit separation of the nasopharynx from the oropharynx by complete coverage of the soft palate against the posterior pharyngeal wall. Patients with cleft palate have abnormalities of the levator veli palatini muscle, resulting in suboptimal velopharyngeal closure, known as VPI. This causes hypernasality that impairs speech development. Nasoendoscopy and videofluoroscopy were used to assess velopharyngeal anatomy. However, nasoendoscopy is invasive as it involves placement of an endoscope into the pharyngeal region and may cause patient anxiety and discomfort, especially in children.In addition, videofluoroscopy, as with other fluoroscopic studies, has inherent measurement errors that may vary with patient positioning[7] With the advances in cross- sectional imaging modalities including (CT) and magnetic resonance imaging (MRI), non-invasive radiological tool to assess bony anatomy and velopharyngeal musculature with easily reproducible anatomy and measurements is now feasible. Preoperative imaging assessment assists pediatric and maxillofacial dental surgeons in surgical interventions.

AIM OF THE WORK

To analyze the CT findings and its correlation to severity of the hypernasality in velopharyngeal insufficiency patients

PATIENTS AND METHODS

Patients:

50 hypernasality patients caused by VPI, recruited from the outpatient Phoniatric clinic at Ain Shams University Hospitals from January 2017 to December 2020, were included in this study.

Selection criteria:

Inclusion criteria:

- Abnormal resonance (opened) judged by Auditory Perceptual Assessment and clinically diagnosed as VPI.
- Native Arabic speakers.

Exclusion criteria:

- Age (below 20 years or above 60 years).
- Patients with respiratory tract infections on the day of examination.
- History of hearing impairment, mental retardation, Neuropsychiatric problems, or allergy.
- Comprehensive language deficits.

The study was conducted in accordance with the ethical standards in the Faculty of Medicine, Ain Shams University, with the prior written consent of the patients.

Methods:

All patients underwent the following steps of the speech protocol:

Patient interview:

- Personal Data: name, age and gender, education, occupation, residence, marital status and number of children / Complaint and analysis of symptoms: Duration - onset – course
- Subjective perceptual assessments of patients: using APA detect severity of hypernasality as 4 Grading system (0= normal resonance, 1=mild hypernasality, 2=moderate hyper-nasality, 3=moderate to severe hypernasality,4= severe hypernasality.

Visual examination of vocal tract:

By using the simple clinical examination tools for reporting on lips, palate morphology and mobility, the mobility of pharyngeal walls, tonsils size, nose, ear examination and laryngeal examination

Radiological Studies: through computed tomography (CT):

It is done by utilizing a computer tomography with a slicing width 3 mm. The plane of tomography is at the extent between the nasolabial angle and therefore the lower margin of the ear lobe. stills are taken at rest and through sustained /a/ vowel, the sigittal and therefore the coronal dimensions are measured. The velopharyngeal port area is calculated both at rest and through sustained phonation. CT as a feasible non-invasive objective procedure for measurement of the velopharyngeal port area and therefore the amount of displacement of the components of the port in one picture. The calculated parameters were easily defined, the supply of automated numerical values regarding the dimensions of the veloph-aryngeal port and therefore the amount of displacement of every wall up refere- nce to surrounding structures are all possible, it allows visualization of various structures in each dimension (width, depth and height)[8]

Statistical Analysis

i. Descriptive statistics:

1. Mean ± SD (standard deviation) and Range for parametric numerical data. Median and Interquartile range (IQR) for non-parametric numerical data.
2. Frequency/Number and Percentage of non-numerical data.

ii. **Analytical statistics:**

Paired t-test was used to assess the statistical significance of the difference between two means measured twice for the same study group.

The distribution of age and gender of the participated Hypernasal tone of speech patients of 21 male cases (42%) and 29 female patients (58%) showed in **Table 1 and Table 2.**

RESULTS

Table 1: The distribution of the sex among hypernasality patients

		Number	%
Sex	Male	21	42%
	Female	29	58%

Table 2: mean of age

	Mean ± SD	Range
Age (years)	37.12 ± 10.47	21 - 59

CT scan (facial view) was done to all patients to detect radiological velo-pharyngeal gap space in mm. It showed that mild degree hyper-nasality will be seen in CT as valve gap (while sustained vowel production) with mean of 1.914 mm gap ranging from (0.03 -5.23 mm) in 17 cases.

While moderate degree hyper-nasality showed CT valve gap with mean of 5.75 range from (2.05-10 mm) in 16 cases. Moderately severe hyper nasality showed CT valve gap with mean of 7.09 range valve gap (3.45-11mm) in 12 cases. Severe degree hyper-nasality showed CT valve gap mean of 10.42 range from (7.05-13 mm) in 5 cases. The overlapping between ranges in different degrees of nasality was obvious.as shown in **(table 3).**

CT Finding is a statistically significant predictor of the severity of nasality.

Table (3): CT scan findings in comparison to grade of hypernasality

HYPER-NASALITY	Count	MEAN	S.D.	Median	Minim.	Maximum
Mild hyper nasality	17	1.9147	1.48899	1.6	0.03	5.23
Moderate hyper nasality	16	5.7531	2.76262	5.31	2.05	10
Moderate to severe hypernasality	12	7.0933	2.48720	7.1150	3.45	11
Severe hypernasality	5	10.4200	2.19523	10.44	7.05	13
Total	50	5.2364	3.51338	4.2650	0.3	13.00

While correlating the APA findings to the CT scan results was found as statically significant as shown in **table (4).**

Table (4): CT scan in comparison to PWSS results

APA	Number of cases	MEAN	SD	Median	Minimum	Maximum
borderline competent VPV	5	0.7620	0.49952	0.9800	0.03	1.30
borderline incompetent VPV	14	2.9107	2.18263	1.9500	0.90	8.70
Incompetent VPV	31	7.0084	2.99	7.0500	2.05	13.00
Total	50	5.2364	3.51	4.2650	0.3	13.00

DISCUSSION;

The purpose of this study was to evaluate the changes to the velopharyngeal anatomy using CT scans. In addition, the differences in these measures between patients and the correlation between velopharyngeal gap size and severity of auditory perceived hypernasality.

In this study, 50 hypernasality patients underwent the clincal assessment and CT scan. On perceptual analysis of patients, 6 were auditory perceived in APA as mild hypernasality, 24 cases were auditorily perceived as moderate hypernasality, 18 patients were found as moderately severe hypernasality and 2 patients as severe hypernasality.

In previous studies CT scan of VPV and nasoendoscopy were used as the objective evaluation of velopharyngeal closure. In patients with cleft palates, CT scans of the velopharynx were made both at rest and through vowel phonation with a scanning time of three seconds and slicing width of 3 mm. At an equivalent time, endoscopic observations of the velopharynx through the nose were administered both at rest and through phonation. CT scan during phonation clearly demonstrated the mobility of the velopharynx, i.e., elevation of the soft palate and medial movement of the lateral pharyngeal walls during a single picture. Its disadvantage is exposure to x-rays and expensive time and resources consuming procedure.

Limitations faced during applying CT scan for hyper nasality patients

1. lack of experienced physician and technicians who concerned with VPV area visualization.
2. limited benefits out of imaging rather than research as it doesn't add to other clinical and instrumental measures to decide the treatment and intervention required.
3. 3-Patient position and degree of stability during imaging at phonation and the slice or cut taken for measurement is the maximum closure which can be subjectively changed according to technicians and age and sex differences
4. plastic surgeons usually use MRI for postoperative follow up and Naso-fibroscopic examination for direct visualization and more acceptable than repeated imaging with less cost and better accessibility for patients and across different cities and hospitals
5. 5-Lack of clear demarcation between different grades of VPI, As we found overlapping of size of gap during phonation that cannot be relied on alone to decide live of treatment especially invasive or surgery without direct visualization and clinical examination of valve functions during both phonation and swallowing functions.

Conclusion & Recommendations:

CT scan can be considered as a good predictor and pre- operative investigations but it can be replaced with other nasality workouts of clinical examination and direct visualization of the velopharyngeal area in patients from 20-60 years old patients.

Further work needs to be done on Larger-scale to compare the CT findings and standardization in hypernasality patients.

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نتائج التصوير المقطعي في مرضى فرط الخنف المفتوح الناجم عن قصور الصمام اللهائي البلعومي

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المقدمة: لا تقتصر الوظائف العصبية والعضلية المعقدة التي تنظم كلام الإنسان على الحنجرة حيث يلعب احكام اغلاق الصمام اللهائي البلعومي دورا هاما في إصدار اصوات السواكن و المتحركات مما يؤثر على درجة وضوح الكلام.عدم كفاءة الصمام اللهائي البلعومي هي الحالة التي تؤدي الى زيادة الرنين الانفي وتشويه الانبعاثات الأنفية أثناء الكلام. ويرجع ذلك إلى عدم القدرة الهيكلية للتبديل التدريجي وفتح البلعوم الأنفي في الحركات الفسيولوجية المنسقة السريعة التي يتم توقيتها بشكل صحيح مع غيرها من آلية النطق.

ضعف او عدم كفاءة وظيفة الصمام اللهائي البلعومي يمكن أن تحدث بسبب مجموعة متنوعة من الأسباب. يمكن أن يكون راجعا إلى خلل تشريحي أو هيكلي عادة ما يشار إلى قصور في البلعوم، أو اضطراب فسيولوجي يسبب ضعف حركة البلعوم، وعادة ما يسمى القصور اللهائي البلعومي. كما يمكن أن يكون أيضا بسبب قصور في إكتساب الكلام، مما أدى إلى استخدام أنماط خاطئة لإغلاق الصمام.

هدف الدراسة: يهدف هذا العمل إلى تحليل نتائج التصوير المقطعي وارتباطها بشدة الخنف المفتوح في مرضى قصور الصمام اللهائي البلعومي.

المرضى وطرق البحث:

<u>المرضى:</u>اشتملت هذه الدراسة على خمسين مريضاً يعانون من رنين خنف مفتوح نتيجة قصور في الصمام اللهائي البلعومي ممن يترددون على عيادة التخاطب في مستشفيات جامعة عين شمس.

<u>معايير الاشتمال هي:</u> رنين غير طبيعي (مفتوح) يحكم عليه التقييم الإدراكي السمعي ويتم تشخيصه إكلينيكيًا على أنه فرط خنف.

- الناطقون باللغة العربية.

<u>معايير الإستبعاد هي :</u>

- العمر (أقل من ٢٠ سنوات أو أكثر من ٦٠ سنة).
- المصابون بعدوى في الجهاز التنفسي في يوم التقييم.
- عجز لغوي شامل.

تم إجراء الدراسة وفقا للمعايير الأخلاقية المنصوص عليها في كلية الطب جامعة عين شمس، مع الحصول على موافقة مكتوبة مسبقاً من المرضى .

سوف يخضع جميع أفراد الدراسة لما يلي :

- مقابلة المريض وكتابة التاريخ المرضي.
- فحص إكلينيكي شامل.
- تم عمل اشعة مقطعية على سقف الحنك ومنطقة الصمام اللهائي البلعومي كوسيلة اكلينيكية لتقييم كفاءة الصمام.

مضافا الى كل ما سبق التحليل الصوتي للكلام الذي يتضمن:

- مقياس الرنين الانفي وهو الأسلوب الأكثر استخداما على نطاق واسع للتحليل الصوتي للكلام.

النتائج: تمت مقارنة نتائج الاشعة المقطعيه مع نتائج التقييم السمعي الادراكي لشدة الخنف المفتوح وجد فروق ذات دلالة إحصائية.

الخلاصة: ان يمكن أن يكون التصوير المقطعي للصمام اللهائي البلعومي مؤشرا جيدا وتحقيقات ما قبل الجراحة ولكن يمكن استبداله بفحوصات أخرى وفحص سريري مفصل

يجب القيام بمزيد من العمل على نطاق واسع لمقارنة نتائج التصوير المقطعي والتوحيد القياسي في مرضى فرط الخنف المفتوح (زيادة الرنين الانفي).