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# Application of Berlin questionnaire in obstructive sleep apnea syndrome through soft palate morphology types

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## Abstract:

**BACKGROUND:** Obstructive sleep apnea (OSA) is a sleep disorder characterized by intermittent complete and partial airway collapse, resulting in frequent episodes of apnea and hypopnea. The Berlin questionnaire (BQ) is a simple, inexpensive instrument used to screen for OSA, which is about risk factors for sleep apnea, namely, snoring behavior, daytime sleepiness or fatigue, and the presence of obesity or hypertension. This 10-question test has since then become well known for its accuracy in predicting the presence of sleep apnea in patients. Cephalometry is a relatively inexpensive method and it permits a good assessment of the soft tissue elements that define the soft palate and its surrounding structures. Therefore, the present study aims to study the morphology of the soft palate using lateral cephalometry and classify it into various types. And to identify the individuals with OSA syndrome through a particular type of soft palate and correlate it with the BQ.

**MATERIAL AND METHODS:** This prospective study was conducted in the Department of Oral Medicine and Radiology of D.Y.Patil Dental College, Pune. About 150 subjects for the study were selected by random sampling from the outpatient department of Oral Medicine and Radiology and the patients were referred from the orthodontics department. Lateral cephalograms were assessed for soft palate morphology types, and all participants filled the BQ. A Chi-square test was applied. The level of significance was set at  $P < 0.05$ .

**RESULTS:** Among six types of the soft palate, the maximum number of participants had type 2 (rat-tail type) of the soft palate (26.0%). A highly significant association was found between the BQ (positive and negative response) and soft palate morphology types (i.e.,  $P < 0.01$ ). A maximum number of participants who responded to the BQ had type 5 (S type) of the soft palate (76.47%).

**CONCLUSION:** The type 2 (rat-tail) soft palate was the most frequent type, while the type 4 (straight-line) shape was the least common among all the six types. The persons with type 5 (S-shape) soft palate responded more positively to the BQ as compared to other types of soft palate. This shows that a particular type of soft palate could be responsible for causing OSA syndrome.

**CLINICAL SIGNIFICANCE:** Lateral cephalogram and BQ, which are relatively inexpensive and widely available, can be used in resource-limited and thickly populated countries like India to correctly identify patients with OSA syndrome.

## Keywords:

Berlin questionnaire, lateral cephalogram, obstructive sleep apnea syndrome, soft palate

## Introduction

The soft palate is the posterior fibromuscular part of the palate that is

attached to the posterior edge of the hard palate. The palate is formed by the fusion of three components; they are two palatal processes and the primitive palate is formed from the frontonasal process.

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The anatomy of the soft palate plays an important role in velopharyngeal closure, which is a sphincteric mechanism constituting velar and pharyngeal components. The movement separates the oral cavity from the nasal cavity during deglutition and speech. When the velum and lateral and posterior pharyngeal walls fail to separate two cavities, velopharyngeal incompetence (VPI) occurs. It participates in many oral functions especially velopharyngeal closure which is related to the normal function of sucking, swallowing, and pronunciation.<sup>[1]</sup> This incompetency can result in many malfunctions especially obstructive sleep apnea (OSA). You *et al.*<sup>[2]</sup> documented the variation in normal velar morphology and classified them into six different categories which have been employed in the present study. Pepin *et al.*<sup>[3]</sup> found the “hooked” appearance of the soft palate also known as the “S” type in awake patients, which indicated a high risk for obstructive sleep apnea syndrome (OSAS).

OSAS is characterized by recurrent occlusion of the upper airways resulting from inspiratory collapse of the pharyngeal walls. OSA is a sleep disorder characterized by intermittent complete and partial airway collapse, resulting in frequent episodes of apnea and hypopnea. These upper airway abnormalities may be subtle and detectable only by CT scan, acoustic reflection, or cephalometry.

It is considered to be the major cause of morbidity and mortality worldwide and is considered to be one of the leading causes of death in India, the main reason being misconception/misinterpretation of the disease and unawareness about the risk factors which hinder early diagnosis and its treatment effectively.<sup>[4]</sup>

The Berlin questionnaire (BQ) is a simple, inexpensive instrument used to screen for OSA, as reported at the Conference on Sleep in Primary Care, which took place in April of 1996 in Berlin, Germany.<sup>[5,6]</sup> The BQ asks about risk factors for sleep apnea, namely, snoring behavior, daytime sleepiness or fatigue, and the presence of obesity or hypertension.<sup>[6]</sup> This 10-question test has since then become well known for its accuracy in predicting the presence of sleep apnea in patients.

Cephalometric analysis is one of the most commonly accepted techniques for evaluating the soft palate. Cephalometry is a relatively inexpensive method and it permits a good assessment of the soft tissue elements that define the soft palate and its surrounding structures. It is hoped that these findings may be used not only as references for the normal soft palate but for cleft reconstruction and the etiological research of OSAS and other conditions.

The fact that a particular morphological variety of the appearance of soft palate predisposes the patient to an OSAS and correlating it with BQ would help in early diagnosis and prevent complications underlines the need for this study.

## Material and Methods

### Study design

This prospective study was conducted in the Department of Oral Medicine and Radiology of D.Y. Patil Dental College, Pune.

### Study participants and sampling

About 150 subjects for the study were selected by random sampling from the outpatient department of Oral Medicine and Radiology and the patients were referred from the orthodontics department from the period of January 2011 to December 2012.

### Informed consent

Each patient was fully informed and explained about the lateral cephalometry procedure and a consent form was given by the investigator to all the participants.

### Inclusion criteria

Subjects with age range starting from 5 years to 79 years.

### Exclusion criteria

Subjects having speech dysfunction, any history of cleft palate, and fracture of the head and neck.

### Data collection tool and technique

#### Digital lateral cephalogram technique

A lateral cephalogram was taken for each individual included in the study. The subjects stood with the sagittal plane parallel to the film and the bilateral ear rods were gently inserted into the external auditory meatus to stabilize the head position during exposure. The head was adjusted so that the Frankfort horizontal plane was parallel to the floor.

The tube potential is adjusted to optimize the contrast of both hard and soft tissues. The digital radiographs were processed by Planmeca Dimax Pro Version 4.2.0 software manufactured by Planmeca Oy, Asentajankatu 6, 00880 Helsinki, Finland. The parameters were kept the same for every patient (Kvp-66 mv, mA-7, time - 18 s, filtration-2.5 mm). In this study, the soft palate was classified according to You M *et al.*<sup>[2]</sup> Based on radiographic appearances, categorization of the soft palate was done into the following six types:

Type 1: Leaf/anceolate shaped: The middle portion of the soft palate is elevated to both nasal and oral sides.

Type 2: Rat-tail shaped: The soft palate shows an inflated anterior portion and free margin with an obvious coarctation.

Type 3: Butt-like: The soft palate shows a shorter and fatter velum appearance with no distinct difference in width of the anterior portion to the free margin.

Type 4: Straight-line-shaped.

Type 5: S-shaped/distorted soft palate.

Type 6: Crooked appearance: The soft palate with posterior portion crooks antero-superiorly.

**BQ**

A prepared questionnaire [Figures 1-3] was filled out by the observer (PGstudent) to all the patients selected for the study. The purpose of this questionnaire was to identify the individuals with OSAS.

Netzer *et al.*<sup>[6]</sup> divided the BQ into the following three categories:

In category 1, high risk was defined as persistent symptoms (3 to 4 times /week) in two or more questions about their snoring.

In category 2, high risk was defined as persistent (3 to 4 times/week) wake time sleepiness, drowsy driving, or both.

In category 3, high risk was defined as a history of high blood pressure or a body mass index of more than 30 kg/m<sup>2</sup>.

To be considered at high risk for sleep apnea, a patient had to qualify for at least two symptom categories.

**Ethical consideration**

The experimental protocol for this study underwent review and approval by the ethical committee of

Berlin questionnaire format

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**SLEEP APNOEA QUESTIONNAIRE**

PERSONAL BIODATA

Name \_\_\_\_\_

Age \_\_\_\_\_ Sex \_\_\_\_\_

Chief complaint \_\_\_\_\_

Past dental history \_\_\_\_\_

Past medical history \_\_\_\_\_

Monthly Income \_\_\_\_\_

Occupation \_\_\_\_\_

Marital Status \_\_\_\_\_

Address: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Phone: \_\_\_\_\_

**SLEEP APNOEA QUESTIONNAIRE**

**Do you regularly...**

- Snore heavily? Yes / No
- Fall asleep while watching television? Yes / No
- Fight sleepiness on the job or when driving? Yes / No
- Wake with headaches? Yes / No
- Have high blood pressure? Yes / No
- Wake feeling tired, fatigued, unrefreshed? Yes / No
- Wake frequently and struggle to fall back to sleep? Yes / No
- Wake with a choking / gasping feeling? Yes / No

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Figure 1: Berlin questionnaire format (part-1)

Berlin questionnaire format

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- Do you smoke? Yes / No

- Suffer sexual dysfunction?

**Does your bed partner complain of...**

- Your loud snoring? Yes / No
- Your legs twitching or kicking at night? Yes / No
- Long breathing pauses during your sleep? Yes / No

Usual time to bed - \_\_\_\_\_ Usual time of waking - \_\_\_\_\_

Employment status? \_\_\_\_\_

Do you suffer from any nasal or sinus problems? \_\_\_\_\_

Current medications? \_\_\_\_\_

**BERLIN QUESTIONNAIRE**

**Category 1.**

**1. Do you snore?**

- yes
- no
- don't know

**2. If you snore, your snoring is?**

- slightly louder than breathing
- as loud as talking
- louder than talking
- very loud, can be heard in adjacent rooms

**3. How often do you snore?**

- nearly every day
- 3-4 times a week
- 1-2 times a week
- 1-2 times a month
- never or nearly never

**4. Has your snoring ever bothered other people?**

- yes
- no

**5. Has anyone noticed that you quit breathing during sleep?**

- nearly every day
- 3-4 times a week
- 1-2 times a week
- 1-2 times a month
- never or nearly never

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Figure 2: Berlin questionnaire format (part-2)

the institution. Each patient was fully informed and explained about the lateral cephalometry procedure.

### Results

The obtained data was compiled systematically, coded in an MS Excel sheet manufactured by Microsoft Coporation, Redmond, Washington, United states and subjected to statistical analysis with the consultation of a statistician. Descriptive and inferential statistical analyses were carried out in the present study. The statistical software IBM SPSS statistics 22.0 (IBM Corporation, Armonk, NY, USA) was used for the analyses of the data, and Microsoft Word manufactured by Microsoft Coporation, Redmond, Washington, United states and Excel were used to generate graphs, etc. Chi-square statistical test was applied to the results obtained from the study; the level of significance was set at  $P < 0.05$ .

In the present study, the age group of patients ranged from 5 to 79 years. Among various types of the soft

palate, the maximum number of participants had rat-tail type of soft palate (26.0%), followed by butt type (20%), crooked type (18.67%), leaf type (14.66%), S-shaped (11.34%), and straight-line (9.33%) [Table 1 and Graph 1].

By applying the Chi-square test, there is a highly significant association between BQ (positive and negative response) and soft palate morphology types (i.e.,  $P < 0.01$ ). Among various types of the soft palate, the maximum number of participants who responded to the BQ had the S type of soft palate (76.47%), followed by butt type (20%), rat-tail shape type (17.95%), and crooked type (3.57%) [Table 2 and Graph 2].

### Discussion

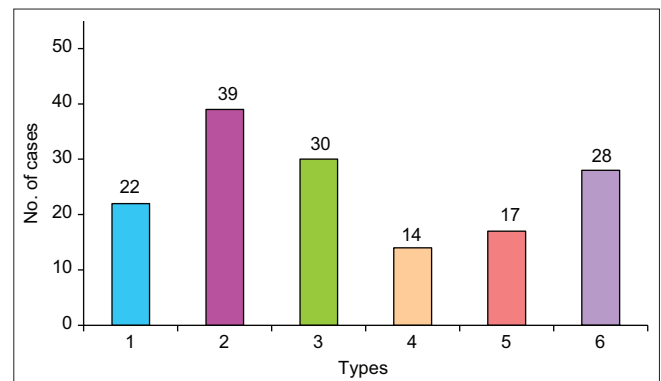
It was found that the type 2 (rat-tail) soft palate was the most frequent type, while the type 4 (straight-line) shape was the least common among all the six types.

These results were in accordance with a study done by Samdani *et al.*<sup>[7]</sup> who investigated the correlation between various shapes of soft palate and types of malocclusion in different gender groups among North Indian individuals and found out the frequency of rat-tail (37.2%) type of soft palate was seen in the highest proportion, whereas the frequency of distorted S-shape (6.80%) was least in both the genders. This study was in accordance with Deepanshu *et al.*<sup>[8]</sup> and Susan *et al.*,<sup>[9]</sup> and Chandan *et al.*<sup>[10]</sup> who investigated various shapes of the soft palate in normal individuals and found out that the normal soft palate can be classified into six types based on its shape. The type 2 rat-tail shape is most common in both genders.

**Table 1: Distribution and proportion of soft palate morphology types**

Type	1	2	3	4	5	6	Total
No.	22	39	30	14	17	28	150
Proportion (%)	14.66%	26%	20%	9.33%	11.34%	18.67%	100%

Types: 1: leaf-shaped; 2: rat-tail shaped; 3: butt-like; 4 straight-line; 5: S-shaped; 6: crook-shaped



**Graph 1: Distribution and proportion of soft palate morphology types**

Berlin questionnaire format

**Category 2**

**6. How often do you feel tired or fatigued after sleep?**

nearly every day  
 3-4 times a week  
 1-2 times a week  
 1-2 times a month  
 never or nearly never

**7. During your wake time, do you feel tired, fatigued or not up to par?**

nearly every day  
 3-4 times a week  
 1-2 times a week  
 1-2 times a month  
 never or nearly never

**8. Have you ever nodded off or fallen asleep while driving a vehicle?**

yes  
 no

**9. If yes, how often does it occur?**

nearly every day  
 3-4 times a week  
 1-2 times a week  
 1-2 times a month  
 never or nearly never

**Category 3**

**10. Do you have high blood pressure?**

yes  
 no

BMI = \_\_\_\_\_  
 (weight in kg) / (height in m<sup>2</sup>)

Scoring Questions: Any answer within box outline is a positive response.  
 Category 1 is positive with 2 or more positive responses to questions 1-5   
 Category 2 is positive with 2 or more positive responses to questions 6-9   
 Category 3 is positive with 1 positive response and a BMI > 30

Final Result: 2 or more positive categories indicates a high likelihood of sleep disordered breathing.

(Signature of the Patient/Parent)

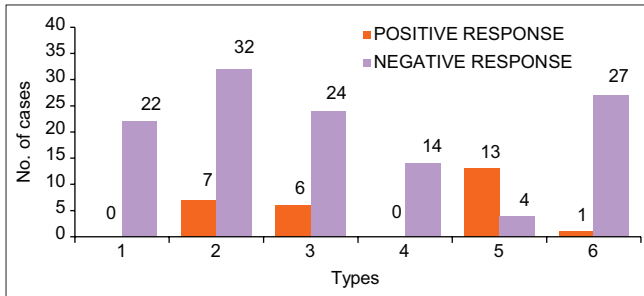
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**Figure 3: Berlin questionnaire format (part-3)**

**Table 2: Berlin questionnaire and soft palate morphology types**

Berlin questionnaire	1 n (%)	2 n (%)	3 n (%)	4 n (%)	5 n (%)	6 n (%)	Total n (%)
Positive response	0	7 (17.95%)	6 (20%)	0	13 (76.47%)	1 (3.57%)	27 (18%)
Negative response	22 (100%)	32 (82.05%)	24 (63.34%)	14 (100%)	4 (23.53%)	27 (96.43%)	123 (82%)
Total	22 (14.66%)	39 (26%)	30 (20%)	14 (9.33%)	17 (11.34%)	28 (18.67%)	150

Value of  $\chi^2=50.60$ ,  $df=5$ , highly significant, i.e.,  $P<0.01$



**Graph 2:** Berlin questionnaire and soft palate morphology types

This study was inconsistent with the study done by Pradhuman Verma *et al.*<sup>[11]</sup> who investigated the variation of soft palate morphology in 300 subjects aged between 15 and 45 years and found that the most frequent type of soft palate was leaf-shaped (48.7%) and the least common was crook-shaped. This study was also inconsistent with the study done by Tejavathi Nagaraj *et al.*<sup>[12]</sup> and Vani *et al.*<sup>[13]</sup> who found out that the leaf-shaped variant is the most commonly observed type of palate.

In the present study, it was found that 76.34% of persons with an “S” shape soft palate responded positively to BQ as compared to other types of the soft palate. This shows that a particular type of soft palate could be responsible for causing OSAS. These findings were in accordance with the study done by Pepin JL *et al.*<sup>[3]</sup> who found the “hooked” appearance of the soft palate also known as the “S” type in awake patients, which indicated a high risk for OSAS. Hooking of the soft palate was defined in their study as angulation of about 30° between the distal part of the uvula and the longitudinal axis of the soft palate. They hypothesized that soft palate hooking plays a key role in the pharyngeal collapse, since hooking results in a sudden and major reduction in the oropharyngeal dimensions, which therefore dramatically increases the upper airway resistance and the transpharyngeal pressure gradient.

However, the findings of the present study need to be confirmed further in a large number of subjects in a community-based setting. We can use computerized tomography (CT) scan or cone-beam computed tomography systems (CBCT) of the face instead of lateral cephalogram for assessing soft palate morphology types for more accurate results. Overnight polysomnography (PSG) which is considered to be the gold standard for diagnosis of OSA can be done on a

sample population along with BQ for more reliable results.

## Conclusion

The present study allowed us to conclude that the type 2 (rat-tail) soft palate was the most frequent type, while the type 4 (straight-line) shape was the least common among all the six types. The test results show that the persons with type 5 (S-shape) soft palate responded more positively to BQ as compared to other types of the soft palate. This shows that a particular type of soft palate could be responsible for causing OSAS. Lateral cephalogram can be an important tool in diagnosing patients with OSAS.

## Clinical significance

Lateral cephalogram and BQ, which are relatively inexpensive and widely available, can be used in resource-limited and thickly populated countries like India to correctly identify patients with OSAS.

## Acknowledgements

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Nil.

## Conflicts of interest

There are no conflicts of interest.

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