Velar Morphological Variants in Oral Submucous Fibrosis: A Comparative Digital Cephalometric Study

Abstract
Context: Soft palate (velar) plays a significant role in various important functions in the head and neck region. Its diverse morphology is implicated in a variety of diseases. Knowledge about the varied morphological pattern of soft palate in oral submucous fibrosis (OSMF) patients can give us a clear understanding about disease progress in the oropharyngeal region for a proper diagnosis and also help the maxillofacial surgeon in successful structural and functional corrections associated with this disorder. Aim: (1) To evaluate the morphological variations of soft palate in OSMF patients using digital lateral cephalogram. (2) To assess the morphological variations of soft palate with respect to the different clinical stages of OSMF patients. Subjects and Methods: A total number of 300 patients were included in the study (150 participants each in study and control group), evaluated clinically, and subjected for digital lateral cephalogram for evaluating velar morphological variants. Statistical Analysis: The data were statistically evaluated using SPSS 11.5 software with Student’s t-test, Chi-square test, and ANOVA. Results: Among Group I, 34 participants had Stage I OSMF, 90 participants had Stage II OSMF, and 26 participants had Stage III OSMF. Type I velar was commonly seen in Stage I OSMF, Type VI velar in Stage II OSMF, and Type III velar in Stage III OSMF. There was statistically highly significant decrease in anterior-posterior (AP) length and increase in width of superior-inferior (SI) measurement, as compared to the Group II. Conclusion: There was diminution in AP length and increase in SI measurement as the OSMF disease progressed.

Keywords: Digital lateral cephalogram, oral submucous fibrosis, soft palate (velar), velar variants

Introduction
Oral submucous fibrosis (OSMF) is an insidious chronic disease affecting any part of the oral cavity and sometimes the pharynx. It is always associated with juxta-epithelial inflammatory reaction followed by fibroelastic changes of the lamina propria with epithelial atrophy leading to stiffness of oral mucosa and causing trismus and inability to eat.[1]

Soft palate participates in most oral functions, especially velopharyngeal closure.[2] Uvula points downward in vast majority of the healthy individuals. The fibrosis of the mucosa over and around the uvula and velar in OSMF leads to certain morphometric variations of velar and characteristic abnormalities in the uvula, such as forward pointing uvula or a vanishing uvula.[3] Cephalometric analysis is one of the most commonly accepted techniques for evaluating the soft palate and is less expensive, more useful, easily achieved with reduced radiation, and correlates with other investigations such as computed tomography.[4‑7]

Haider et al. study stated that velar is the first tissue to be affected in OSMF; there is a need to analyze its morphology in OSMF patients.[1] Merely three such studies are reported in the literature by Shankar et al.,[8] Mohan et al.,[9] and Tekchandani et al.[10] to evaluate the morphological variants of velar in OSMF. Hence, the present study was undertaken to assess the effect of OSMF on morphological variations of velar using digital cephalogram.

Subjects and Methods
The study included of 300 participants and categorized into:
• Group I: 150 patients diagnosed with OSMF constituted the study group
• Group II: 150 normal patients with no deleterious habits and without any velar disorders constituted the control group.

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Inclusion criteria

• Patients clinically diagnosed with OSMF and staged according to Bailoor and Nagesh (1993)\(^{[11]}\) and confirmed by histopathology.
• Normal healthy individuals for control group were included in the study.

Exclusion criteria

• Congenital cleft lip and palate, oromucosal disorders with clinical features same as OSMF, patients who are under treatment of OSMF, and known history of surgery of palate were excluded from the study.

The study strictly adhered to ethical protocols and written consent was obtained from all the participants to include them in study.

After clinical examination, participants were positioned in cephalostat with Frankfort plane parallel to the floor and were asked to swallow once to clear any saliva in the oral cavity and pharynx and then to close their mouth tightly to place their upper and lower teeth in centric occlusion and with their oropharyngeal musculature relaxed and were subjected for digital lateral cephalogram on KODAK 8000C Digital Panoramic and Lateral Cephalometric System. The images were viewed on a flat screen compaq TFT-LCD monitor with a resolution of 2906 × 2304 pixels in JPEG format with 24-bit grayscale.

The morphology of the velar on lateral cephalogram was examined and evaluated for anterior-posterior dimension (AP distance) by measuring the linear distance from the posterior nasal spine to the tip of the uvula of the resting velar; superior-inferior (SI distance) was measured at the thickest area of velar by DICOM software.\(^{[8]}\) [Figure 1]. Soft palates were classified based on their morphology according to You et al.\(^{[2]}\) as Type I (leaf-shaped), Type II (rat-tail shaped), Type III (butt-like), Type IV (straight line), Type V (S-shaped), and Type VI (crook-shaped) [Figure 2].

Statistical analysis

Data analysis was done using SPSS software 11.5 version. All the variables were statistically analyzed for the mean values, standard deviation, and “\(P\)” value. Stage-wise comparison was done by ANOVA. Chi-square test was performed to evaluate significant relationships among variables. Evaluation of results and Statistical analysis was carried using Student’s \(t\)-test. For all tests, \(P\) value of 0.05 or less was utilized for statistical significance. One hundred lateral cephalograms were reobserved and measured after 10 months for calculating intraobserver variability.

Results

Gender-wise distribution of the subjects

Among 150 study Group I participants, 140 (93.3%) were male and 10 (6.7%) were female. In Group II participants, 77 (51.3%) were male and 73 (48.7%) were female [Table 1].

In Group I, 34 (22.7%) participants had Stage I OSMF, 90 (60.0%) participants had Stage II OSMF, and 26 (17.3%) participants had Stage III OSMF [Table 2].

Velar variants among Group I and Group II

In Group I, 38 (25.3%) participants showed Type I velar morphology, 22 (14.7%) participants had Type II velar, 26 (17.3%) participants had Type III velar, 2 (1.3%) participants had Type IV velar, 2 (1.3%) participants had Type V velar, and 60 (40.1%) participants had Type VI velar.

Type VI was most commonly seen in Group I, followed by Type I, Type III, Type II, Type V, and Type IV.

In Group II, 96 participants (64.0%) showed Type I velar morphology, 20 participants (13.3%) had Type II velar, 3 participants (2.0%) had Type III velar, 18 participants (12.0%) had Type IV velar, 2 participants (1.3%) showed Type V velar, and 11 participants (7.4%) had Type VI velar [Graph 1].

The most common type of velar found in Group II was Type I followed by Type II, Type IV, Type VI, Type III, and Type V.

Comparison of anterior-posterior measurements of velar variants among Group I and Group II subjects

AP measurement for Type I velar in Group I participants was 31.17 ± 3.25, whereas in Group II, it was 33.19 ± 3.87,
which was statistically significant ($t = 3.06, P < 0.05$). For Type II velar in Group I was $30.30 ± 3.10$, whereas in Group II, it was $32.89 ± 3.91$, which was statistically significant ($t = 2.37, P < 0.05$). Type III velar in Group I was $27.35 ± 2.63$, whereas in Group II, it was $35.10 ± 3.82$, which was statistically highly significant ($t = 3.41, P < 0.01$). Type IV velar in Group I was $28.25 ± 1.75$, whereas in Group II, it was $32.11 ± 2.76$, which was statistically significant ($t = 2.71, P < 0.05$). Type V velar in Group I was $29.7 ± 2.2$, whereas in Group II, it was $31.5 ± 1.6$, which was statistically not significant ($t = 0.93, P > 0.05$). Type VI velar in Group I was $26.80 ± 3.07$, whereas in Group II, it was $30.31 ± 3.37$, which was statistically significant ($t = 3.25, P < 0.05$) [Table 3].

Comparison of superior-inferior measurements of velar variants among Group I and Group II subjects

SI measurement for Group I with Type I velar was $10.24 ± 1.32$, whereas in Group II, it was $8.37 ± 1.69$, which was statistically very highly significant ($t = 6.8, P < 0.001$). Type II velar in Group I was $10.57 ± 2.16$, whereas in Group II, it was $9.15 ± 1.17$, which was statistically significant ($t = 2.67, P < 0.05$). Type III velar in Group I was $30.30 ± 3.10$, whereas in Group II, it was $29.7 ± 2.2$, which was statistically not significant ($t = 0.93, P > 0.05$). Type IV velar in Group I was $28.25 ± 1.75$, whereas in Group II, it was $27.35 ± 2.63$, which was statistically highly significant ($t = 3.41, P < 0.01$). Type V velar in Group I was $35.10 ± 3.82$, whereas in Group II, it was $31.5 ± 1.6$, which was statistically not significant ($t = 0.93, P > 0.05$). Type VI velar in Group I was $11.09 ± 0.94$, whereas in Group II, it was $9.26 ± 0.99$, which was statistically highly significant ($t = 3.27, P < 0.01$). Type IV velar in Group I was $9.9 ± 0.6$, whereas in Group II, it was $10.15 ± 1.58$, which was statistically not significant ($t = 0.803, P > 0.05$). Type V velar in Group I was $10.15 ± 1.05$, whereas in Group II, it was $9.95 ± 0.6$, which was statistically not significant ($t = 0.219 P > 0.05$). Type VI velar in Group I was $10.68 ± 1.42$, whereas in Group II, it was $8.28 ± 1.09$, which was statistically very highly significant ($t = 6.48, P < 0.001$) [Table 3].

Comparison between oral submucous fibrosis stages and variants of velar morphologies

Among 150 Group I participants, 34 (22.7%) of Stage I OSMF had 32 Type I velar morphologies. There were no participants with Type II velar, Type III velar, Type IV velar, and Type V velar, and two participants had Type VI velar. Among 90 (60.0%) participants of Stage II OSMF, 6 participants had Type I velar morphology, 11 participants had Type II velar, 10 had Type III velar, 2 had Type IV velar, and 2 had Type V velar.

Table 1: Gender-wise distribution of the participants

| Participants | Males (%) | Females (%) | Total (%) |
|--------------|-----------|-------------|-----------|
| Study group  | 140 (93.3)| 10 (6.7)    | 150 (100) |
| Control group| 77 (51.3) | 73 (48.7)   | 150 (100) |

Table 2: Distribution of the Group I participants in different stages of oral submucous fibrosis

| Stages of OSMF | Participants (%) |
|----------------|------------------|
| Stage I        | 34 (22.7)        |
| Stage II       | 90 (60.0)        |
| Stage III      | 26 (17.3)        |
| Total          | 150 (100.0)      |

Table 3: Comparison of anterior-posterior and superior-inferior measurements among Group I and Group II in Type I - Type VI velar

| Velar types | Groups   | AP (mean±SD) | $t$-test and $P$ | SI (mean±SD) | $t$-test and $P$ |
|-------------|----------|--------------|-----------------|--------------|-----------------|
| Type I      | Group I  | 31.17±3.25   | $t$=3.06        | 10.24±1.32   | $t=6.8$         |
|             | Group II | 33.19±3.87   | $P<0.05$        | 8.37±1.69    | $P<0.001$       |
| Type II     | Group I  | 30.30±3.10   | $t=2.37$        | 10.57±2.16   | $t=2.67$        |
|             | Group II | 32.89±3.91   | $P<0.05$        | 9.15±1.17    | $P<0.05$        |
| Type III    | Group I  | 27.35±2.63   | $t=3.41$        | 11.19±0.94   | $t=3.27$        |
|             | Group II | 35.10±3.82   | $P<0.01$        | 9.26±0.99    | $P<0.01$        |
| Type IV     | Group I  | 28.25±1.75   | $t=2.71$        | 9.9±0.6      | $t=0.803$       |
|             | Group II | 32.11±2.76   | $P<0.05$        | 9.45±1.58    | $P<0.05$        |
| Type V      | Group I  | 29.7±2.2     | $t=0.93$        | 10.15±1.15   | $t=0.219$       |
|             | Group II | 31.5±1.6     | $P<0.05$        | 9.95±0.6     | $P<0.05$        |
| Type VI     | Group I  | 26.8±3.07    | $t=3.25$        | 10.68±1.42   | $t=6.48$        |
|             | Group II | 30.31±3.37   | $P<0.05$        | 8.28±1.09    | $P<0.001$       |

AP=Anterior-posterior, SI=Superior-inferior, SD=Standard deviation
had Type II velar, 14 participants had Type III velar, 1 participant had Type IV velar, 2 participants had Type V velar, and 56 participants had Type VI velar.

Among 26 (17.3%) participants of Stage III OSMF, 11 participants had Type II velar, 12 participants had Type III velar, 2 participants had Type VI velar morphology, and there were no participants with Type I, Type IV, and Type V velar morphology, which were statistically very highly significant ($\chi^2 = 54.26, P < 0.001$) [Table 4].

**Mean length of velar with oral submucous fibrosis stages**

Thirty-four participants with Stage I OSMF showed total AP mean length of 30.45 ± 3.16 and SI mean length of 10.46 ± 1.43. Ninety participants with Stage II OSMF showed AP and SI mean length of 26.98 ± 2.96 and 10.26 ± 1.62, respectively. Twenty-six participants with Stage III OSMF showed AP and SI mean length 28.27 ± 2.76 and 10.52 ± 1.07, respectively [Table 5].

The intraobserver reliability analysis was done by reobserving 100 lateral cephalograms after 10 months. Velar morphologies and measurements were measured again, and the results were statistically evaluated and statistically analyzed using Student’s $t$-test [Graphs 2-4].

There was a statistically insignificant difference of AP and SI measurements during and after 10 months in all velar types with $P > 0.05$.

**Discussion**

OSMF is a progressive disorder of the oral cavity. The fibrosis of the mucosa overlying the soft palate and the surface of uvula pulls the tip of the uvula in the forward direction. The uvula in such patients is smaller in size and less mobile and in extreme cases may completely disappear. Disappearance of the uvula can be attributed to extensive fibrosis leading to retraction. [3]

Yet, there was a need to analyze the morphology of soft palate, so our research study was focused to spurn this prevailing myth and to describe the velar variants in different stages of OSMF.

There were maximum participants of Stage II OSMF seen in our study followed by Stage I and Stage III OSMF; a similar distribution was observed by Shankar et al., [8] Mohan et al., [9] and Tekchandani et al.[10] studies for Stage II and Stage III OSMF participants.

**Table 4: Comparison between oral submucous fibrosis stages and variants of velar morphologies**

| OSMF stages | Velar variants | Total (%) |
|-------------|----------------|-----------|
| I           | II  | III | IV  | V   | VI  |          |
| Stage I     | 32  | 0   | 0   | 0   | 2   | 34 (22.7) |
| Stage II    | 6   | 11  | 14  | 2   | 56  | 90 (60.0) |
| Stage III   | 0   | 11  | 12  | 0   | 2   | 26 (17.3) |
| Total       | 38  | 22  | 26  | 2   | 60  | 150 (100.0) |

$\chi^2=54.26$, $P<0.001$ (very highly significant). OSMF=Oral submucous fibrosis

**Table 5: Mean length of velar with oral submucous fibrosis stages**

| OSMF Participants | AP mean length | SD | SI mean length | SD |
|-------------------|----------------|----|----------------|----|
| I                 | 34             | 30.45 | 3.16       | 10.46 | 1.43 |
| II                | 90             | 26.98 | 2.96       | 10.62 | 1.62 |
| III               | 26             | 28.27 | 2.76       | 10.52 | 1.07 |

AP=Anterior-posterior, SI=Superior-inferior, SD=Standard deviation
There was a disparity in distribution of participants with Stage I OSMF when compared with the studies done by Shankar et al.,[8] Mohan et al.,[9] and Tekchandani et al.[10] This could be due to smaller sample size and different staging systems of OSMF.

Cephalometric evaluation in 150 participants of Group I, Type VI velar was the most common finding in our study, but according to Shankar et al.,[8] Mohan et al.,[9] and Tekchandani et al.[10] Type I was the most common form of soft palate.

Type I was the second common finding in our study, which was conflicted with Shankar et al.,[8] Mohan et al.,[9] and Tekchandani et al.[10] as in their studies, Type I was the most common velar type.

Type IV and V velar was least common variety, which was similar with study of Shankar et al.,[8] Mohan et al.,[9] and Tekchandani et al.[10]

Group II participants showed maximum of Type I velar variant, the most common and classical form of soft palate, which coincide with Shankar et al.,[8] You et al.,[2] Kumar et al.,[12] Verma et al.,[13] Smriti et al.,[14] and Smriti et al.[15] studies, whereas Praveen et al.[16] quoted the most frequent form as Type II velar.

Type III and V were least observed velar types, which coincide with Tekchandani et al.[10] and Mohan et al.[9] and conflicted with Shankar et al.[8] and Verma et al.[13] studies, whereas Kumar et al.[12] and Praveen et al.[16] studies coincide with our study for Type V velar.

The AP mean length of Type I velar showed reduction in length of velar which coincides with Shankar et al.[8] study whereas the SI mean length of Group I showed an increase in the thickness of velar, which was similar with the results reported by Tekchandani et al.[10] and Mohan et al.[9] and was contradictory with Shankar et al. study.[8]

Type II velar in Group I participants showed a decrease in length and increase in thickness of velar compared to Group II, which was statistically significant, which coincided with Mohan et al.[9] study and was contradictory with Shankar et al.[8] and Tekchandani et al. studies.[10]

Type III velar among Group I participants showed reduction in AP length and increase in width of velar SI mean length compared to Group II, which was statistically highly significant. Overall, there was increase in width and decrease in length of velar, and similar results were also obtained in Shankar et al.[9] and Tekchandani et al.[10] studies and conflict with Mohan et al.[9] study.

Type IV velar showed a decrease in AP mean length in Group I participants compared to Group II, which was statistically significant and dissimilar with Shankar et al.[8] study due to smaller sample size in their study. Moreover, the SI mean length in both groups showed no statistically significant values, and similar results coincided with Shankar et al.[8] and Mohan et al.[9] study and contradicted with Tekchandani et al.[10] study. This is because, there were only two participants in study group and 18 participants in control group among the total 300 participants reported with this velar variety

Type V velar in both groups showed no adequate results in AP and SI mean length, which was statistically nonsignificant, but in Shankar et al.[8] study, no cases reported with Type V velar.

Type VI velar in Group I showed statistically significant values with reduction in AP mean length and increased in SI mean length compared to Group II, which coincides with Tekchandani et al.[10] study and conflicted with studies of Shankar et al.[8] and Mohan et al.[9]

Overall, there was reduction in velar length and increase in thickness of velar as the disease progressed; this may hinder in various normal velopharyngeal functions and could be an etiological factor in obstructive sleep apnea syndrome and other conditions.

Stage I OSMF showed Type I velar as most commonly observed, which contradicts with Shanker et al.[8] as in their study, it was observed in Stage II OSMF; no cases were reported in Tekchandani et al.[10] study, and Mohan et al.[9] observed three cases with Type I velar although they followed different OSMF staging.

Stage II OSMF with Type VI as most commonly observed velar, which was dissimilar to the results reported by Shankar et al.,[8] as in their study, Type I was most commonly observed in this Stage II OSMF.

Shanker et al.[8] and Mohan et al.[9] studies also observed maximum number of cases in Stage II with Type I soft palate, and Tekchandani et al.[10] study observed the second maximum cases in this Stage II with Type I (leaf shape) velar, inspite of dissimilar OSMF staging.

Stage III OSMF showed Type III as most commonly observed in our study and similar results reported by Shankar et al.[8] and Mohan et al.[9] studies.

The second most maximum number of cases observed in Shanker et al.[8] and Mohan et al.[9] studies in Stage III OSMF, and maximum cases observed in Tekchandani et al.[10] study with Type I velar with different staging of OSMF.

There was a reduction in AP mean length as disease progressed, with statistical significance, which was similar to Shankar et al.,[8] Mohan et al.,[9] and Tekchandani et al.[10] studies, and increase in width of velar was observed in our study with statistical significance when compared with individual velar type with the control group, which coincides with Tekchandani et al.[10] study, but conflicts with Shankar et al.[8] and Mohan et al.[9] studies.

Our study showed that the values of intraobserver for reliability analysis for AP and SI velar measurements were
very high, proving the reliability of the method used in the study.

**Conclusion**

Our study prevailed that as OSMF disease progressed from Stage I to Stage II and Stage III, there were variations in velar morphology from Type I to Type VI and Type III as the degree of fibrosis increased with reduced AP and increased SI dimensions of velar. Scrupulous acquaintance of velar variants with OSMF will help the maxillofacial surgeon in successful structural and functional corrections associated with this disorder.

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**Conflicts of interest**

There are no conflicts of interest.

**References**

1. Haider SM, Merchant AT, Fikree FF, Rahbar MH. Clinical and functional staging of oral submucous fibrosis. Br J Oral Maxillofac Surg 2000;38:12-5.
2. You M, Li X, Wang H, Zhang J, Wu H, Liu Y, *et al.* Morphological variety of the soft palate in normal individuals: A digital cephalometric study. Dentomaxillofac Radiol 2008;37:344-9.
3. Chaturvedi P. Uvular abnormalities in patients with submucous fibrosis. Oral Dis 2009;15:516.
4. Bejdová S, Krajíček V, Peterka M, Treťný P, Velemínská J. Variability in palatal shape and size in patients with bilateral complete cleft lip and palate assessed using dense surface model construction and 3D geometric morphometrics. J Craniomaxillofac Surg 2012;40:201-8.
5. Shimomatsu K, Nozoe E, Ishihata K, Okawachi T, Nakamura N. Three-dimensional analyses of facial soft tissue configuration of Japanese females with jaw deformity – a trial of polygonal view of facial soft tissue deformity in orthognathic patients. J Craniomaxillofac Surg 2012;40:559-67.
6. Heliläiväara A, Rautio J. A comparison of craniofacial cephalometric morphology and the later need for orthognathic surgery in 6-year-old cleft children. J Craniomaxillofac Surg 2011;39:173-6.
7. Samman N, Mohammadi H, Xia J. Cephalometric norms for the upper airway in a healthy Hong Kong Chinese population. Hong Kong Med J 2005;9:25-30.
8. Shankar VN, Hegde K, Ashwini NS, Praveena V, RaviPrakash SM. Morphometric evaluation of soft palate in oral submucous fibrosis – A digital cephalometric study. J Craniomaxillofac Surg 2014;42:48-52.
9. Mohan RS, Verma S, Singh U, Agarwal N. Morphometric evaluation of soft palate in oral submucous fibrosis-A digital cephalometric analysis. West Afr J Radiol 2014;21:7-11.
10. Tekchandani V, Thakur M, Palve D, Mohale D, Gupta R. Co relation of clinical and histologic grade with soft palate morphology in oral submucous fibrosis patients: A histologic and cephalometric study. J Dent Specialities 2015;3:68-75.
11. Bailer DN, Nagesh KS. Fundamentals of Oral Medicine and Radiology. 3rd ed. New Delhi: Jaypee Brothers Medical Publishers ltd; 2005. p. 183-4.
12. Kumar K, Gopal S. Morphological variants of soft palate in normal individuals: A digital cephalometric study. J Clin Diagn Res 2011;5:1310-3.
13. Verma P, Verma KG, Kumasawam KL, Basavaraju S, Sachdeva SK, Juneja S, *et al.* Correlation of morphological variants of the soft palate and Need’s ratio in normal individuals: A digital cephalometric study. Imaging Sci Dent 2014;44:193-8.
14. Smriti J, Patni VM, Mukta M. Correlation of types of soft palate, body mass index and apnoea hypoapnoea index in patients with sleep apnoea: A pilot study. J Dent Med Sci 2014;13:74-7.
15. Smriti K, Pai KM, Vineetha R, Pentapati K C. Radiographic evaluation of soft palate morphology and correlation with gender on lateral cephalograms. World J Dent 2015;6:147-9.
16. Praveen BN, Amrutesh S, Pal S, Shubhasini AR, Vaseemuddin S. Various shapes of soft palate: A lateral cephalometric study. World J Dent 2011;2:207-10.