Craniofacial profile in Asian and white subjects with obstructive sleep apnoea

B Lam, M S M Ip, E Tench, C F Ryan

Background: Clinical detection of structural narrowing of the upper airway may facilitate early recognition of obstructive sleep apnoea (OSA). To determine whether the craniofacial profile predicts the presence of OSA, the upper airway and craniofacial structure of 239 consecutive patients (164 Asian and 75 white subjects) referred to two sleep centres (Hong Kong and Vancouver) were prospectively examined for suspected sleep disordered breathing.

Methods: All subjects underwent a history and physical examination with measurements of anthropometric parameters and craniofacial structure including neck circumference, thyromental distance, thyromental angle, and Mallampati oropharyngeal score. OSA was defined as an apnoea-hypopnoea index (AHI) of ≥ 5/hour on full overnight polysomnography.

Results: Discriminant function analysis indicated that the Mallampati score (F = 0.70), thyromental angle (F = 0.60), neck circumference (F = 0.54), body mass index (F = 0.53), and age (F = 0.53) were the best predictors of OSA. After controlling for ethnicity, body mass index and neck circumference, patients with OSA were older, had larger thyromental angles, and higher Mallampati scores than non-apnoeic subjects. These variables remained significantly different between OSA patients and controls across a range of cut-off values of AHI from 5 to 30/hour.

Conclusions: A crowded posterior oropharynx and a steep thyromental plane predict OSA across two different ethnic groups and varying degrees of obesity.

SLEEP DISORDERED BREATHING

Structural narrowing of the upper airway is a major factor contributing to pharyngeal occlusion during sleep in the obstructive sleep apnoea-hypoponea syndrome (OSAHS). Patients with OSAHS manifest a spectrum of abnormalities of craniofacial soft tissue and skeletal anatomy that appear to act synergistically to promote upper airway obstruction during sleep. Adiposity in the neck region and retrognathia are recognised risk factors for OSAHS. Many patients with OSAHS have evidence of both neck adiposity and skeletal abnormalities. The relative contributions of soft tissue and skeletal abnormalities vary among patients and between ethnic groups: Asians have more pronounced skeletal abnormalities and are less obese than white subjects for a given degree of severity of OSAHS.

Epidemiological data demonstrating the relationship between OSAHS and cardiovascular morbidity highlight the potential importance of early recognition and treatment. Yet, despite recent advances in the diagnosis and treatment of sleep disordered breathing, OSAHS remains under-recognised. This may be partly related to the limited availability of diagnostic facilities and to the non-specific nature of symptoms associated with OSAHS. Various attempts to use diagnostic algorithms based on features of the history, physical examination, and overnight oximetry to identify patients with OSAHS have met with limited success. Common symptoms such as snoring and daytime hypersomnolence lack specificity for the diagnosis of OSAHS. Witnessed apnoea is an important clue but requires observation by a regular bed partner. Oximetry is widely used as a case selection tool for OSA, but its sensitivity and specificity in predicting OSA are quite variable. Prediction models based on physical findings have used measurements that may not be easily incorporated into the routine physical examination. Some readily detectable visual cues to the presence of OSAHS would be useful for the primary care physician whose encounters with patients may be brief and infrequent.

In a preliminary report we observed that certain characteristics of craniofacial structure were commonplace in patients with OSAHS and could be readily identified on routine physical examination. We therefore hypothesised that a simple clinical assessment of craniofacial profile using measurements of soft tissue and skeletal abnormalities that may contribute to upper airway narrowing would predict the presence of OSAHS. We also wished to determine whether ethnicity affected the utility of this assessment.

Some of the results of this study have been previously reported in the form of an abstract. The study was reviewed and approved by the ethics review boards of our respective institutions.

METHODS

We studied 239 consecutive patients referred for the assessment of possible OSAHS to two university based regional sleep disorders clinics—one in Hong Kong and the other in Vancouver, British Columbia—between January and December 1999. At the time of the initial visit, having given written informed consent, each patient underwent a detailed history and physical examination including anthropometric measurements—height, weight, and calculation of body mass index (BMI).

Craniofacial measurements

Craniofacial measurements were made with the patient seated upright in a straight backed chair in the natural head position looking straight ahead (fig 1). Natural head position was defined in the following way:

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Abbreviations: AHI, apnoea-hypopnoea index; BMI, body mass index; MS, Mallampati score; NC, neck circumference; OSA, obstructive sleep apnoea; OSAHS, obstructive sleep apnoea-hypopnoea syndrome; TMA, thyromental angle; TMD, thyromental distance

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Craniofacial profile in sleep apnoea

12 weeks of the initial assessment, reflecting the waiting
each patient had full overnight polysomnography within
polysomnography was performed using methodology, instru-
was scored by technicians at the respective sites according to
was defined as an apnoe-
hypopnoea index (AHI) of ≥5/hour of total sleep time.

Figure 2 Mallampati oropharyngeal score (MS) measured during a
breath hold at end-tidal inspiration with the mouth wide open, tongue
maximally protruded, but without phonation or attempted elevation of
the soft palate.

Statistical analysis
The rationale and methodology for the statistical analysis are
outlined in detail in the supplement available online at the
Thorax website (http://www.thoraxjnl.com/supplemental). A
summary of the analysis is given here. Spearman rank
relation, to account for outlying measurements, was used
to assess intra- and inter-observer reliability in the cranio-
facial measurements. SPSS Version 10.0.7 was used for all
other analyses. The statistical strategy in this study was to
determine which clinical, anthropometric, and craniofacial
variables could be broadly applied to predict which patients
were more likely to have OSA. The clinical variables of
interest were age, BMI, NC, MS, TMA, TMD, and Epworth
Sleepiness Scale. First, three Hotelling’s T² analyses ex-
amined the relationship between (1) sex, (2) ethnic group,
and (3) OSA and the clinical variables. The sample of patients
was then randomly divided into two groups of 120 and 119
patients balanced with respect to sex, ethnicity, and OSA
status. Discriminant function analysis was applied to the
initial group of 120 patients to generate an equation using the
clinical variables to predict whether a patient was more likely
to have OSA or to be normal. A receiver operator character-
istic curve (ROC) was also plotted to assess the equation in
terms of sensitivity and specificity and for comparison with
other previously published prediction equations. The second
group of 119 patients was used to perform a prospective data
analysis (cross validation) to assess the performance of the
equation in a different but comparable group from the one in
which it was originally developed. Finally, an analysis of
covariance (ANCOVA) was performed to effectively make all
patients equivalent for BMI, NC, and ethnic group in order to
determine whether the relationship between selected clinical
variables from the discriminant analysis was still significant
when the group of patients was statistically rendered
equivalent on these three variables. Additionally, several
different cut-offs for the definition of OSA (AHI ≥5, ≥10,
≥15, ≥30) were tested to determine whether the same
variables were significant for more rigorous definitions of
OSA. Summary data are presented as mean (SD).

RESULTS
Demographic data summarised by group differences in
disease category, ethnic group, and sex are shown in table 1.
Of the 239 patients, 201 had OSA (AHI ≥5). As a group, these

Polysomnography
Each patient had full overnight polysomnography within
12 weeks of the initial assessment, reflecting the waiting
times in our facilities at the time of the study.

Reliability of measurements
A training session was held at one centre before study
commencement during which the measurement techniques
for all variables were standardised. Measurements were
performed by a single investigator at each centre (CFR and
BL). Intra-observer agreement was assessed for MS, NC, and
TMD in a sample of 20 patients. On a sample of 50 randomly
selected patients, tests of intra- and inter-observer agreement
were performed for the measurement of TMA. For intra-
observer reliability, measurements were made in random
order on two occasions separated by several days. For inter-
observer reliability, measurements were made at one centre
and repeated in random order on duplicate images at the
other centre in a blinded fashion.

Polygraphic testing
Polysomnography
Each patient had full overnight polysomnography within
12 weeks of the initial assessment, reflecting the waiting
times in our facilities at the time of the study.

Polysomnography was performed using methodology, instru-
mentation, and analysis standardised between both sleep
centres according to the recommendations on syndrome
definition and measurement techniques published by the
American Academy of Sleep Medicine.¹⁵ Polysomnograms
were scored by technicians at the respective sites according
to usual clinical practice. OSA was defined as an apnoea-
hypopnoea index (AHI) of ≥5/hour of total sleep time.
patients were middle aged (49 [12] years), moderately obese (BMI 29.5 [6.3] kg/m²), and had moderate to severe OSA (AHI 31.9 [22.2]/h). All of the Hong Kong subjects (n = 154) and 10 of the Vancouver subjects were Asian; the remaining 75 Vancouver subjects were white. The majority (83%) were male. There was no change in body weight between the performance of the anthropometric measurements and the polysomnogram.

Spearman rank correlation indicated intra-observer agreement (confidence intervals) of 0.81 (0.56 to 0.92) for MS; 0.97 (0.93 to 0.99) for NC; and 0.85 (0.71 to 0.90) for TMD. For TMA, intra-observer agreement was 0.91 (0.87 to 0.94) and inter-observer agreement was 0.83 (0.71 to 0.90). Values greater than 0.80 indicate acceptable reliability.

**Hotelling’s T² analyses of OSA and clinical variables**

The results of the initial T² analyses (OSA defined as AHI ≥5) of the full demographic data set are provided in table 1. Patients with OSA had higher MS, larger TMA, and higher AHI than subjects without OSA. Asians had higher MS and shorter TMD than whites. Men had larger NC and higher AHI than subjects without OSA. Asians had higher MS and larger TMA, and higher BMI, and were older than normal subjects. An equation was derived from this analysis to categorise patients as either OSA or normal (table 3). When this equation was applied to the initial set of 120 patients from which it was derived, it correctly classified 86% of the patients. When applied prospectively to the second set of 119 patients its performance was comparable, correctly classifying 82% of patients as either OSA or normal.

**Discriminant analysis**

From the preceding analyses a subset of potentially useful predictor variables including TMA, MS, age, BMI, NC and TMD was selected for a discriminant analysis. This analysis confirmed that these variables could be used to discriminate between patients with OSA and normal subjects. The size of each correlation (function) described in table 2 reveals the strength of the relationship between that predictor and OSA. Patients with OSA had, in order of importance, significantly higher MS, larger TMA, larger NC, higher BMI, and were older than normal subjects. An equation was derived from this analysis to categorise patients as either OSA or normal (table 3). When this equation was applied to the initial set of 120 patients from which it was derived, it correctly classified 86% of the patients. When applied prospectively to the second set of 119 patients its performance was comparable, correctly classifying 82% of patients as either OSA or normal.

**Analysis of covariance (ANCOVA)**

Following the positive results of the discriminant analysis, the data from the 120 and 119 patients were again pooled for the ANCOVA. The purpose of the ANCOVA was to examine the relationship between OSA and MS, TMA, TMD, and age after statistically removing prior differences in three potentially important confounding variables—BMI, NC, and ethnic group. By treating ethnic group as an independent variable rather than a covariate, differences between ethnic groups could also be examined separately after removing prior differences in BMI and NC. BMI was significantly related to the set of dependent variables, as was NC and ethnic group (p <0.05). Thus, these three variables could be used to statistically render patients as if they had all scored equally on these variables. It is notable that there was no interaction between OSA and ethnic group. The relationship between

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**Table 1** Group differences by disease category, ethnicity and sex†

<table>
<thead>
<tr>
<th>Variable</th>
<th>Disease category</th>
<th>Ethnicity</th>
<th>Sex</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OSA (n = 201)</td>
<td>Normal (n = 38)</td>
<td>Male (n = 199)</td>
</tr>
<tr>
<td>M/F</td>
<td>169/32</td>
<td>30/8</td>
<td>161 (18)</td>
</tr>
<tr>
<td>MS (1–4)</td>
<td>3.7 (0.5)</td>
<td>3.4 (0.8)*</td>
<td>3.9 [0.4]</td>
</tr>
<tr>
<td>TMA (degrees)</td>
<td>161 (18)</td>
<td>149 (19)*</td>
<td>161 (18)</td>
</tr>
</tbody>
</table>

Values are mean (SD). *p value <0.001.

OSA, obstructive sleep apnoea; BMI, body mass index; MS, Mallampati oropharyngeal score; TMA, thyromental angle; TMD, thyromental distance; ESS, Epworth Sleepiness Scale; AHI, apnoea-hypopnoea index.

**Table 2** Discriminant function analysis for the prediction of OSA (AHI ≥5)†

<table>
<thead>
<tr>
<th>Variable</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mallampati score</td>
<td>0.70*</td>
</tr>
<tr>
<td>Thyromental angle</td>
<td>0.60*</td>
</tr>
<tr>
<td>Neck circumference</td>
<td>0.54*</td>
</tr>
<tr>
<td>Body mass index</td>
<td>0.53*</td>
</tr>
<tr>
<td>Age</td>
<td>0.53*</td>
</tr>
<tr>
<td>Thyromental distance</td>
<td>-0.13</td>
</tr>
</tbody>
</table>

*Significant correlation.

†Correlation between clinical variables and discriminant function for the initial sample of 120 patients split by OSA.

**Table 3** Prediction equations for the presence or absence of OSA (AHI ≥5)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>OSA</th>
<th>Normal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mallampati score</td>
<td>× (7.135)</td>
<td>(6.227)</td>
</tr>
<tr>
<td>+ Thyromental angle</td>
<td>× (0.171)</td>
<td>(0.163)</td>
</tr>
<tr>
<td>+ Neck circumference</td>
<td>× (2.883)</td>
<td>(2.758)</td>
</tr>
<tr>
<td>- Body mass index</td>
<td>× (0.075)</td>
<td>(0.163)</td>
</tr>
<tr>
<td>× Age</td>
<td>× (0.166)</td>
<td>(0.131)</td>
</tr>
<tr>
<td>+ Thyromental distance</td>
<td>× (102.571)</td>
<td>(92.088)</td>
</tr>
</tbody>
</table>

* A patient’s score is calculated for both equations by multiplying the raw score for each coefficient and summing these products. The larger score indicates the group to which the patient more likely belongs.
OSA and age, MS, TMA and TMD could therefore be examined without regard to ethnic group; also investigation of ethnic group could proceed independently of OSA status. In addition, we were interested in determining whether the relationship remained stable using varying cut off levels of AHI to define OSA (>5, >10, >15, and >30).

**OSA**

The set of dependent variables was related significantly to OSA (p<0.05). Follow up ANOVAs, with Bonferroni corrections to control the error rate, showed that age, MS, and TMA distinguished patients with OSA from normal subjects (p<0.05). In order of importance, these comparisons revealed that OSA patients were older than normal subjects (M = 49.27 v 44.08), had larger TMA (M = 161.17 v 148.92) and had higher MS (M = 3.71 v 3.37).

**Ethnic group**

After removal of prior differences in BMI and NC, Asians differed from whites in MS, TMD and TMA. In order of importance, Asians had higher MS, smaller TMD, and larger TMA than white subjects (p<0.05).

**Table 4** Comparisons between subjects with OSA and normal subjects for different cut off values for apnoea-hypopnoea index after adjustment for BMI, neck circumference, and ethnicity†

<table>
<thead>
<tr>
<th>AHI (h)</th>
<th>Age (years)</th>
<th>Mallampati score (1–4)</th>
<th>Thyromental angle (degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OSA Normal</td>
<td>p value</td>
<td>OSA Normal</td>
</tr>
<tr>
<td>&lt;5</td>
<td>49 (201)</td>
<td>44</td>
<td>* 3.7</td>
</tr>
<tr>
<td>&gt;5</td>
<td>50 (168)</td>
<td>46</td>
<td>* 3.7</td>
</tr>
<tr>
<td>&gt;10</td>
<td>50 (143)</td>
<td>46</td>
<td>* 3.8</td>
</tr>
<tr>
<td>&gt;15</td>
<td>51 (88)</td>
<td>47</td>
<td>* 3.8</td>
</tr>
<tr>
<td>&gt;30</td>
<td>51 (151)</td>
<td>47</td>
<td>* 3.8</td>
</tr>
</tbody>
</table>

Values are means.

*p<0.05.

†ANCOVA with adjustment for BMI, neck circumference and ethnicity; Bonferroni corrections for multiple comparisons; and follow-up univariate analyses.

**Figure 3** Receiver operator characteristic curves for the predictive equations using different cut off values of apnoea-hypopnoea index (AHI) for the definition of obstructive sleep apnoea: (A) AHI >5, (B) AHI >10, (C) AHI >15, (D) AHI >30. AUC = area under the curve.
Ross and co-workers conducted a systematic review and meta-analysis of the literature regarding the diagnosis of OSA. Among the articles reviewed were eight studies reporting prediction equations. The pooled estimates of these models were 66.5 (14%) for sensitivity and 88.7 (4.9%) for specificity. Rowley and colleagues prospectively evaluated four clinical prediction equations for the diagnosis of OSA and the prioritisation of patients for polysomnography. The performance characteristics of these equations were similar with AUCs ranging from 0.669 to 0.736, comparable to those of the ROC curves for the prediction equation in our study. The authors concluded that these models could be used as part of a clinical pathway to prioritise patients for polysomnography.

Several craniofacial characteristics have been shown to be associated with the development and severity of sleep disordered breathing. The most commonly reported abnormalities include an inferiorly positioned hyoid bone, a posteriorly placed maxilla and mandible, an enlarged tongue and soft palate, and a smaller velopharyngeal cross sectional area. These craniofacial abnormalities have been reported in both white and Asian patients with OSA.

Our results indicate that patients with OSA of differing severity of obstruction in OSA. Among the articles reviewed were eight studies reporting prediction equations. The pooled estimates of these models were 66.5 (14%) for sensitivity and 88.7 (4.9%) for specificity. Rowley and colleagues prospectively evaluated four clinical prediction equations for the diagnosis of OSA and the prioritisation of patients for polysomnography. The performance characteristics of these equations were similar with AUCs ranging from 0.669 to 0.736, comparable to those of the ROC curves for the prediction equation in our study. The authors concluded that these models could be used as part of a clinical pathway to prioritise patients for polysomnography.

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Figure 4 Lateral photographs of the head and neck region showing examples of the thyromental angle in (A) white and (B) Asian patients with varying degrees of severity of obstructive sleep apnoea. TMA = thyromental angle (degrees); AHI = apnoea-hypopnoea index (/hour).

**Varying definitions of OSA**

For each definition of OSA (AHI ≥5, ≥10, ≥15, and ≥30), increasing age, MS, and TMA were significantly associated with the presence of OSA (table 4). ROC curves of the predictive equations for different degrees of OSA severity are shown in fig 3. The area under the curve (AUC) was similar for each cut off (0.705 for AHI ≥5; 0.676 for AHI ≥10; 0.696 for AHI ≥15; and 0.713 for AHI ≥30). Figure 4 shows examples of the TMA measurement in white and Asian patients with different degrees of severity of OSA.

**DISCUSSION**

Our results indicate that patients with OSA of differing ethnicity and varying degrees of obesity have a crowded posterior oropharynx and a steep thyromental plane compared with non-apnoeic controls. After accounting for ethnic group, BMI and NC, patients with OSA are older and have larger MS and TMA. These craniofacial features probably reflect structural narrowing of the upper airway that contributes directly to the pathogenesis of upper airway obstruction in OSA. A crowded posterior oropharynx and a steep thyromental plane appear to be particularly useful clinical markers of OSA since they remain strong predictors even after correction for two important confounding variables—ethnicity and obesity—and over a wide range of cut-off values for the definition of OSA.

Whether clinical features can be reliably used to predict OSA among suspected individuals is still controversial.

Ross and co-workers conducted a systematic review and meta-analysis of the literature regarding the diagnosis of OSA. Among the articles reviewed were eight studies reporting prediction equations. The pooled estimates of these models were 66.5 (14%) for sensitivity and 88.7 (4.9%) for specificity. Rowley and colleagues prospectively evaluated four clinical prediction equations for the diagnosis of OSA and the prioritisation of patients for polysomnography. The performance characteristics of these equations were similar with AUCs ranging from 0.669 to 0.736, comparable to those of the ROC curves for the prediction equation in our study. The authors concluded that these models could be used as part of a clinical pathway to prioritise patients for polysomnography.
constraints. The TMD represents the position of the chin relative to the thyroid cartilage and may be related to the length of the anterior cranial base. The MS and TMD have been shown to correlate with both difficult endotracheal intubation and OSA.26–28 The TMA has not been reported previously. To obtain an objective measurement of this feature of the craniofacial profile for the purpose of this study, we chose to determine the TMA from a lateral photograph of the head and neck obtained in a standardised fashion. We believe this angle reflects features of both obesity and abnormal craniofacial skeletal structure. Central obesity with accumulation of adipose tissue in the submental region will result in a large TMA. A short TMD or anterior cranial base will also result in a large TMA. Since the majority of patients with OSA have evidence of both obesity and craniofacial abnormalities, it is not surprising that TMA emerged as a significant predictor of OSA in our study. A high MS indicates a crowded posterior oropharynx which can be caused by obesity or craniofacial abnormality, or a combination of both. The predictive value of a large TMA and a high MS—after adjusting for ethnicity, BMI and NC, and for different AHI cut-off values for the definition OSA—indicates a strong relationship between these two measurements and OSA. Both BMI and NC have previously been shown to correlate well with OSA, and both emerged as significant variables in our predictive equation, although less so than MS and TMA. Symptoms were not included in our predictive equation: a previous study found that they do not differentiate reliably between patients with and without OSA.29 Our results show that a simple clinical assessment of anthropometric features and craniofacial structure can help predict the presence of OSA.

Tsai and associates recently developed a decision rule for the diagnosis of OSA based on similar features of upper airway morphology including cricovaginal space (the perpendicular distance to the skin of the neck from the midpoint of a line joining the cricoid to the mentum); pharyngeal grade (similar to the MS); and overbite.30 Use of the decision rule allowed these investigators to confidently confirm or exclude OSA in 44% of patients. These results, together with our data, strongly suggest that clinical measurements from the craniofacial profile are good candidates for inclusion in the development of clinical prediction algorithms for the diagnosis of OSA and the prioritisation of patients for polysomnography. Our results extend the potential utility of these simple clinical measurements by demonstrating their applicability to patients of differing ethnicity and degrees of obesity.

We found that Asians had higher MS, shorter TMD and larger TMA, and tended to have more severe OSA than white subjects. Although the shorter TMD might suggest retrognathia, previous studies have shown that Asians have a more protruded maxilla and mandible.11 We suspect that the shorter TMD in Asians may be explained by a shorter anterior cranial base reflecting their smaller anteroposterior facial dimensions.12 Li and associates compared two consecutive series of 50 Asian and 50 white men with OSA.9 When matched for obesity, Asians had more severe OSA than whites. After controlling for the severity of OSA, Asians were less obese than whites and had a more anteriorly positioned maxilla and mandible but a shorter anterior cranial base dimension (p<0.0001). Although the TMD did not differ between patients with OSA and normal controls in our study, the shorter TMD in Asians could contribute to a larger TMA and steeper thyromental plane in patients with OSA in this ethnic group. The higher MS and shorter TMD in Asians may reflect abnormalities of craniofacial anatomy that contribute to structural narrowing of the upper airway independent of obesity. The higher MS in Asians, reflecting more severe posterior oropharyngeal narrowing, might also explain why Asian men have more severe OSA than white men when matched for age and BMI.4 A few of our subjects (17%) were women and, as shown in previous studies, they had smaller neck circumferences and less severe OSA than the men. The TMA and MS did not differ significantly between men and women.

Our study has certain limitations that may have an impact on the generalisability of our findings. There was a high prevalence of OSA in our sample, as defined by our a priori definition of AHI >5. We chose this definition to correspond with the generally accepted criteria proposed by the American Academy of Sleep Medicine.13 We performed post hoc analyses using different definitions for OSA which indicated that the predictive variables retained their utility over a wide range of cut-off values for AHI. Furthermore, discriminant analysis allows one to specify that prior probabilities are based on actual rather than equal group sizes, thus avoiding the problem of spuriously increased specificity. We studied only Asian and white, so our results may not be applicable to other ethnic groups. There is a clear need for more data on the manifestations of sleep disordered breathing in different ethnic groups.

In conclusion, we have shown that risk factors for OSA such as obesity and craniofacial features that reflect structural narrowing of the upper airway are readily identified and can easily be incorporated into the routine physical examination. Patients with OSA of differing ethnicity and varying degrees of obesity have a crowded posterior oropharynx and a steep thyromental plane. Recognition of these abnormalities in the craniofacial profile should alert the physician to the possibility of OSA.

In conclusion, we have shown that risk factors for OSA such as obesity and craniofacial features that reflect structural narrowing of the upper airway are readily identified and can easily be incorporated into the routine physical examination. Patients with OSA of differing ethnicity and varying degrees of obesity have a crowded posterior oropharynx and a steep thyromental plane. Recognition of these abnormalities in the craniofacial profile should alert the physician to the possibility of OSA.

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