RUJUKAN

UNIVERSITI SAINS MALAYSIA

PEJABAT PENGURUSAN & KREATIVITI PENYELIDIKAN
RESEARCH CREATIVITY AND MANAGEMENT OFFICE [RCMO]

LAPORAN AKHIR PROJEK PENYELIDIKAN JANGKA *PENDEK*
FINAL REPORT OF SHORT TERM RESEARCH PROJECTS

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1) **Nama Ketua Penyelidik** :
Name of Research Leader :

Ketua Penyelidik *Research Leader*	PTJ *School/Centre*
Dr. Hasnah Hashim	Pusat Pengajian Sains Pergigian (sehingga September 2006), Institut Perubatan dan Pergigian Termaju (bermula September 2006)

Nama Penyelidik Bersama
(Jika berkaitan) :
Name/s of Co-Researcher/s
(if applicable)

Penyelidik Bersama *Co-Researcher*	PTJ *School/Centre*
Prof. Ab. Rani Samsudin	Pusat Pengajian Sains Pergigian
Dr. Nizam Abdullah	Pusat Pengajian Sains Pergigian
Dr. Lin Naing / Mohd. Ayub Saddiq	Pusat Pengajian Sains Pergigian
Dr. Haji M. Abdul Kareem	Pusat Pengajian Sains Perubatan

2) **Tajuk Projek** : Dentofacial features of Obstructive Sleep Apnoea Syndrome (OSAS) Among Army Personnel Based in Kelantan

3) **Abstrak untuk penyelidikan anda**

(Perlu disediakan di antara 100 – 200 perkataan di dalam **Bahasa Malaysia dan Bahasa Inggeris.** Ini kemudiannya akan dimuatkan ke dalam Laporan Tahunan Bahagian Penyelidikan & Inovasi sebagai satu cara untuk menyampaikan dapatan projek tuan/puan kepada pihak Universiti & luar).

Abstract of Research

(Must be prepared in 100 – 200 words in Bahasa Malaysia as well as in English. This abstract will later be included in the Annual Report of the Research and Innovation Section as a means of presenting the project findings of the researcher/s to the university and the outside community)

As attached

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ABSTRAK

'Obstructive Sleep Apnea' (OSA) ialah masalah saluran pernafasan yang tersekat sama ada sepenuhnya atau separa yang terjadi berulang-ulang kali semasa tidur, hingga menyebabkan pernafasa terhenti ('apnea') atau pengurangan pergerakan udara pernafasan (hypopnea) walaupun otot-otot pernafasan masih meneruskan usaha pernafasan. Anggaran 9% wanita dan 24% lelaki pertengahan usia menghidapi OSA manakala 2% wanita dan 4% lelaki pertengahan usia menghidapi 'obstructive sleep apnea syndrome', OSAS (OSA yang melibatkan simptom-simtom antaranya rasa mengantuk yang keterlaluan di siang hari). Objektif kajian ini adalah untuk menentukan prevalen simptom-simptom OSAS dan kelainan ciri-ciri struktur muka dan rahang di antara angota-anggota tentera yang bertugas di Kelantan yang berisiko tinggi dan mereka yang berisiko rendah menghidapi OSAS serta untuk mengetahui faktor-faktor yang mempunyai kaitan dengan risiko menghidapi OSAS. 911 anggota tentera yang bertugas di Kem Desa Pahlawan telah dipilih secara rawak untuk menjawab borang kajiselidik 'Berlin'. Prevalen simptom-simptom OSAS ditentukan berdasarkan jawapan-jawapan yang diberi, dan subjek-subjek kemudiannya dikategorikan ke dalam kumpulan risiko tinggi ataupun rendah. Model pergigian, radiograf 'cephalometry' lateral dan ukurlilit leher diambil dari 35 subjek-subjek berisiko tinggi dan 37 subjek-subjek berisiko rendah. Sebahagian dari subjek-subjek ini juga menjalani ujian pernafasan semasa tidur. Keputusan: 661 borang kajiselidik telah dipulangkan. Purata umur para peserta ialah 31.4 tahun ('standard deviation (SD) 6.45) manakala purata indeks jisim badan ('BMI') ialah 24.4 kg / m^2 (SD 2.47). Taburan prevalen simptom adalah pelbagai dengan 45 subjek (6.8%, 95% CI: 5.0-9.0) telah dikategorikan di dalam kumpulan berisiko tinggi Tiada perbezaan umur dan BMI yang signifikan di antara 35 subjek berisiko tinggi dan 37 subjek berisiko rendah yang terlibat di dalam kumpulan perbandingan. Ukurlilit leher, 'PNS_P' (panjang lelangit lembut), 'MPT' (ketebalan lelangit lembut), 'MPH' (jarak di antara plen mandibel dan tulang hyoid), jarak di antara

gigi molar atas, jarak di antara gigi molar bawah dan 'middle PAS' (ruang saluran udara tengah) mempunyai perbezaan signifikan. Jarak di antara gigi molar bawah, PNS_P dan MPH mempunyai hubungkait yang signifikan dengan risiko mempunyai OSAS. Kajian ini menunjukkan adalah penting untuk membuat penilaian struktur muka dan rahang terhadap mereka yang berisiko tinggi menghidapi OSAS terutamanya di kalangan mereka yang mempunyai BMI yang rendah.

ABSTRACT

Obstructive sleep apnea (OSA) is repeated complete or partial upper airway obstruction during sleep, causing cessation of breathing (apnea) or reduction in airflow (hypopneas) despite persistent respiratory effort. It occurs in 9% and 24% middle-aged women and men respectively while obstructive sleep apnea syndrome, OSAS (OSA plus presence of symptoms such as excessive daytime sleepiness) occurs in 2% and 4% middle-aged women and men respectively. The objectives of the study were to determine the prevalence of symptoms of OSAS and the differences in dentofacial features of army personnel based in Kelantan who are at high risk and low risk of having OSAS, and to find factors associated with the risk of having OSAS. 911 army personnel based in the Desa Pahlawan camp were randomly selected to answer the Malay version of Berlin questionnaire. The distributions of symptoms of OSAS were determined and subjects were categorised as being either at high risk or low risk of having OSAS. Dental study models, lateral cephalometric radiographs and neck circumference for the determination of the dentofacial dimensions were taken from 35 high risk and 37 low risk subjects. A proportion of these subjects underwent overnight sleep studies. Results: 661 questionnaires were returned. The mean age of total participants was 31.4 years (standard deviation (SD) 6.45) while the mean BMI was 24.4 kg / m^2 (SD 2.47). There was a range of prevalence of the main symptoms of OSAS with 45 subjects (6.8%, 95% CI: 5.0-9.0) categorised in the high risk group for OSAS. There were no significant differences in age and BMI between the 35 high risk and 37 low risk subjects that formed the subsequent comparison groups. The neck circumference, PNS_P (length of the soft palate), MPT (maximum soft palate thickness), MPH (distance between the mandibular plane and the hyoid bone), maxillary intermolar distance, mandibular intermolar distance and middle PAS (posterior airway space) were significantly different between both groups. There were significant associations between the following variables and the risk of having OSAS: mandibular intermolar distance,

PNS_P and MPH. The current study demonstrates presence of symptoms of OSAS and the distinct dentofacial features in subjects at high risk of OSAS. This study also confirms that symptoms of OSAS still exist even without the classical sign of OSAS, i.e. obesity. It also shows that greater attention should be paid to the evaluation of the dentofacial features in subjects with a low BMI at high risk for the disorder.

4) Sila sediakan Laporan teknikal lengkap yang menerangkan keseluruhan projek ini. [Sila gunakan kertas berasingan]
Kindly prepare a comprehensive technical report explaining the project (Prepare report separately as attachment)

Senaraikan Kata Kunci yang boleh menggambarkan penyelidikan anda :
List a glosssary that explains or reflects your research:

Bahasa Malaysia	Bahasa Inggeris
Apnea Tidur Obstruktif	Obstructive sleep apnea
Faktor risiko	Risk factors
Ciri dentofasial	Dentofacial features

5) **Output Dan Faedah Projek**
Output and Benefits of Project

(a) * Penerbitan *(termasuk laporan/kertas seminar)*
Publications (including reports/seminar papers)
(Sila nyatakan jenis, tajuk, pengarang, tahun terbitan dan di mana telah diterbit/dibentangkan).
(Kindly state each type, title, author/editor, publication year and journal/s containing publication)

INTERNATIONAL

1. Hasnah Hashim & AR Samsudin. Sleep Apnea and Dentistry. Asian Dentist. 12:9 (2005) pp 25-30

2. Hasnah Hashim & AR Samsudin. A study of dentofacial features in relation to obstructive sleep apnea syndrome among Malay male adults in Malaysia. Clinical Oral Investigation. (Submitted for publication)

NATIONAL

1. Hasnah Hashim & AR Samsudin. The distribution of symptoms of obstructive sleep apnea syndrome among army personnel in Kelantan. Malaysian Journal of Public Health Malaysia.

2. Hasnah Hashim & AR Samsudin. Dentofacial features of Malay men with and without symptoms of obstructive sleep apnea syndrome. The Medical Journal of Malaysia, Vol 59 (Supp D), August 2004, p. 93 (Abstract publication)

3.Hasnah Hashim & AR Samsudin. A study of dentofacial parameters in relation to obstructive sleep apnea syndrome among army personnel in Kelantan. Malaysian Journal of Public Health Medicine,. Vol 4 (Supp 1), 2004, p. 36 (Abstract publication)

4.Hasnah Hashim & AR Samsudin. The distribution of symptoms of obstructive sleep apnea syndrome among army personnel in Kelantan. Malaysian Journal of Public Health Medicine,. Vol 4 (Supp 1), 2004, p. 42 (Abstract publication)

5. Hasnah Hashim & AR Samsudin. The dentofacial features of to obstructive sleep apnea syndrome among army personnel based in Kelantan. Malaysian Journal of Public Health Medicine,. Vol (Supp), 2005 p. (Abstract publication)

6. Hasnah Hashim. Henti Nafas Dalam Tidur. Mingguan Malaysia. Published on 26/6/2005.

(b) **Faedah-Faedah Lain Seperti Perkembangan Produk, Prospek Komersialisasi Dan Pendaftaran Paten atau impak kepada dasar dan masyakarat.**
Other benefits such as product development, product commercialisation/patent registration or impact on source and society

Database on Obstructive Sleep Apnoea Syndrome (OSAS) and the dentofacial features that contribute to the presence of OSAS among Malay male individuals. This can facilitate preliminary clinical screening in individuals presenting with the symptoms for the disorder.

UNIVERSITI SAINS MALAYSIA
JABATAN BENDAHARI
KUMPULAN WANG PENYELIDIKAN GERAN USM(304)
PENYATA PERBELANJAAN SEHINGGA 31 OKTOBER 2006

Jumlah Geran:	RM	Tiada Rekod	Ketua Projek:	DR. HASNAH HASHIM
Peruntukan 2004 (Tahun 1)	RM	8,304.00	Tajuk Projek:	Dentofacial Features of Obstructive Sleep Apnoea Syndrome(OSAS) Among Army Personnel Based in Kelantan
Peruntukan 2005 (Tahun 2)	RM	8,305.00		
Peruntukan 2006 (Tahun 3)	RM	0.00	Tempoh:	1 Sept 04-31 Ogos 06
			No.Akaun:	304/PPSG/6131334

Kwg	Akaun	PTJ	Projek	Donor	Peruntukan Projek	Perbelanjaan T'kumpul Hingga Tahun Lalu	Peruntukan Semasa	Tanggungan Semasa	Bayaran Tahun Semasa	Belanja Tahun Semasa	Baki Projek
304	11000	PPSG	6131334		1,027.70	-	1,027.70	-	-	-	1,027.70
304	14000	PPSG	6131334		-	-	-	-	-	-	-
304	15000	PPSG	6131334		-	-	-	-	-	-	-
304	21000	PPSG	6131334		4,276.30	2,561.00	1,715.30	-	316.00	1,389.00	1,399.30
304	22000	PPSG	6131334		-	-	-	-	-	-	-
304	23000	PPSG	6131334		-	279.88	(279.88)	-		-	(279.88)
304	24000	PPSG	6131334		-	-	-	-	-	-	-
304	25000	PPSG	6131334		-	34.40	(34.40)	-		-	(34.40)
304	26000	PPSG	6131334		-	-	-	-	-	-	-
304	27000	PPSG	6131334		1,105.00	8,461.90	(7,356.90)	500.00	1535.00	8,320.00	(8,891.90)
304	28000	PPSG	6131334		-	-	-	-		-	(500.00)
304	29000	PPSG	6131334		3,500.00	2,636.70	863.30	-	200.00	1,677.00	663.30
304	32000	PPSG	6131334		-	-	-	-	-	-	-
304	35000	PPSG	6131334		6,700.00	-	6,700.00	-	-	-	6,700.00
					16,609.00	13,973.88	2,635.12	500.00	2,051.00	11,386.00	84.12

(c) **Latihan Gunatenaga Manusia**
Training in Human Resources

i) Pelajar Siswazah :
Postgraduate students:
(perincikan nama, ijazah dan status)
(Provide names, degrees and status)
self: Hasnah Hashim, Master in Community Medicine, 2005

ii) Pelajar Prasiswazah : .....
Undergraduate students:
(Nyatakan bilangan)
(Provide number)
2 (undergraduates of Doctor of Dental Surgery programme)

iii) Lain-Lain : -.....
Others:
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6. **Peralatan Yang Telah Dibeli :**
Equipment that has been purchased:
1 unit of Acer laptop, 1 unit of Zire palmtop, 1 unit Xerox laser printer, 1 unit Epson printer
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KOMEN JAWATANKUASA PENYELIDIKAN PUSAT PENGAJIAN
Comments of the Research Committees of Schools/Centres

The project was done successfully.
Report submitted was complete.

b/p

TANDATANGAN PENGERUSI
JAWATANKUASA PENYELIDIKAN PUSAT PENGAJIAN
Signature of Chairman
[Research Committee of School/Centre]

23/11/06

TARIKH
Date

PROF. DR. RUSLI BIN NORDIN
Profesor Perubatan Masyarakat
Timbalan Dekan
(Penyelidikan & Pengajian Siswazah)
Pusat Pengajian Sains Pergigian
USM Kampus Kesihatan
16150 Kubang Kerian
Kelantan

Updated : 16MAC2006

Dentofacial features of Obstructive Sleep Apnoea Syndrome (OSAS) Among Army Personnel Based in Kelantan

Introduction

Obstructive Sleep Apnea Syndrome (OSAS) is a syndrome to describe repetitive obstructions of the airway which lead to cessation of breathing during sleep for more than 10 seconds at least 5 times per hour. It is associated with loud snoring, events of choking and gasping during sleep (usually noticed by the bed partner) and chronic sleep disruption [3]. Often, the patients will experience excessive daytime sleepiness or related problems in daytime functions [12].

Dentofacial features are structures in the head and neck region, including those in the oral cavity. The relation of dentofacial morphologies in OSAS is of particular interest to many sleep disorder researchers. For example, Dempsey *et al.* [2] reported that 24% of the variance of OSAS severity is explained by craniofacial anatomy. Studies have proposed that normal weight patients exhibit more anatomical abnormalities than obese patients and hence, suggested that craniofacial abnormalities might be the major contributors to the development of sleep apnea in the non-obese OSAS patients [1,10,11]. It has also been proposed that the upper airway and craniofacial structures may be of particular significance in Asians with OSAS. Ito *et al.* [6] noticed that many Japanese patients with severe OSAS were not obese. Chinese subjects were also found to have more severe craniofacial abnormalities than their Caucasian counterparts when matched for age, sex, BMI and OSAS severity [5].

The aim of this study was to determine the associated factors of the risk of having OSAS among army personnel based in Kelantan.

Materials and method

Nine hundred and eleven Malay army personnel based in Kelantan were provided with a copy of the Malay version of Berlin questionnaire. This questionnaire was developed during a conference on sleep medicine held in Berlin, Germany in April 1996 [9]. It is a self-administered questionnaire asking about a set of known symptoms and clinical features of OSAS. The Malay version was developed and previously pre-tested among student staff nurses in a nursing college by a sleep research team in Universiti Sains Malaysia. The questionnaire asked for symptoms indicative of OSAS: snoring, excessive daytime sleepiness/fatigue, and obesity/hypertension. The exclusion criteria for the subsequent selection of the study subjects were previous history of maxillofacial trauma, current use of sedative drugs, and reduced nasal airway patency (determined by assessing the formation of moisture on a cold spatula placed at the nasal opening with the subjects breathing normally). Thirty five subjects who qualified for at least two out of the three symptom categories and considered at high risk for sleep apnea were randomly selected to be included in the study. Thirty seven low risk subjects were randomly selected among respondents with no symptoms. Eleven of the high risk group and low risk group each underwent an overnight sleep study conducted using Embletta Diagnostic System (Flaga Medical Devices, Iceland). The mean Apnea-Hypopnea Index (AHI) in the high risk group was 15.9 events/hour (SD 20.78) with the highest AHI recording of 58.8 while the mean AHI in the low risk group was 2.6 events/hour (SD 0.50). The sensitivity and specificity of the questionnaire in predicting OSAS with an AHI of at least five among our study subjects were 90.0% (95% Confidence Interval (CI): 55.5, 99.7) and 75.0% (95% CI: 42.8, 94.5) respectively while its positive and negative predictive values were 81.8% (95% CI: 48.2, 97.7) and 90.9% (95% CI: 58.7, 99.8) respectively.

The neck circumference was measured at the cricothyroid membrane level. The dentofacial parameters were assessed using dental study models (figure 1) and lateral cephalometric radiographs (figure 2). The measurements were made at least twice with the second episode of measuring done two weeks after the first one. The mean value of the two measurements was taken as the value of each parameter. The associations between the independent variables and outcome variable (risk of having OSAS) were analyzed with simple and multiple logistic regressions using the Intercooled Stata, version 7.0 (Stata Corp, Texas) statistical software.

Results

Of the 911 questionnaires distributed, 661 were returned. The response rate was therefore 72.6%. They originated from throughout the country and most had been employed there for less than five years. The age range of the respondents was between 19.0 and 46.2 years with a mean of 31.4 (SD 6.45) year while the range of the BMI of the total respondents was between 15.2 and 45.6 kg/m^2 with a mean of 23.4 (SD 3.50) kg/m^2. Out of the 661 respondents, 45 (6.8%; 95% CI: 5.0, 9.0) were categorised in the high risk group for OSAS.

Table 1 shows the results of the simple logistic regression analysis of the data collected from the 35 high risk and 37 low risk subjects. It showed that neck circumference, maxillary intermolar distance, mandibular intermolar distance, MPH, middle PAS, PNS_P and MPT were significantly associated with the risk of having OSAS. The other variables were not significantly associated with the risk of having OSAS

After going through the multiple logistic regression procedure, the independent variables that were found to be significantly associated with the risk of having OSAS are as shown in table 2 below.

Table 1: The factors associated with the risk of having OSAS analysed with simple logistic regression

Variable	Crude OR [a] (95% CI)	*LR* [b] Statistic (*df*)	*p*-value
Age (years)	1.04 (0.96, 1.14)	0.98 (1)	0.327
BMI (kg/m^2)	1.15 (0.94, 1.41)	1.86 (1)	0.179
Neck circumference (cm)	1.78 (1.26, 2.50)	14.98 (1)	0.001
Maxillary intermolar distance (mm)	0.78 (0.64, 0.96)	6.71 (1)	0.016
Mandibular intermolar distance (mm)	0.53 (0.36, 0.79)	13.61 (1)	0.002
Palatal height (mm)	1.19 (0.96, 1.48)	2.76 (1)	0.108
SNA (°)	1.02 (0.94, 1.11)	0.32 (1)	0.574
SNB (°)	1.03 (0.90, 1.17)	0.16 (1)	0.685
ANB (°)	1.14 (0.96, 1.35)	2.31 (1)	0.136
MPH (mm)	1.84 (1.36, 2.50)	29.84 (1)	<0.001
Inferior PAS (mm)	0.83 (0.66, 1.04)	2.71 (1)	0.108
Middle PAS (mm)	0.70 (0.54, 0.90)	9.36 (1)	0.006
Superior PAS (mm)	0.87 (0.69, 1.10)	1.38 (1)	0.249
PNS_P (mm)	1.30 (1.07, 1.59)	8.99 (1)	0.008
MPT (mm)	1.89 (1.27, 2.81)	12.40 (1)	0.002

[a] Odds Ratio

[b] Log-likelihood ratio

Table 2: The factors significantly associated with the risk of having OSAS analysed with multiple logistic regression model [a]

Variable	Adjusted OR (95% CI)	*LR* Statistic (df)	*p*-value
MPH (mm)	1.94 (1.32, 2.86)	23.49 (2)	0.001
Mandibular intermolar distance (mm)	0.44 (0.26, 0.76)	39.41 (2)	0.003
PNS_P (mm)	1.37 (1.07, 1.74)	40.76 (2)	0.012

[a] Pseudo R^2 of the final model: 0.533, The model fits well (Hosmer-Lemeshow test p value = 0.619

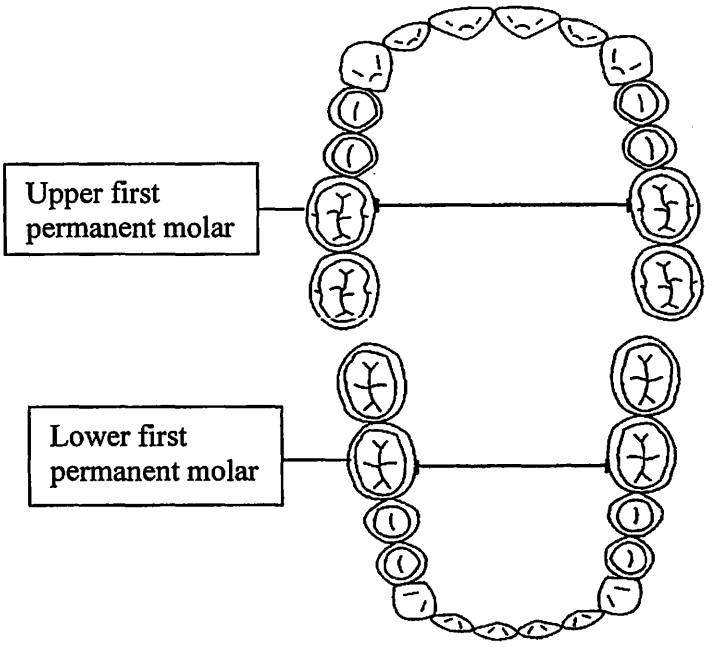

Figure 1 Maxillary and intermolar distance measurements

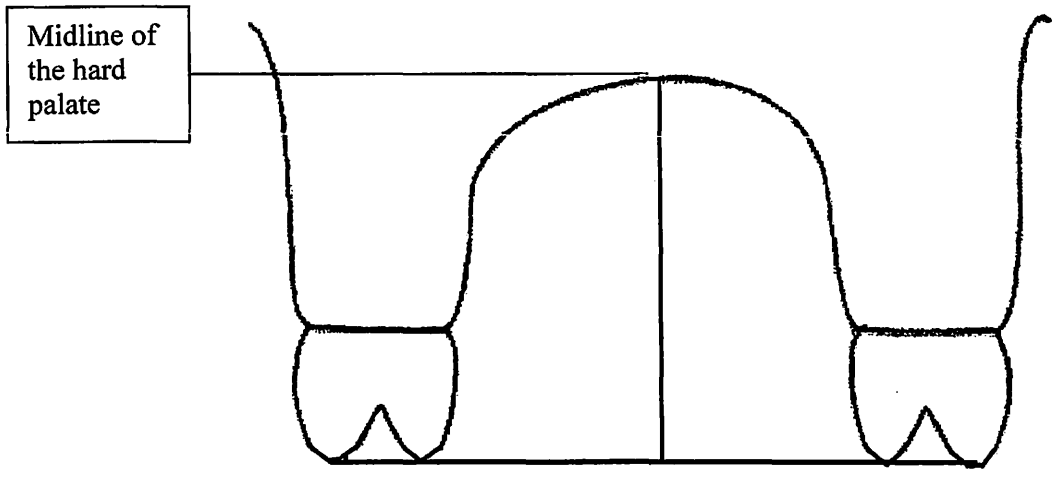

Figure 2 Palatal height measurement

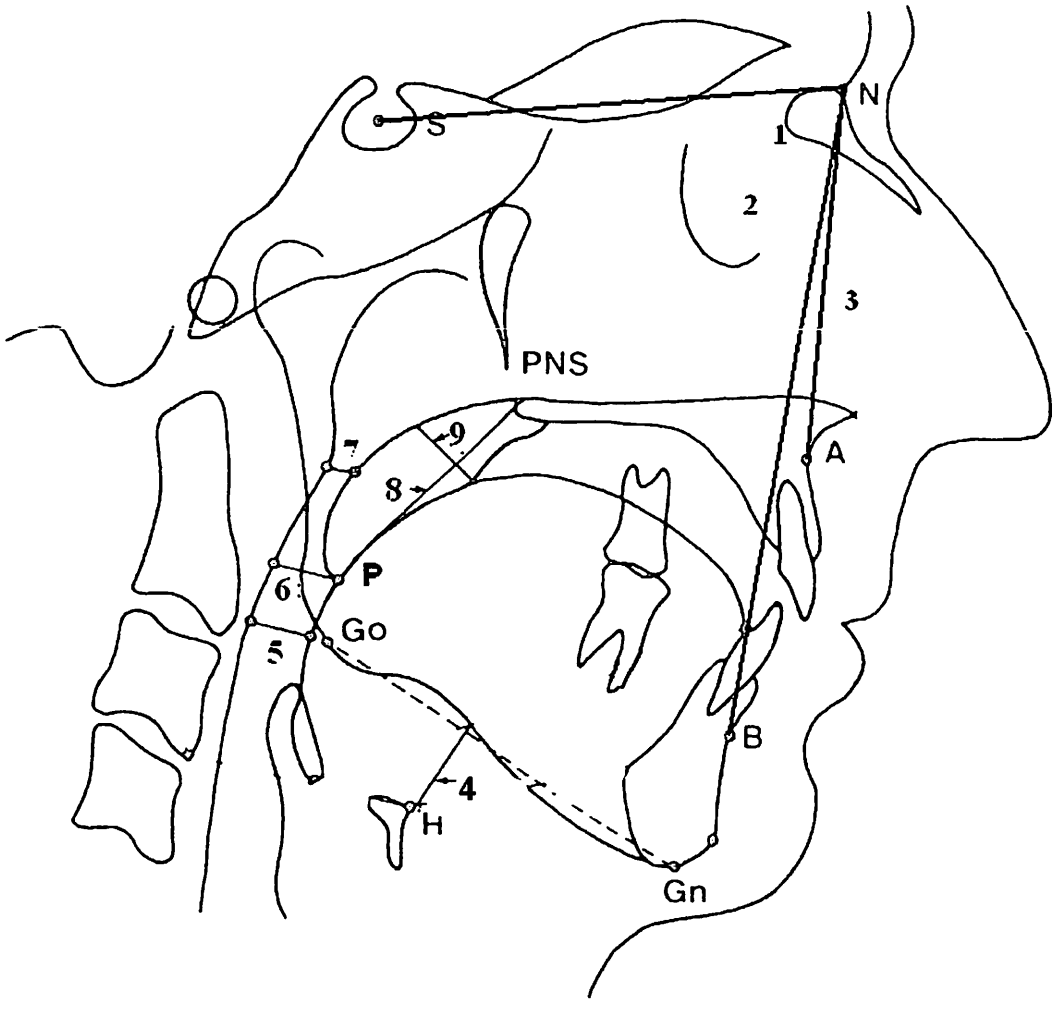

Figure 3 Lateral cephalometric landmarks and measurements

Landmarks:

S = center of the sella tursica; N = nasion; PNS = posterior nasal spine tip; A = subspinale; B = submentale; Gn = gnathion; Go = gonion; H = anterior superior tip of hyoid bone.

Measurements:

1 = SNA; 2 = SNB; 3= ANB; 4 = MPH; 5 = inferior PAS; 6 = middle PAS; 7 = superior PAS; 8 = PNS_P; 9 = MPT

The dentofacial parameters were measured in three ways, namely clinical measurements, dental study models and lateral cephalometric study. The measurements were done as follow:

a) Neck circumference: measured in cm at the level of the cricothyroid membrane with the subjects positioning their head in the natural posture.

b) Maxillary intermolar distance: determined as the distance in mm between the palatal surfaces of the first permanent upper molars or if absent, appropriate surrogate landmarks. These measurements were made in the middle of the palatal part of the teeth and exactly at the level of the gingival margin (figure 1).

c) Mandibular intermolar distance: determined as the distance in mm between the lingual surfaces of the first permanent lower molars or if absent, appropriate surrogate landmarks. Likewise, these measurements were made in the middle of the lingual part of the teeth and exactly at the level of the gingival margin (figure 1).

d) The palatal height was established as the depth in the midline part of the hard palate from the occlusal plane level (figure 2)

e) SNA (position of the maxilla in relation to the skull base): angle measurement from sella (S) to nasion (N) to point A (subspinale, the deepest point of the maxillary anterior alveolar bone).

f) SNB (position of the mandible): angle measurement from sella (S) to nasion (N) to point B (supramentale, the deepest point of the mandibular anterior alveolar bone).

g) ANB (maxillary-mandibular discrepancy): angle between the line from point A to N and the line from B to N.

h) MPH (distance between mandibular plane and hyoid bone): measured on the line connecting the mandible and the hyoid bone perpendicular to the mandibular plane.

i) Inferior posterior airway space (PAS): width of the pharynx measured between the posterior pharyngeal wall and the dorsum of the tongue on a line joining gonion (Go) and supramentale (point B).

j) Middle PAS: width of the pharynx measured between the posterior pharyngeal wall and the dorsum of the tongue on a line parallel to Go-B through the tip of the soft palate (P).

k) Superior PAS: width of the pharynx measured between the posterior pharyngeal wall and the posterior border on a line parallel to Go-B through the midpoint of PNS_P.

l) PNS_P (length of the soft palate): distance from posterior nasal spine (PNS) to the tip of the soft palate (P).

m) MPT (maximum palatal thickness): measured on the line perpendicular to the PNS_P line.

Discussion

The study subjects were relatively young and they had a low mean BMI. Significant associations with the risk of having OSAS were exhibited by the distance between the mandibular plane and the hyoid bone, the mandibular intermolar distance, and the length of the soft palate. In spite of the diverse measurement techniques utilised in studies available to date, a cursory review found that two of these characteristics (distance from the hyoid bone to the mandibular plane and length of the soft palate) are mentioned consistently as having association with OSAS. An assessment on Chinese patients with OSAS also found that the position of the hyoid bone was a significant variable for risk of OSAS [4]. The explanation for the relative importance of the hyoid bone position in OSAS is that when it is abnormally low, the bulk of the tongue that it anchors will be in the pharyngeal area and when the muscles are hypotonic during REM sleep, it will fall back causing obstruction of the airway [8]. The problem is aggravated when the mandible is narrow as the space to accommodate the tongue is further compromised. Accordingly, it is strongly recommended that the position of this bone should be carefully assessed in all patients suspected of having OSAS.

The length of the soft palate in an earlier study has been demonstrated to be positively correlated with OSAS when obesity and age were controlled [8]. Our study has also discovered a significant association between this parameter and the risk of OSAS. However, the maximum thickness of the soft palate in our study subjects did not exhibit a significant association.

A study by Kushida *et al.* [7] which incorporated clinical measurements of the oral cavity showed significant differences in the maxillary and mandibular intermolar distances of their study subjects but they did not explore the contribution of this parameter to the risk of OSAS. To the best of our knowledge, the contribution of the mandibular intermolar

distance to the risk of this syndrome particularly among Asian subjects is not well-investigated and reported in other studies. Hence, this is a new contributory factor that needs to be taken into consideration when assessing the risk of OSAS.

We did not discover any significant association between neck circumference, maxillary intermolar distance, palatal height, SNA, SNB and ANB and the airway dimensions with the risk of having OSAS although these features have been stated to be related to this syndrome. For example, Dempsey *et al.* [2] reported the odds of having moderate to severe sleep disordered breathing increased three to seven times in subjects with reduced airway dimensions. In contrast, our results did not detect any significant association between the posterior airway space at all three levels (superior, middle and inferior) with the risk of having OSAS. The lack of association of these features among Asian subjects may be due to the differences in craniofacial morphology between different racial groups. Perhaps the establishment of the dentofacial norms among the various ethnic groups in Asia would elucidate a clearer explanation on the differences in these findings.

In conclusion, the significant dentofacial features among Malay male subjects with a low mean BMI found to be associated with the risk of having OSAS in this study were reduced mandibular intermolar distance, increased distances from the posterior nasal spine to the tip of the soft palate and from the mandibular plane to the hyoid bone. In addition, greater attention should be paid to the assessment of the mandibular intermolar distance as this parameter is not commonly explored in other studies.

Acknowledgment

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References

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