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The Effect of Mandibular Protrusion on Dynamic Changes in Oropharyngeal Caliber

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The purpose of this study was to determine the sites of narrowing/obstruction and to measure the regional severity of narrowing through the evaluation of dynamic changes in upper-airway of healthy subjects. The selected 9 subjects were proved not to have any sleep-related disorder such as snoring or obstructive sleep apnea through clinical examination, radiological examination, sleep study with a portable recording system. Afterward, the Electron Beam Tomography was performed during the waking and sleeping state of subjects, with their mandible in resting and protruded position. Intravenous injection of Dormicum® was used for the induction of sleep. The maximum and minimum cross-sectional areas at each airway level during tidal ventilation were measured and the Collapsibility Index for each level of cross-section was also computed. In a comparison with results under variable conditions, the result was showed that the significant difference between each airway level divided with upper, middle, lower region of upper airway is not observed in the average minimum cross-sectional areas and Collapsibility Index. The significant difference only between in wake and sleep state was observed in the average minimum cross-sectional area at the lower region. Also, in wake state, the significant difference between resting and protrusive position of mandible for the average minimum was also observed in cross-sectional area at middle region. In sleep state, no significant difference between resting and protrusive position of mandible was observed in cross-sectional area and the Collapsibility Index.

Key words : healthy subject, dynamic change of upper-airway, Electron Beam Tomography, protrusive position of mandible

Ⅰ. INTRODUCTION

The obstructive sleep apnea(OSA) is a common disorder affecting at least 2-4% of the adult population. This is defined as the cessation of airflow due to a total airway collapse despite a persistent effort to breathe. It is characterized by recurrent apneas and hypopneas during sleep with resultant oxyhemoglobin desaturations. Moreover, the clinical sequelae of OSA include daytime hypersomnolence, cognitive impairment, systemic and/or pulmonary hypertension, myocardial infarction, cardiac arrhythmias, stroke, and increased risk of motor vehicle accidents[1,2,3)].

In predisposed individuals, a decrease in upper airway muscle tone during sleep contributes to pharyngeal obstruction. Such obstruction in the upper airway can occur in three areas. They are the nasopharyngeal, oropharyngeal, and hypopharyn-

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geal regions. The nasopharynx is the part of the pharynx that lies above the level of the soft palate. The oropharynx is the division of the pharynx that lies between the soft palate and the upper edge of the epiglottis. The hypopharynx is the division of the pharynx that lies below the upper edge of the epiglottis and opens into the larynx and esophagus. Of them, the oropharynx is not surrounded by the rigid wall like bone and cartilage but mostly by the nonrigid, elastic wall like musculature. Moreover, it has the redundant peripharyngeal soft tissues. Consequently the oropharynx is more frequent site of obstruction and stenosis in upper airway, as the tone of the pharyngeal musculature is decreased during sleep. In particular, the oropharynx behind the base of the tongue is a common site of oropharyngeal obstruction in sleep apnea because the base of the tongue can impinge on the airway just above the glottis. The velopharynx, a part of nasopharynx which is located in posterior area of soft palate, also is the frequent obstructive site.

Though two parts in upper airway are the frequent obstructive and narrowing sites for OSA, the obstructive and narrowing sites may vary individually.

Many different therapeutic strategies for OSA, both medical and surgical, have been dsecribed in the past with varying amounts of success. Although uvulopalatopharyngoplasty(UPPP) and Continuous Positive Airway Pressure (CPAP) are the principal treatments for these disorders, CPAP has the problem in obtaining compliance for wearing this equipment and surgical treatments of the soft palate have the possibilities of many complications like hemorrhage, swelling, infection.

Consequently, oral appliances, especially mandibular advancement devices (MAD), have been developed as alternatives to surgery and CPAP for the relief of upper airway obstruction. Mandibular advancement devices are increasingly being considered as a possible therapeutic option for sufferers of mild to moderate obstructive sleep apnea[4]. The effectiveness of such devices is dependent upon maintenance of the mandible and tongue in a protruded posture during sleep, thereby preventing upper airway occlusion[5,6]. Reported success rates vary, as do the authors′ criteria for its achievement. If a reduction in the number of apneic events of 50 per cent or greater is adequate, then success rates as high as 87 per cent have been described[5]. Where fewer than 10 such occurrences per hour are equated with success, outcome rates vary from 46 to 71 per cent[7].

Although the MAD therapy is effective but not always same, even in same severity of OSA, there have been a few detailed studies related with indication of MAD therapy for obstructive sleep apnea, based on anatomic considerations not on severity of obstructive sleep apnea. This absence of diagnostic and prognostic informations may explain the wide variations in success. Therefore, it is very important and essential to detect the accurate sites of obstruction and the most effective site by mandibular advancement device for the establishment of indications.

In the absence of a precise topographical diagnosis it is not possible to determine which of the treatment methods can most benefit each patient. Moreover, the demonstrations of obstruction at nonfixed and dynamic upper airway have had many difficult imaging problem. The methods that have been used in the assessment of changes in upper airway before and after mandibular advancement device treatment for sleep apnea include X-ray cephalometry[7,8,9], fluoroscopy [10], and conventional CT[11], and MRI[12].

Battagel et al.[9] using cephalometry reported that in male and female the minimum distances between the posterior pharyneal wall behind soft palate and tongue significantly increased. To the contrast, Eveloff et al.[8] reported that comparison of pre- and post-treatment cephalometric values revealed no significant change in the posterior airway space (PAS) despite a reduction in mean apnea-hypopnea index (AHI). However, despite economical benefit, cephalometry provided the limited value of the two-dimensional image obtained under awake state and mostly in the standing position.

L'Estrange et al.[10] using fluoroscopy reported that the response of the upper airway to mandibular advancement varied considerably. Fluoroscopy of the airway can give excellent anatomic information, but, if symptoms are intermittent, this technique is of limited value. Moreover, this has the disadvantages including overlapping images, low contrast resolution, high radiation dose and absence of transverse orientated images.

In a case study using a three-dimensional MRI, Smith[12] reported that total airway volume increased by 32% after insertion of a mandibular advancement device and the largest improvement site in the airway was the mid-soft palatal uvula/nasopharynx region. MRI and conventional CT can give excellent anatomic detail, but its application in the dynamic study of airway is limited by relatively long data acquisition time.

The Electron Beam Tomography (EBT) is a kind of cine CT, and it has a very short scan time and interscan delay, and multiple levels can be scanned almost simultaneously without moving the patient. The EBT can provide the representative images closer to continuous changes of upper airway due to very short imaging time. Therefore, it have the benefit to acquire dynamic information, unobtainable from MRI and conventional CT images. Cine CT has previously been used to show narrowed upper airways in patients with OSA[13,14].

The dynamic movement of the oropharyngeal wall during respiration can be seen on the reconstructed EBT images and the cross-sectional area of upper airway lumen is obtainable by the computerized program of the EBT system. The purpose of this study was to compare the cross-sectional areas of upper airway lumen between wakefulness and sleep and between normal jaw position and protruded jaw position.

Ⅱ. MATERIALS AND METHODS

1. Subjects

Asymptomatic nine male subjects participated in the study. They were selected from dental students at the Kyungpook National University according to the following exclusion criteria; the presence of the respiratory disease or any anatomical abnormalities on cephalometric radiograph, weight over 100 kg, as well as the usual contraindications to EBT scanning. Each subject completed a consent form outlining the objectives of the research and any experimental risks.

2. Methods

1) Sleep Study

For each subject a sleep study was performed for a night to screen any major sleep abnormalities with a portable recording system (EdenTraceⅡ Plus Multichannel Recording System, EdenTec Inc, Eden Prairie, Minnesota, U.S.A.). The system is a six-channel digital recording device for monitoring heart rate, recordings of nasal airflow, snoring sounds, oxygen saturation, thoracic movement, and body position. The heart rate is monitored through a two-lead ECG. Snoring sounds are monitored through an electric subminiature microphone that is taped above the larynx. Oxygen saturation is measured with a flex finger probe. The body position sensor, thoracic movement is placed on the lower part of the sternum of the subject.

2) Fabrication of protrusive bite block

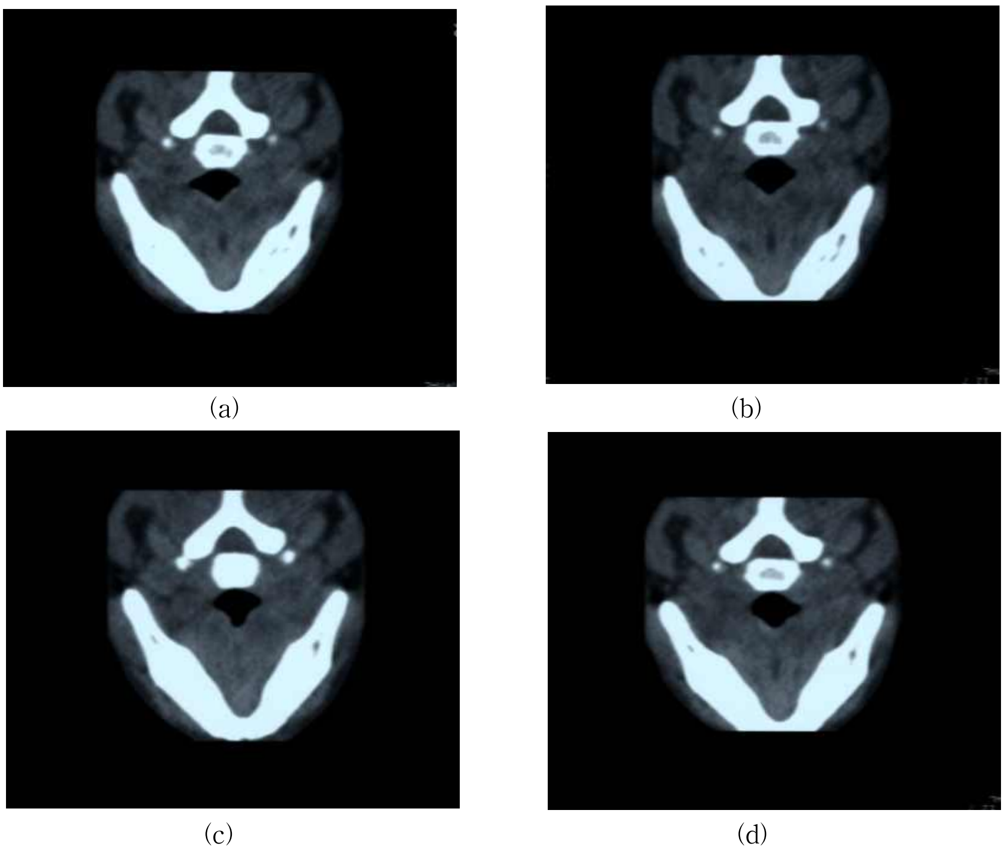
Two protrusive bite blocks were made with putty type-vinyl polysiloxane impression material (Exaflex®, GC america inc, Alsip, Illinois, USA) and bilaterally positioned on canine and premolar area with incisors area opened, to permit oral air flow. They repositioned the mandible more forward by 4 to 6 mm than centric occlusion position and opened by 3 mm at central incisor. The protrusive distance (4 to 6 mm) corresponds to about 60 to 75% of maximum protrusion in each subjects.

3) EBT study

The Electron Beam Tomography (Ultrafast CT® Imatron C-150, San Francisco, U.S.A.) was used to study the dynamic changes in the upper airway while the patient was awake and in sleep, with the mandible in resting position and in protruded position.

EBT was performed in the head neutral, supine position. Head position was carefully aligned without a pillow except one subject. The subject was relatively obese (BMI 29), so needed a pillow to prevent his head bent backward. After scanning lateral view to determine the level of the hard palate, axial views were then scanned with 7-mm thickness from the level of hard palate (Level 1) to the hypopharynx. Each series of multilevel scans may be repeated at 0.4-sec intervals. In this study, a series of 20 scans at 5 to 6 levels according to the length of oropharynx were obtained, resulting in 120 to 160 scans for each observation period. The images of each level were reconstructed in "time mode" for dynamic viewing. After the awake-resting sequences were obtained, the awake-protrusive sequences were then obtained with bite blocks inserted.

After the initial awake sequences at resting and protrusive position were completed, sleep was induced by intravenous injection of 5㎎ of benzodiazepine (Dormicum®, Roche Ltd, Basel, Switzerland) through pre-positioned intravenous route. While the patient was sleeping, the sleep-protrusive sequences were obtained with the bite block inserted and then the sleep-resting sequences were obtained with the bite block removed. For recovery of the subject from sleeping, 5㎎ of imidazobenzodiazepine(Anexate®, Roche Ltd, Basel, Switzerland) was injected.



(a) (b) (c) (d)

Fig. 1. Cross-sectional EBT images of upper airway at the same level in subject 9, obtained in resting position under awake state (a), in protrusive position under awake state (b), in protrusive position under sleep state (c), in resting position under sleep state (d).

The cross-sectional area of the airway was measured with an automatic tracing device available on the physician's console of EBT that joins adjacent pixels of equal densities and computes surface area from the image(Fig. 1-a, b, c, d). We used window width of 400 HU and median level of 40 HU, respectively, for airway cross-sectional area measurements. The maximum and minimum cross-sectional areas (CSAmax and CSAmin) at each airway level during tidal ventilation were measured, and for assessment of the regional oropharyngeal collapsibility, the Collapsibility Index (CI) for each level of cross-section was computed as the following formula;

Collapsibility Index
= (CSAmax - CSAmin) × 100 / CSAmax

The value means percent reductions in airway size during tidal ventilation. The upper airway was divided into three regions: the high upper airway including the upper two segments, middle upper airway including the two midmost segments, and the lower upper airway including the lower one or two segments.

The data were analyzed using the SAS 6.12 program. Wilcoxon's signed rank tests were performed to compare differences between each conditions, awake and sleep state, resting and protrusive position of mandible for the minimum cross-sectional areas and the collapsibiliy indices at each level of the oropharynx. Differences of the average minimum cross-sectional areas and those of the average collapsibility indices among the upper, middle, and lower oropharynx were assessed by the repeated measures ANOVA.

The 0.05 level of confidence was selected as indicating statistical significance.

Ⅲ. RESULTS

Table 1 illustrates the age and other physical characteristics of the 9 subjects. Their mean age was 24.2 years with a range of 24-26 years. Their mean body mass index was 23.2 kg/m^2 with a range of 20.4-29.0 kg/m^2. Their mean neck circumference was 37.4 cm with a range of 34.6-41.6 cm. All subjects were diagnosis as absence of OSA or snoring, with a mean respiratory disturbance index(RDI) 2.8 (range 0.2-6.7).

To determine the difference between three regions for the average minimum cross-sectional areas and collapsibility indices at each conditions-protrusion of mandible and sleeping, the repeated measures ANOVA was performed but the results showed that none of the differences were significant.

Table 2 show the difference between awake and sleep states in the resting position of mandible for average minimum cross-sectional areas and collapsibility indices, The significant difference was observed in the average minimum cross-sectional area at the lower region.

Table 3 show the difference between resting and protrusive position of mandible for the average minimum cross-sectional areas and collapsibility indices in awake state. The significant difference was observed in the average minimum cross-

Table 1. Age and other physical characteristics(mean±SD)

	Mean±SD	Minimum	Maximum
Age (year)	24.2±0.7	24	26
Respiratory disturbance index	2.8±2.2	0.2	6.7
Body Mass Index(kg/m^2)	23.2±2.6	20.7	29.0
Neck circumference(cm)	37.4±2.2	34.6	41.6

Table 2. The regional average CSAmin(mm^2) and CI in awake and sleep states in the resting position of mandible

		awake state	sleep state
upper	CSAmin	285.90±82.96	241.71±91.90
	CI	14.63±9.67	20.07±10.56
middle	CSAmin	254.08±93.30	140.86±104.37
	CI	12.73±7.48	35.06±25.99
lower	CSAmin	319.14±92.46	187.09±142.34 *
	CI	9.66±7.75	36.68±26.47

* : $p < 0.05$

Table 3. The regional average CSA(mm^2) and CI(%) in resting and protrusive position of mandible during awake state

		resting position	protrusive position
upper	CSAmin	285.90±82.96	356.02±106.12
	CI	14.63±9.67	9.40±7.75
middle	CSAmin	254.08±93.30	287.24±128.01 **
	CI	12.73±7.48	8.25±7.68
lower	CSAmin	319.14±92.46	386.11±136.47
	CI	9.66±7.75	10.06±7.04

** : $p < 0.01$

Table 4. The regional average CSA(mm^2) and CI(%) in resting and protrusive position of mandible during sleep state

		resting position	protrusive position
upper	CSAmin	241.71±91.90	290.72±83.52
	CI	20.07±10.56	16.60±13.03
middle	CSAmin	140.86±104.37	226.42±121.94
	CI	35.06±25.99	13.43±13.98
lower	CSAmin	187.09±142.34	280.91±120.05
	CI	36.68±26.47	13.61±6.32 [a]

a : $p = 0.0695$

Table 5. the rate of reduction in CSA by sleeping, at the resting mandibular position

subjects No.	the rate of reduction of CSA(%)		
	upper	middle	lower
1	8.6	45.1	72.0
2	32.6	33.1	18.6
3	-24.9	82.1	70.8
4	48.8	62.7	56.7
5	25.8	45.5	32.2
6	-32.4	-8.0	-59.2
7	-5.5	83.1	92.1
8	48.6	57.2	55.3
9	21.1	37.0	51.7
In each levels, the number of subjects with the maximum reduction rate	0	6	3

Table 6. the rate of increase in CSA by protrusion, in sleep state

subjects No.	the rate of increase of CSA(%)		
	upper	middle	lower
1	-10.0	183.6	383.7
2	41.9	68.5	28.2
3	-1.3	217.5	158.9
4	50.4	25.4	31.5
5	35.6	40.6	-4.3
6	-9.4	-1.1	1.0
7	17.9	588.7	1468.0
8	64.0*	64.0	-7.0
9	46.2	28.6	42.6
In each levels, the number of subjects with the maximum increase rate	3	3	3

* In subject 8, the rate of increase of CSA at upper level is larger than middle by 0.03%

sectional area at the middle region. Table 4 show the difference between resting and protrusive position of mandible for the minimum cross-sectional areas and collapsibility indices in sleeping state. None of the difference were significant. but some difference(p=0.0695) was observed in collapsibility indices at the lower region.

Table 5 shows the rate of reduction in CSA by sleeping, at the resting mandibular position. It show that middle and low region was more frequently reduced with the larger rate. Table 6 show the rate of increase in CSA by protrusion, in sleep state. It show that regions with the maximum increase rate varied widely individually.

Ⅳ. DISCUSSION

Until recently, many different therapeutic strategies for OSA and their indications have been introduced. But the suggested indications have the essential limitation that based mainly on the severity of OSA, not the anatomic consideration including dynamic changes in upper airway[15]. Moreover, the many previous studies for anatomic consideration have some limitation that the images of upper airway was taken under awake state not sleep state, or in upright position not supine position, with representation of merely static images not dynamic images. We recognize that the many previous images gained by cephalogram, conventional CT, MRI, fluoroscopy may be the poor representation for the real events during sleep. Therefore we performed examination with dynamic images gained by EBT, under the drug-induced sleep state in the supine position. Like other examinations during drug-induced sleep, benzodiazepine was used for sleep induction[16,17]. However, a study has shown that benzodiazepines could induce suppression of respiration and aggravation of SAS[18]. Benzodiazepine may have some effects on the results in this study. Therefore other drugs which have the weaker muscle-relaxing effect should be used in the further studies.

For the obstruction or stenosis site in upper airway during sleep, it has been suggested that upper airway anatomy varies considerably among OSA patients so that no single finding is pathognomonic of obstructive apnea. But narrowing of the upper airway is commonly observed at the level of the soft palate and the base of the tongue[19,20]. In this study, the significant difference between awake and sleep states was observed in the average minimum cross-sectional area at the low region. Because high region could be approximately matched to the level of the soft palate and low region to the base of the tongue, this finding suggests that the airway at level of the base of the tongue is more susceptible to narrow during sleep.

For the regional effects by protrusion of mandible, Bennett et al.[4] have assumed that the mandibular advancement devices exert their effects predominantly in the oropharynx and hypopharynx, rather than the velopharynx. To the contrary, Ryan et al.[21] using endoscopy reported that a mandibular advancement device increases the cross sectional area of upper airway during wakefulness, particularly in the velopharynx. But this study have the defect that the endoscopy was performed during awake. Isono et al.[22] using endoscopy under general anesthesis, which suppressed active neuromuscular factors, reported that advancement of the mandible widened the retropalatal airway as well as that at the base of the tongue. In the present study, some differences for CI between resting and protrusive position of mandible was found at the low region though at not significant but border-line level. The Collapsibility Index means percent reduction of airway cross-sectional area. Therefore this finding suggests that protrusion of mandible may be more effective on collapsible tendency at the level of the base of the tongue which airway is more susceptible to narrowing during sleep. Futhermore, the protrusion of mandible may stabilize the upper airway, particularly at the base of tongue, and reduce its tendency to obstruct during sleep. These opinions are supported by previous many investigators, who suggested that the mechanism of the action of mandible advancement is the forward displacement of the base of the tongue where upper airway closure was thought to occur primarily[5,7,23].

For the regional effects by uvulopalatopharyngoplasty(UPPP), contrary to mandibular advancement device, previous many investigators reported that UPPP produced maximal increases in cross-sectional area conversely at the velopharynx

[24]. As above, major effective sites of mandibular advancement oral appliance and uvulopalatopharyngoplasty (UPPP), which are two major treatment method except CPAP, may be considerably different.

Because the dynamic change of upper airway varied widely individually and the effects of mandibular advancement device also did, we suggest that it is necessary to evaluate for the dynamic change such as obstructive or narrowing site and intensity during sleep and to predict for the effectiveness of appliance by using easily fabricated bite block, prior to the choice of treatment method. Unless the suggested dynamic studies could or should be performed, the reversible treatment method including mandibular advancement device should be preferentially considered.

In summary, though we cannot predict with a significant degree of accuracy for potential success of mandibular advancement device because of small subject and large variability, we can find that oropharynx at the base of tongue may be the potential site among the expected obstructive sites during sleep and the more effective site for applying oral appliance. We also guess that further studies are needed to clarify the precise obstructive sites during sleep and effective site by mandibular advancement oral appliance.

REFERENCES

1. Koskenvuo, M., Kaprio, G., Partinen, M. et al. : Snoring as a risk for hypertension and angina pectoris. Lancet., 2 : 893-896, 1985.
2. Partinen, M., Palomaki, H. : Snoring and cerebral infarction. Lancet., 2 : 1325-1326, 1985.
3. Gislason, T., Benediktsdottir, B., Bjornsson, J.K. et al. : Snoring, hypertension and the sleep apnea syndrome: an epidermiologic survey of middle-aged women. Chest., 103 : 1147-1151, 1993.
4. Bennett, L.S., Davies, R.J., Stradling, J.R. : Oral appliances for the management of snoring and obstructive sleep apnea. Thorax., 53(Suppl 2) : 58-64, 1998.
5. Clark, G.T, Arand, D., Chung, E., Tong, D. : Effect of anterior mandibular positioning on obstructive sleep apnea. Am Rev Respir Dis., 147 : 624-629, 1993.
6. Low, A.A. : How does airway lend itself to therapy? Can we predict the success of dental appliance therapy for the treatment of obstructive sleep apnea based on anatomic considerations? Sleep., 16 : S93-S95, 1993.
7. Schmidt-Nowara, W.W., Meade, T.E., Hays, M.B. : Treatment of snoring and obstructive sleep apnea with a dental orthosis. Chest., 99 : 1378-1385, 1991.
8. Eveloff, S.E., Rosenberg, C.L., Carlisle, C.C., Millman, R.P. : Efficacy of a Herbst mandibular advancement device in obstructive apnea. Am J Respir Crit Care Med., 149 : 905-909, 1994.
9. Battagel, J.M., Johal, A., L'Estrange, P.R., Croft, C.B., Kotecha, B. : Changes in airway and hyoid position in response to mandibular protrusion in subjects with obstructive sleep apnoea(OSA). Eur J Orthod., 21 : 363-376, 1999.
10. L'Estrange, P.R., Battagel, J.M., Harkness, B. et al. : A method of studying adaptive changes of the oropharynx to variation in mandibular position in patients with obstructive sleep apnoea. J Oral Rehabil., 23 : 699-711, 1996.
11. Lowe, A., Fleetham, J., Ryan, F., Mathews, B. : Effect of a mandibular repositioning appliance used in the treatment of obstructive sleep apnea on tongue muscle activity. In Issa, F.G., Suratt, P.M., Remmers, J.E. (eds.) Sleep and respiration, New York, 1990, Wiley-Liss, Inc., pp 395-405.
12. Smith, S.D. : A three-dimensional airway assessment for the treatment of snoring and/or sleep apnea with jaw repositioning intraoral appliance: A case study. Cranio., 14 : 332-343, 1996.
13. Ell, S.R., Jolles, H., Galvin, J.R. : Cine CT demonstration of nonfixed upper airway obstruction. AJR., 146 : 669-677, 1986.
14. Stein, M.G., Gamsu, G., de Geer, G. et al. : Cine CT in obstructive sleep apnea. AJR., 148 : 1069-1074, 1987.
15. American Sleep Disorders Association Report: Practice parameters for the treatment of snoring and obstructive sleep apnea with oral appliances. Sleep., 18 : 511-513, 1995.
16. Morrison, D.L., Launois, S.H., Isono, S. et al : Pharyngeal narrowing and closing pressure in patients with obstructive sleep apnea. Am Rev Respir Dis., 148 :606-611, 1993.
17. Croft, C.B., Pringle, M. : Sleep nasendoscopy:a technique of assessment in snoring and obstructive

sleep apnea. Clin Otolaryngol., 16 : 504-509, 1991.

18. Dolly, F.R., Block, A.J. : Effect of flurazepam on sleep disordered breathing and nocturnal oxygen desaturation in asymptomatic subjects subjects. Am J Med., 73 : 239-43, 1982.
19. Suratt, P.M., Dee, P., Atkinson, R.L., Armstrong, P., Wihol, S.C. : Fluoroscopic and computerized tomographic features of the pharyngeal airway in obstructive sleep apnea. Am Rev Respir Dis., 127 : 487-492, 1983.
20. Haponik, E.F., Smith, P.L., Bohlman, M.E. et al. : Computerized tomography in obstructive sleep apnea-correlation of airway size during sleep and wakefulness. Am Rev Respir Dis., 127 : 221-226, 1983.
21. Ryan, C.F., Love, L.L., Peat, D., Fleetham, J.A., Lowe, A.A. : Mandibular advancement oral appliance therapy for obstructive sleep apnoea: effect on awake calibre of the velopharynx. Thorax., 54 : 972-977, 1999.
22. Isono, S., Tanaka, A., Sho, Y., Konno, A., Nishino, T. : Advancement of the mandible improves velopharyngeal airway patency. J Appl Physiol ., 79 : 2132-2138, 1995.
23. Nakazawa, Y., Sakamoto, T., Sasutake, R. et al. : Treatment of sleep apnea with prosthetic mandibular advancement(PMA). Sleep., 15 : 499-504, 1992.
24. Shepard, J.W., Thawley, S.E. : Evaluation of the upper airway by computerized tomography in patients undergoing uvulopalatopharyngoplasty for obstructive sleep apnea. Am Rev Respir Dis., 140 : 711-716, 1989.

국문초록

하악의 전방이동이 구인두 내경의 동적 변화에 미치는 영향

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정재광 · 허윤경 · 최재갑

저자는 상기도부의 동적변화를 관찰하여 수면시의 협착부위와 그 정도를 확인하며, 하악의 전방이동이 상기도부에 미치는 영향과 부위를 조사하고자 하였으며 총 9명의 건강한 피험자를 대상으로 임상적 검사, 방사선학적 검사 및 간이수면다원검사를 실시하여 코골이 및 수면무호흡증 등의 수면장애가 없음을 확인한다. 각성시 및 수면시, 하악의 안정위 및 전방이동시에서 각각 전자선 단층촬영(EBT)을 시행하여 각 조건하의 구인두의 부위별 최대 최소 단면적 및 허탈지수를 구하였다. 이때 수면의 유도를 위해 Dormicum®을 정맥투여하였다. 그 결과, 각 조건에 따라 비교하였을때 수면 및 하악 전돌에 따른 상부, 중간부, 하부 상기도간의 최소 단면적 및 허탈지수의 유의한 차이는 없었다. 반면 하악 안정위에서 각성 및 수면상태간의 비교시에 구인두의 하부에서 단면적의 유의성 있는 차이가 관찰되었다. 한편, 각성상태에서 하악 안정시와 전돌시간의 비교시에는 중간부에서 단면적의 유의성 있는 차이과 관찰되며 수면상태에서는 하악 안정시와 전돌시 단면적의 변화율을 나타내는 허탈지수에 있어 유의한 차이는 없었다.

주제어 : 건강한 피험자, 상기도부의 동적변화, 전자선 단층촬영, 하악의 전방이동