Prevalence of obstructive sleep apnea in male patients with surgically treated maxillary and zygomatic fractures

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Background: Midface fractures can cause airway obstruction and breathing disturbances. The purpose of the present study was to determine the prevalence of undiagnosed obstructive sleep apnea (OSA) among patients with surgically treated maxillary and zygomatic fractures.

Methods: We retrospectively analyzed the medical records of 44 patients who had undergone surgical treatment of maxillary or zygomatic fractures between Jan. 1, 2003, and Dec. 31, 2013 at a single centre. All participants underwent polygraphy testing and were asked to complete the STOP (snoring, tiredness, observed apnea and high blood pressure) questionnaire, Nasal Obstruction Symptom Evaluation (NOSE) scale and Epworth Sleepiness Scale.

Results: There were 27 participants (61%) with maxillary fracture and 17 (39%) with zygomatic fracture. Obstructive sleep apnea was diagnosed in 24 (54%) of the 44 participants, of whom 15 (62%) had maxillary fractures and 9 (38%) had zygomatic fractures. Participants with OSA had a mean Apnea–Hypopnea Index (AHI) of 15.5 (standard deviation [SD] 9.7) events/h, compared to 2.4 (SD 1.5) events/h for those without OSA ($p < 0.001$). Of the 30 participants with nose obstruction, 18 (60%) had an AHI of 5 or greater.

Conclusion: The results suggest that the prevalence of OSA was higher in surgical patients with midface fractures, independent of the type of fracture, than in the general population. The NOSE scale results showed significant correlation with the presence of OSA.

Contexte : Les fractures affectant la portion médiane du visage peuvent provoquer une obstruction des voies respiratoires et gêner la respiration. La présente étude avait pour but de déterminer la prévalence de l'apnée obstructive du sommeil (AOS) non diagnostiquée chez des patients ayant été traités chirurgicalement pour des fractures du maxillaire et de l'os zygomatique.

Méthodes : Nous avons analysé rétrospectivement les dossiers médicaux de 44 patients ayant subi un traitement chirurgical pour une fracture du maxillaire ou de l'os zygomatique entre le 1er janvier 2003 et le 31 décembre 2013 dans un seul établissement. Tous les participants ont subi un test polygraphique et ont été invités à répondre aux questionnaires STOP (snoring, tiredness, observed apnea et high blood pressure), NOSE (Nasal Obstruction Symptom Evaluation), de même qu'à l'échelle de somnolence d'Epworth.

Résultats : Vingt-sept participants (61 %) avaient subi une fracture du maxillaire et 17 (39 %) de l'os zygomatique. L'AOS a été diagnostiquée chez 24 participants sur 44 (54 %), dont 15 (62 %) avaient subi une fracture du maxillaire et 9 (38 %) une fracture de l'os zygomatique. Les participants qui présentaient une AOS avaient un indice d'apnée-hypopnée (IAH) moyen de 15,5 (écart-type [É.-T.] 9,7) événements/h, contre 2,4 (É.-T. 1,5) événement/h pour les participants indemnes d'ASO ($p < 0,001$). Parmi les 30 participants qui avaient une obstruction nasale, 18 (60 %) avaient un IAH de 5 ou plus.

Conclusion : Ces résultats donnent à penser que la prévalence de l'AOS était plus élevée chez les patients opérés pour une fracture affectant la portion médiane du visage (indépendamment du type de fracture) que dans la population générale. Les résultats au questionnaire NOSE ont montré une corrélation significative avec la présence d'AOS.

Maxillofacial fractures may result from a variety of injury types. The diagnosis and treatment of these injuries frequently require a multidisciplinary team approach. Zygomatic fractures are the second most common facial fractures, after nasal fractures.[1] Mandibular and zygomatic bone fractures account for 80% of all facial bone fractures, and maxillary fractures account for 5%.[1] The outcomes of maxillofacial trauma are of great significance, both functionally and aesthetically.[1,2] The best aesthetic and functional outcomes are obtained with early rigid fixation with screws and plates.[2,3] Functionally, skeletal factors, which are usually not readily apparent on physical examination, may be important determinants of upper-airway patency during wakefulness but also during sleep.[4,5]

Among sleep-related breathing disorders, according to studies in the general population,[6] obstructive sleep apnea (OSA) has emerged as a highly prevalent breathing disorder, affecting 3%–7% of adult men and 2%–5% of adult women.[7] Obstructive sleep apnea arises from a combination of pathophysiological and anatomic factors, resulting in narrowing of the upper airway. The exact levels of obstruction may vary from one person to another. Invasive and noninvasive methods can be used to identify and evaluate the level of obstruction, but some (e.g., magnetic resonance imaging and fibroscopy) are too expensive and too invasive to be used in field surveys. Therefore, the classical sleep questionnaires, anthropometric measurements and simple nose–throat examinations, which are readily accepted by patients, are useful for the identification of those at increased risk for OSA.[8]

Patients who have undergone surgical treatment of maxillary or zygomatic fractures may have upper airway abnormalities related to the fracture and to the surgical procedure. Regular screening for OSA in these patients by means of standard questionnaires such as the STOP (snoring, tiredness, observed apnea and high blood pressure) questionnaire, the STOP-Bang questionnaire and the recently developed Nasal Obstruction Symptom Evaluation (NOSE) scale[9–12] may be of additional value. The aim of the present study was to determine the prevalence of undiagnosed OSA among patients with surgically treated maxillary and zygomatic fractures. Also, we wanted to explore whether clinical data and NOSE scale scores can be used to identify those at increased risk for OSA in this population.

Methods

Setting and participants

In this retrospective cohort study, we reviewed the medical records of male patients aged 18 years or more who had undergone surgical treatment of maxillary or zygomatic fractures between Jan. 1, 2003, and Dec. 31, 2013, at the Department of Maxillofacial and Oral Surgery, University Hospital Center Split, Split, Croatia. Surgical treatment consisted of open reduction and rigid plate and screw fixation. We considered the healing process to be complete 6 months postoperatively. Maxillary fractures were classified according to Le Fort patterns. Dentoalveolar fractures of the upper jaw were excluded. Zygomatic fractures were defined as zygomatic complex fractures (zygomaticomaxillary fractures). Patients with isolated fractures of the zygomatic arch were excluded. Other exclusion criteria included postoperative malocclusion (less than ideal bone reposition achieved) and eventual rhinoseptoplasty after the initial surgical treatment. Patients who had concomitant neurosurgical trauma were also excluded.

Patients who met the diagnostic and treatment criteria were contacted by letter or telephone, and those willing to participate were recruited for the study.

This study was approved by the Ethics Committee of the University of Split School of Medicine and the University Hospital Center Split and was undertaken in agreement with the principles of the Declaration of Helsinki. All participants signed written informed consent before participation.

Sleep assessment

All participants underwent unattended whole-night polygraphy testing. The device used in this study to identify participants with OSA was the Embletta portable diagnostic system (Medcare). This system is highly sensitive and specific in quantifying the Apnea–Hypopnea Index (AHI) and has been validated as a screening and diagnostic tool for OSA.[13] We defined apnea as complete cessation of respiratory airflow for a minimum of 10 seconds and hypopnea as a decrease in airflow by more than 50% from baseline for at least 10 seconds, combined with a reduction in hemoglobin oxygen saturation of at least 3%.[14–16] We defined the AHI as the average number of apneic and hypopneic events per hour of sleep, and we calculated the oxygen desaturation index as the number of decreases in arterial oxygen saturation of 3% or more per hour of sleep.[14–16] We used the AHI to quantify the severity of OSA as follows: AHI 5–14.9: mild OSA; $15 \leq \text{AHI} \leq 30$: moderate OSA; and AHI > 30: severe OSA.

All data were manually scored and evaluated in accordance with published guidelines of the American Academy of Sleep Medicine and the European Sleep Research Society[14–16] by the same certified sleep physician, who was blind to the participants' involvement in the study. The data were analyzed if the total recorded time was 4 hours or longer.

Questionnaires

Demographic and anthropometric characteristics (e.g., age, body mass index, neck circumference) were

collected at the Split Sleep Medicine Center before the whole-night sleep assessment. Participants were asked to complete the STOP questionnaire, NOSE scale and Epworth Sleepiness Scale (ESS). The STOP questionnaire is 4-item self-reported questionnaire that has been shown to be a concise, easy-to-use screening tool for identifying patients who are at increased risk for OSA (≥ 2 positive answers).[9] The NOSE scale is a validated disease-specific instrument designed to measure nasal obstruction, commonly used in otolaryngology practice to provide an objective measure of nasal obstruction.[10,12] It consists of 5 self-rated items, each scored from 0 to 4.[10] The NOSE scale score represents the sum of the scores for the responses to the 5 individual items and ranges from 0 (no nasal obstruction) to 100 (worst possible problems caused by nasal obstruction).[10] The ESS is a self-administered questionnaire used to evaluate the level of daytime sleepiness.[17] Patients are asked to rate their chance of falling asleep during 8 routine daytime situations on a scale of 0–3. The final score is the total score for the 8 items and ranges from 0 to 24, with the cut-off value of 9 suggesting the presence of excessive daytime sleepiness.[18]

The Croatian versions of the STOP questionnaire and ESS have been validated.[18]

Statistical analysis

We performed statistical analyses using MedCalc for Windows version 11.5.1.0 (MedCalc Software). Continuous data were presented as mean and standard deviation (SD), and categorical variables were presented as whole numbers and proportions. We determined differences in variables between groups using the Mann–Whitney test for independent samples and the χ^2 test. We evaluated correlations between study variables and AHI using Spearman's rank correlation coefficients. Statistical significance was set at $p < 0.05$.

Results

The study population consisted of 44 participants, 27 (61%) with maxillary fractures and 17 (39%) with zygomatic complex fractures. None of the participants had malocclusion or rhinoseptoplasty in the postoperative period. Of the 27 participants with maxillary fractures, 8 had Le Fort I fractures, 8 had Le Fort II fractures, 4 had Le Fort III fractures, and 7 had a combination of 2 different patterns. The baseline demographic and anthropometric characteristics of the participants are presented in Table 1. There were no statistically significant differences between those with maxillary fractures and those with zygomatic complex fractures.

All participants had at least 4 hours of recorded time on polygraphy testing. The sleep characteristics of the participants are presented in Table 2. There were no statistically significant differences between those with maxillary fractures and those with zygomatic fractures. In addition, the questionnaire scores did not differ significantly between the 2 groups (Table 3). Therefore, we decided to unify the 2 groups of participants into 1 group for further analyses.

Obstructive sleep apnea was diagnosed in 24 participants (54%). There were 14 participants (32%) with mild OSA, 7 (16%) with moderate OSA and 3 (7%) with severe OSA. Of the 24, 15 (62%) had maxillary fractures and 9 (38%) had zygomatic fractures. The participants with OSA differed significantly from those without OSA in mean age (49.0 [SD 15.4] yr v. 33.3 [SD 15.1] yr, $p = 0.001$) and all sleep characteristics (Table 4). The participants with OSA had a mean AHI of 15.5 (SD 9.7) events/h, compared to 2.4 (SD 1.5) events/h for those without OSA ($p < 0.001$). The corresponding oxygen desaturation index values were 11.6 (SD 8.9) events/h and 1.9 (SD 1.2) events/h ($p = 0.002$).

Table 1. Baseline demographic and anthropometric characteristics of participants with maxillary or zygomatic complex fractures

Characteristic	Group; mean ± SD		*p* value
	Maxillary *n* = 27	Zygomatic *n* = 17	
Age, yr	41.8 ± 17.5	41.9 ± 17.1	0.95
Height, cm	184.0 ± 7.0	182.0 ± 6.0	0.3
Weight, kg	85.5 ± 8.9	85.0 ± 12.8	0.7
Body mass index	25.2 ± 3.9	25.9 ± 2.1	0.3
Neck circumference, cm	39.5 ± 3.3	39.4 ± 2.2	0.7

SD = standard deviation.

Table 2. Sleep characteristics of the 2 groups

Characteristic	Group; mean ± SD		*p* value
	Maxillary	Zygomatic	
Apnea–Hypopnea Index (events/h)	10.8 ± 11.2	7.6 ± 6.6	0.8
Arterial oxygen saturation, %	95.3 ± 2.0	95.6 ± 1.3	0.9
Minimum arterial oxygen saturation, %	88.2 ± 6.1	89.1 ± 4.4	0.9
Oxygen desaturation index, %	9.2 ± 9.2	3.2 ± 1.8	0.2
Snoring time, min	261.2 ± 99.8	193.6 ± 58.9	0.2

SD = standard deviation.

Table 3. Questionnaire results for the 2 groups

Questionnaire	Maxillary	Zygomatic	*p* value
Positive result† on STOP questionnaire, no. (%)	5 (18)	4 (24)	0.7*
Epworth Sleepiness Scale score, mean ± SD	4.3 ± 3.8	5.4 ± 3.2	0.2
NOSE scale score, mean ± SD	17.8 ± 21.9	29.1 ± 28.8	0.3

NOSE = Nasal Obstruction Symptom Evaluation; SD = standard deviation; STOP = snoring, tiredness, observed apnea, high blood pressure.
*χ^2 test (positive v. negative result).
†Two or more positive answers.

Table 4. Comparison between participants with and without obstructive sleep apnea

Variable	Group; mean ± SD* OSA *n* = 24	No OSA *n* = 20	*p* value
Age, yr	49.0 ± 15.4	33.3 ± 15.1	0.001
Body mass index	26.2 ± 3.8	23.2 ± 2.9	0.09
Positive result on STOP questionnaire, no. (%)	8 (33)	1 (5)	0.05†
Epworth Sleepiness Scale score	5.4 ± 3.9	3.9 ± 3.1	0.2
NOSE scale score	29.2 ± 28.5	13.8 ± 17.6	0.04
Apnea–Hypopnea Index (events/h)	15.5 ± 9.7	2.4 ± 1.5	< 0.001
Oxygen desaturation index, %	11.6 ± 8.9	1.9 ± 1.2	0.002
Arterial oxygen saturation, %	94.9 ± 2.0	96.0 ± 1.2	0.04
Minimum arterial oxygen saturation, %	86.3 ± 6.0	91.1 ± 3.2	0.003

NOSE = Nasal Obstruction Symptom Evaluation; OSA = obstructive sleep apnea; SD = standard deviation; STOP = snoring, tiredness, observed apnea, high blood pressure.
*Except where noted otherwise.
†χ^2 test (positive v. negative result).

Table 5. Nasal Obstruction Symptom Evaluation scale scores of participants with and without obstructive sleep apnea

Score	Group; no. (%) of participants OSA	No OSA	*p* value
0 (no obstruction)	6 (25)	8 (40)	0.3*
1–25 (mild obstruction)	8 (33)	8 (40)	
26–50 (moderate obstruction)	3 (12)	2 (10)	
> 50 (serious obstruction)	7 (29)	2 (10)	

OSA = obstructive sleep apnea.
*χ^2 test (obstruction v. no obstruction).

Table 6. Correlations between study variables and the Apnea–Hypopnea Index in the overall study population

Variable	Spearman's coefficient ρ	*p* value
Age	0.554	< 0.001
Body mass index	0.297	0.06
STOP questionnaire score	0.501	0.001
Epworth Sleepiness Scale score	0.146	0.4
NOSE scale score	0.323	0.04

NOSE = Nasal Obstruction Symptom Evaluation; STOP = snoring, tiredness, observed apnea, high blood pressure.

Thirty-five participants (80%) had no risk for OSA, as estimated by the STOP questionnaire (Table 4). Of the 35, 19 did not have OSA according to the sleep study data. According to the STOP questionnaire, 9 participants (20%) had increased risk for OSA, and OSA was confirmed in 8 (89%) of them during polygraphy testing.

The NOSE scale results showed that 30 participants (68%) had nose obstruction and 14 (32%) did not (Table 5). Of the 30 participants with nose obstruction, 18 (60%) had an AHI of 5 or greater. Only 6 (25%) of the 24 participants with OSA had no nose obstruction according to the NOSE scale. Significant correlations were found between the AHI and the NOSE scale score ($r = 0.323$, $p = 0.04$) when we performed analysis on the overall study population (Table 6).

Five of the participants with OSA experienced excessive daytime sleepiness, with a mean ESS score of 11.6 (SD 1.8). Of the 5, 2 had a STOP score of 2 or greater, and 4 had nasal obstruction, estimated by the NOSE scale. Only 1 participant in the non-OSA group had excessive daytime sleepiness according to the ESS score.

Discussion

In this retrospective analysis of the prevalence of OSA, nasal obstruction and daytime sleepiness in a sample of 44 participants with surgically treated maxillary or zygomatic fractures, the prevalence of OSA was higher in our study population than in general population.[7,19,20]

The use of questionnaires as a screening tool for OSA proved to be a valuable, but special attention should be paid when using the STOP questionnaire in specific populations, since in our participants with midface injury it was unable to identify risk in a substantial proportion of those with confirmed OSA. The NOSE scale showed good correlation with the presence of OSA: 75% of participants with OSA reported nose obstruction according to this scale. Nasal obstruction has been identified as a risk factor for OSA and is a common sign in patients with the disorder.[12,21,22]

Obstructive sleep apnea is prevalent in surgical populations and is considered to be an independent risk factor for perioperative complications in noncardiac operations.[23] Surgical patients with OSA are vulnerable to sedation, anesthesia and analgesia. The perioperative risk of patients with OSA may be reduced by appropriate screening to detect undiagnosed OSA and to plan a specific perioperative management plan for those with OSA.[24] Therefore, it is important to identify patients at high risk for OSA preoperatively, which is not always easy. The short interval between the preoperative clinic visit and scheduled surgery date, lack of patient willingness to undergo preoperative polysomnography or polygraphy testing and potentially long wait times for a sleep clinic appointment may hinder the diagnosis of OSA before surgery. By incorporating the STOP or STOP-Bang questionnaire and the NOSE scale into preoperative clinic practice, surgical patients at risk for OSA can be better detected, which can help during their perioperative and postoperative treatment.[25]

The STOP questionnaire has been validated in surgical patients at preoperative clinics.[9] In our study population, the STOP questionnaire proved to have good predictive value to detect participants with OSA: the disorder was confirmed during polygraphy testing in 89% of patients who had a STOP score of 2 or greater.

In the study by Chung and colleagues,[9] the STOP questionnaire administered preoperatively to surgical patients had a sensitivity of 65.6%, 74.3% and 79.5% with AHI cut-off values of greater than 5 events/h, greater than 15 events/h and greater than 30 events/h, respectively. In addition, an earlier study from our group showed a high level of sensitivity and specificity of the STOP questionnaire in patients referred to the Split Sleep Medicine Center.[18] The probability that the STOP questionnaire correctly predicted an AHI greater than 5 events/h was 84%, with a sensitivity of 96% and a specificity of 83% at a cut-off point of 2 events/h for determining the risk of OSA. Our unpublished research on around 4000 participants in the general population residing in the same region as those in the current study showed the risk of OSA to be 15.6% in participants aged 31–40 and 25.8% in those aged 41–50, substantially lower than the proportion of participants with confirmed OSA in the present study, 54% (24/44).

The ESS scores of both participants with OSA and those without OSA in the current study were lower than those in the study by Pecotic and colleagues.[18] This means that people with surgically treated midface injury either experienced less excessive daytime sleepiness or ignored it and reported fewer signs.

Limitations

We did not have any data on nose obstruction, snoring or risk of OSA in our study population before the midface trauma. However, we believe that our results support screening for OSA with the STOP questionnaire, STOP-Bang questionnaire and NOSE scale, as well as use of the ESS for assessing excessive daytime somnolence, in surgical populations to avoid perioperative and postoperative complications. However, caution must be used when interpreting our results owing to possibility of a large proportion of false-negative results in this specific population compared to the general population referred to sleep centres.

Conclusion

The NOSE scale showed significant correlation with the presence of OSA. Therefore, we recommend its use in common otolaryngology and surgical practice. Specific questionnaires such as the STOP questionnaire used in this study may underestimate the risk of OSA in patients with surgically treated midface fractures, and the ESS may underestimate excessive daytime somnolence. In general, we recommend use of all those questionnaires, but special attention should be paid when they are used in specific surgical populations, such as patients with surgically treated midface injuries. Finally, the prevalence of OSA was higher in surgical patients with midface fractures regardless of the type of fracture, maxillary or zygomatic, than in the general population.

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Competing interests: None declared.

Contributors: S. Lupi-Ferandin and Z. Dogas designed the study. S. Lupi-Ferandin, N. Ivkovic and R. Pecotic acquired the data, which S. Lupi-Ferandin, T. Galic, R. Pecotic and Z. Dogas analyzed. S. Lupi-Ferandin, T. Galic, R. Pecotic and Z. Dogas wrote the article, which all authors reviewed and approved for publication.

References

1. Kostakis G, Stathopoulos P, Dais P et al. An epidemiologic analysis of 1,142 maxillofacial fractures and concomitant injuries. *Oral Surg Oral Med Oral Pathol Oral Radiol* 2012;114(5 Suppl):S69-73.
2. Girotto JA, MacKenzie E, Fowler C, et al. Long-term physical impairment and functional outcomes after complex facial fractures. *Plast Reconstr Surg* 2001;108:312-27.
3. Manson PN, Clark N, Robertson B, et al. Subunit principles in midface fractures: the importance of sagittal buttresses, soft-tissue reductions, and sequencing treatment of segmental fractures. *Plast Reconstr Surg* 1999;103:1287-306, quiz 1307.
4. Davies RJ, Stradling JR. The relationship between neck circumference, radiographic pharyngeal anatomy, and the obstructive sleep apnoea syndrome. *Eur Respir J* 1990;3:509-14.
5. Partinen M, Guilleminault C, Quera-Salva MA, et al. Obstructive sleep apnea and cephalometric roentgenograms. The role of anatomic upper airway abnormalities in the definition of abnormal breathing during sleep. *Chest* 1988;93:1199-205.
6. *International Classification of Sleep Disorders*. 3rd ed. Darien (IL): American Academy of Sleep Medicine; 2014.
7. Young T, Palta M, Dempsey J, et al. The occurrence of sleep-disordered breathing among middle-aged adults. *N Engl J Med* 1993; 328:1230-5.
8. Teculescu DB, Montaut-Verient B, Hannhart B, et al. Breathing pauses during sleep: Can a non-invasive ENT examination help identify subjects at risk in epidemiological settings? *Med Hypotheses* 2001;56:653-6.
9. Chung F, Yegneswaran B, Liao P, et al. STOP questionnaire: a tool to screen patients for obstructive sleep apnea. *Anesthesiology* 2008;108: 812-21.
10. Stewart MG, Smith TL, Weaver EM, et al. Outcomes after nasal septoplasty: results from the Nasal Obstruction Septoplasty Effectiveness (NOSE) study. *Otolaryngol Head Neck Surg* 2004;130:283-90.
11. Leitzen KP, Brietzke SE, Lindsay RW. Correlation between nasal anatomy and objective obstructive sleep apnea severity. *Otolaryngol Head Neck Surg* 2014;150:325-31.
12. Ishii L, Godoy A, Ishman SL, et al. The Nasal Obstruction Symptom Evaluation survey as a screening tool for obstructive sleep apnea. *Arch Otolaryngol Head Neck Surg* 2011;137:119-23.
13. Ng SS, Chan TO, To KW, et al. Validation of Embletta portable diagnostic system for identifying patients with suspected obstructive sleep apnoea syndrome (OSAS). *Respirology* 2010;15:336-42.
14. Sleep-related breathing disorders in adults: recommendations for syndrome definition and measurement techniques in clinical research. The Report of an American Academy of Sleep Medicine Task Force. *Sleep* 1999;22:667-89.

15. McNicholas WT. Sleep-related breathing disorders: nosological classification, definitions, epidemiology. In: Bassetti C, Dogas Z, Peigneux P, editors. *Sleep medicine textbook*. Regensburg (Germany): European Sleep Research Society; 2014:215-20.
16. Fischer J, Dogas Z, Bassetti CL, et al. Standard procedures for adults in accredited sleep medicine centres in Europe. *J Sleep Res* 2012;21: 357-68.
17. Johns MW. Daytime sleepiness, snoring, and obstructive sleep apnea. The Epworth Sleepiness Scale. *Chest* 1993;103:30-6.
18. Pecotic R, Dodig IP, Valic M, et al. The evaluation of the Croatian version of the Epworth Sleepiness Scale and STOP questionnaire as screening tools for obstructive sleep apnea syndrome. *Sleep Breath* 2012;16:793-802.
19. Peppard PE, Young T, Barnet JH, et al. Increased prevalence of sleep-disordered breathing in adults. *Am J Epidemiol* 2013;177: 1006-14.
20. Heinzer R, Vat S, Marques-Vidal P, et al. Prevalence of sleep-disordered breathing in the general population: the HypnoLaus study. *Lancet Respir Med* 2015;3:310-8.
21. Young T, Evans L, Finn L, et al. Estimation of the clinically diagnosed proportion of sleep apnea syndrome in middle-aged men and women. *Sleep* 1997;20:705-6.
22. Liistro G, Rombaux P, Belge C, et al. High Mallampati score and nasal obstruction are associated risk factors for obstructive sleep apnoea. *Eur Respir J* 2003;21:248-52.
23. Chung F, Mokhlesi B. Postoperative complications associated with obstructive sleep apnea: time to wake up! *Anesth Analg* 2014; 118:251-3.
24. Chung F, Elsaid H. Screening for obstructive sleep apnea before surgery: Why is it important? *Curr Opin Anaesthesiol* 2009;22:405-11.
25. Nagappa M, Liao P, Wong J, et al. Validation of the STOP-Bang Questionnaire as a screening tool for obstructive sleep apnea among different populations: a systematic review and meta-analysis. *PLoS One* 2015;10:e0143697.

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