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The effect of maxillary-mandibular advancement surgery on two-dimensional cephalometric analysis, polysomnographic and patient-reported outcomes in 32 patients with sleep disordered breathing: A retrospective cohort study

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A R T I C L E I N F O

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A B S T R A C T

This retrospective study evaluated the effect of bimaxillary advancement surgery on pre- and postoperative 2D cephalometric soft- and hard tissue measurements, polysomnography (PSG) and patient-reported snoring scores including Epworth sleepiness scale (ESS) after multidisciplinary treatment planning in 32 patients with obstructive sleep apnea or sleep disordered breathing (OSAS/SDB). Apnea-hypopnea index significantly improved with a mean difference of 18.32 ± 13.97 ($P = 0.004$). ESS, snoring intensity and snoring severity scores all significantly improved after surgery. The preoperative surgical planning was achieved based on 2D pre- and postoperative cephalometric comparison. Most 2D cephalometric measurements did not correlate with postoperative PSG findings. Amount of maxillary and mandibular advancement measured on 2D cephalograms did correlate with postoperative time below 88% oxygen saturation on PSG. In conclusion: bimaxillary advancement surgery has clinically significant favourable results in patients with OSAS/SDB both measured by PSG and with patient-reported outcomes after careful multidisciplinary treatment planning. Current 2D cephalometric airway analysis insufficiently predicted the effect of maxillomandibular advancement surgery in patients with OSAS/SDB.

1. Introduction

Obstructive sleep apnea syndrome (OSAS) and sleep-disordered breathing (SDB) are an increasingly recognized entity with significant morbidity and considerable societal costs. Careful evaluation based on physical examination, polysomnography (PSG) and drug-induced sleep endoscopy (DISE) with Esmarch manoeuvre including multidisciplinary discussion allow for a personalized treatment planning [1]. Patients with a retrognathic profile (skeletal class 2) and a positive effect of the Esmarch manoeuvre during DISE are good candidates for orthognathic surgery. Currently, maxillofacial treatment planning is increasingly based on two and three-dimensional imaging. It is unknown if cephalometric measurements pre- and postoperatively in patients undergoing

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maxillomandibular advancement (MMA) add useful information to predict the outcome in patients with SDB and OSAS. Hence, we hypothesize that changes on cephalometry correlate with positive improvement on postoperative polysomnography. Moreover, we aim to assess the effect of MMA on 2D airway measurements and if the planned surgical advancement is actually achieved. Preoperative snoring severity, intensity, snoring score and Epworth sleepiness scale score (ESS) are compared with postoperative results.

2. Materials & methods

This study has been conducted in accordance with the declaration of Helsinki and Good Clinical Practice. Informed consents were waived due to the retrospective nature of the study. We conducted a retrospective analysis of all patients diagnosed with OSAS or SDB who underwent orthognathic maxillomandibular advancement surgery between 2010 and 2017. All patients were treated by the same maxillofacial surgeon (PV). Patients were assessed pre-operatively during a multidisciplinary meeting with ENT specialists, maxillofacial surgeons, orthodontists and pneumologists. During this meeting, a specific care pathway is followed (Fig. 1). All patients underwent a complete work-up prior to the multidisciplinary meeting including a thorough history and dedicated clinical examination by an ENT specialist, polysomnography interpreted by a pneumologist and drug-induced sleep endoscopy (DISE) with Esmarch manoeuvre performed by an ENT specialist. Based on this initial evaluation, a treatment plan is proposed.

Demographic data were collected as well as data from pre- and postoperative polysomnography (PSG) and 2D cephalometric analysis. Two-dimensional cephalograms were traced determining skeletal and soft tissue landmarks (Fig. 2, Table 1). Specific airway landmarks were measured according to literature and compared pre- and postoperatively. Maxillomandibular advancement was measured by the difference between points AXA, AXB, AXPg (Fig. 2). Data from preoperative surgical planning was collected. Specifically the planned movements, to allow comparison with final achieved advancement measurements. Data from a snoring questionnaire was collected pre- and postoperatively in dutch (Appendix 1). This questionnaire included snoring intensity, snoring severity and a snoring score. Patients were asked to complete the questionnaire together with their bed partner. Additionally the Epworth sleepiness scale was registered.

Statistical analysis was performed using IBM SPSS version 25.0. Patient demographic data were calculated by number of observations, mean, median, standard deviation and range. Categorical variables are described using absolute counts and percentages. A paired Wilcoxon signed rank test was applied to detect differences between sleep tests before and after surgery. For AHI and time saturation under 88%, a one-sided test was performed. Spearman rank correlations and their *P*-value were calculated to model the relation between landmark changes and sleep test parameters. Linear regression was calculated between planned and achieved advancement. The regression coefficients and their variance-covariance matrix were used to test the hypothesis that variables and slope were equal to (0,1) by means of a Mahalanobis test. A paired samples T-test was used to compare the results from the snoring questionnaire pre- and postoperatively. Data are mean ± standard deviation unless otherwise stated. *P*-values lower than 0.05 were considered significant.

3. Results

In total, 32 (26 males, 81%) patients were included with a mean age of 48 years (22–64). Baseline characteristics are summarized in Table 2. The mean snoring time was 83.2 ± 76.1 min. Mean body mass index (BMI) measured 25.8 ± 3.5 preoperatively and 25.2 ± 2.8 postoperatively. Mean preoperative apnea-hypopnea index (AHI) was 17.7 ± 13.3 and arousal index 26.6 ± 19.7. PSG analysis comparing pre (87 ± 41) and postoperative results (121 ± 43) showed a significant increase in the number of sleep stage changes ($P = 0.0497$). Arousal index was significantly lower postoperatively (19.54 ± 3.12, $P = 0.0195$). AHI index significantly improved postoperatively with a mean difference of 18.32 ± 13.97 ($P = 0.004$). No significant differences were found on following measures:

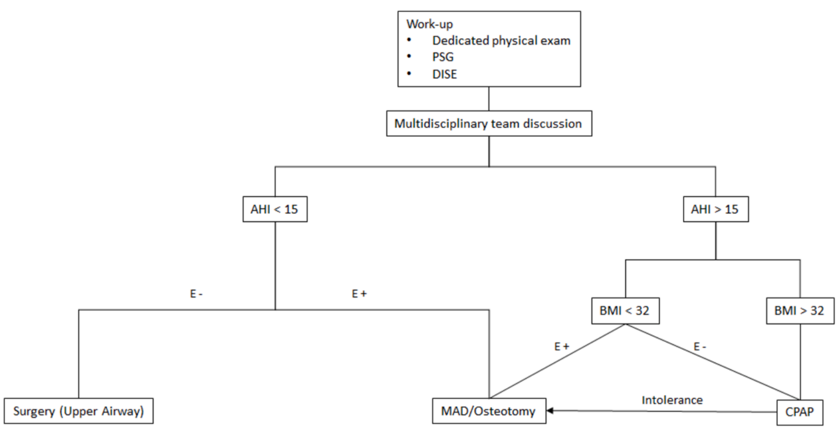

Fig. 1. OSAS/SDB Care pathway. PSG: polysomnography. DISE: drug-induced sleep endoscopy. AHI: apnea-hypopnea index. BMI: body mass index. CPAP: continuous positive airway pressure. MAD: mandibular advancement device. E-: negative Esmarch manoeuvre. E+: positive Esmarch manoeuvre.

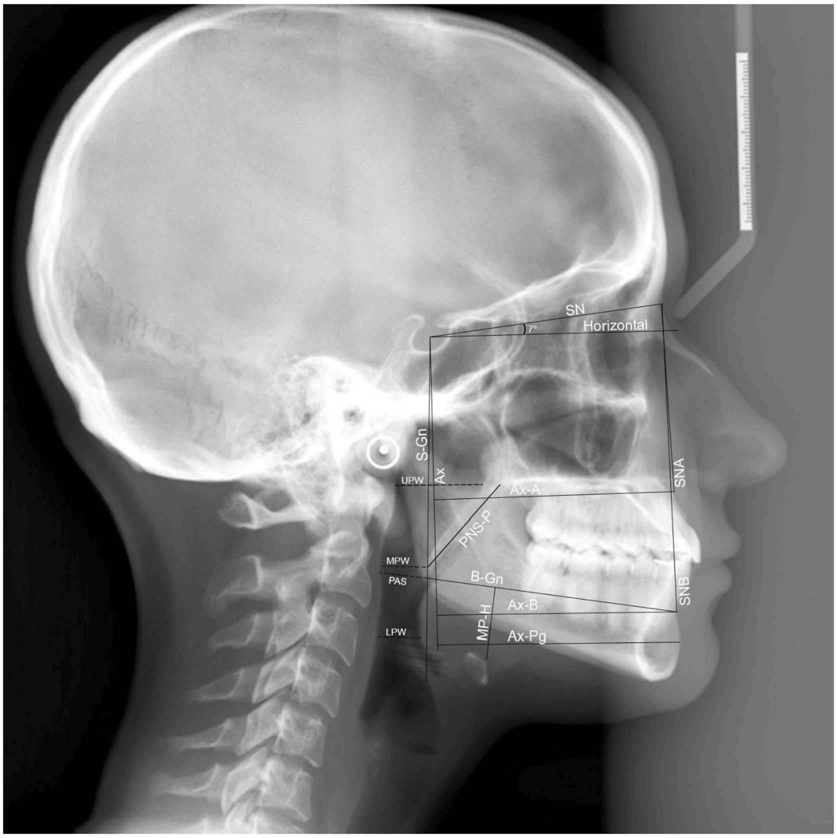

Fig. 2. 2D Cephalometric landmarks. Description of all landmarks are explained in Table 1.

Table 1
Cephalometric soft and hard tissue landmarks traced on twodimensional cephalometry.

Landmark	Description
SNA (°)	Angle formed between the plane constructed from Nasion (N) to Sella (S) and point A
SNB (°)	Angle formed between the plane constructed from Nasion (N) to Sella (S) and point B
ANB (°)	Difference between SNA and SNB angles
AXA (mm)	Distance perpendicular from Ax to point A
AXB (mm)	Distance perpendicular from Ax to point B
AXPg (mm)	Distance perpendicular from Ax to Pogonion (Pg)
SN	Line connecting Sella (S) and Nasion (N)
Horizontal	Constructed by drawing a line 7° clockwise from SN with center in S
Ax	True vertical
	Perpendicular to Horizontal
PNS-P (mm)	Soft palate length
	Linear distance between posterior nasal spine (PNS) and P
B-Gn	Mandibular plane
	Line connecting Point B with Gonion (Gn)
S-Gn	Line connecting Sella (S) and Gonion (Gn)
MP-H (mm)	Line perpendicular to Mandibular plane and most anterior superior point of the hyoid bone
UPW (mm)	Upper pharyngeal wall
	Point of intersection of the line perpendicular to the posterior pharyngeal wall from posterior nasal spine
PAS (mm)	Posterior airway space
	Distance on the mandibular plane from anterior to posterior pharyngeal wall
MPW (mm)	Middle pharyngeal wall
	Intersection of the perpendicular line from the uvula to the posterior pharyngeal wall
LPW (mm)	Lower pharyngeal wall
	Intersection of the perpendicular line from vallecula to the posterior pharyngeal wall

Table 2
Overview of pre-operative parameters in 32 patients with SDB/OSAS undergoing bimaxillary surgery.

(N = 32)	Minimum	Maximum	Mean	Std. Deviation
Age	22	64	47,59	8,66
BMI	18,0	33,20	25,84	3,49
Apnea-Hypopnea Index	1,40	52,60	17,65	13,32
Arousal Index	0,00	77,10	26,62	19,77
Planned Maxillary Advancement	3,00	10,00	5,04	1,37
Planned Mandibular Advancement	7,00	13,00	9,21	1,37
Planned Chin Advancement	5,00	8,00	6,00	1,06

total snoring time (prone/side position), time of oxygen saturation below 88%, mean heart rate during sleep, the total duration of sleep, duration of REM sleep, the total number of arousals.

ESS socres pre-operatively (8.36 ± 4.80) declined postopratively (4.64 ± 2.06) with a statistically significant reduction of 3.71 (95% CI, 1.18 to 6.25), $t(13) = 3.16$, $P = 0.007$ (Table 3). Similarly, we saw a reduction in snoring severity postoperatively (2.15 ± 1.95) compared to preoperatively (5.85 ± 1.52) with a significant difference of 3.69 (95% CI, 1.87 to 5.51), $t(12) = 4.42$, $P = 0.001$. Snoring intensity measured 7.31 ± 2.18) preoperatively and was reduced to 2.46 ± 1.81 postoperatively with a significant reduction of 4.85 (95% CI, 3.27 to 6.42), $t(12) = 6.70$, $P < 0.001$). The snoring score did not significantly differ before and after surgical intervention ($P = 0.687$).

Surgical planning reported a mean maxillary advancement of 5.0 mm ± 1.3 (ranging from 3 mm to 10 mm), mean mandibular advancement of 9.2 mm ± 1.4 (ranging from 7 mm to 13 mm) and mean chin advancement of 6 mm ± 1.1 (ranging from 5 mm to 8 mm). Cephalometric comparison of pre- and postoperative skeletal landmarks showed a mean maxillary advancement 3.2 mm ($s = 2.9$), mean mandibular advancement 5.6 mm ($s = 3.5$) and mean chin advancement 8.7 mm ($s = 4.5$) (Table 4). Surgical planned advancement was compared to cephalometric achieved advancement by comparing pre and postoperative landmarks: AXA, AXB and AXPg. All significantly matched the planned advancement within the clinically significant error margin of 2 mm ($P < 0.001$).

Most baseline cephalometric measurements, AHI or arousal index did not correlate with postoperative PSG findings. A significant correlation was found between pre and postoperative AXA and postoperative time below 88% oxygen saturation (Spearman correlation coefficient: 0.8152, $P = 0.0336$), AXB (Spearman correlation coefficient 0.7792, $P = 0.0424$). This was not true for AXPg compared to the time of saturation below 88%, MPH, PNSP, UPW, UPW, PAS, LPW.

Cephalometric landmarks that were investigated and did not correlate were AXA, AXB, AXPg, upper pharyngeal airway (UPW), middle pharyngeal airway (MPW), posterior airway space (PAS, lower posterior airway (LPW), SNA, SNB, ANB).

4. Discussion

Postoperative evaluation and comparison with pre-operative planning and measures are becoming more and more standard of care. In our study, a mean maxillary and mandibular advancement of 3.2 mm and 5.6 mm respectively was achieved. At pogonion, a mean advancement of 8.7 mm was measured. The amount of advancement of maxilla and mandible correlated with the time below 88% oxygen saturation measured during sleep analysis. To date, there are no guidelines on the amount of advancement necessary to achieve clinical success in these patients. Computational Fluid Dynamics (CFD) could aid in predicting the necessary advancement preoperatively in the future [2,3]. Research has been conducted to implement CFD in orthognathic planning softwares however, this is not yet routine practice. We demonstrated that the planned advancement movements are actually achieved. A significant positive improvement was noted on AHI index preoperatively (27 ± 13) and postoperatively (9 ± 7.6) ($P = 0.0359$). However, in our small sample set, we did not find significant changes in 2D airway measurements pre- and postoperatively. In a previous paper by our study group, we discussed the different surgical procedures for snoring and their results [4,5]. Highest reduction in snoring scores was achieved with osteotomy, uvulopalatopharyngoplasty (UPPP) and functional expansion pharyngoplasty (FEP) procedures: 92% for the osteotomy group and 88% for the UPPP/FEP group respectively.

In this study, we confirm the positive impact on patient-reported outcome measures after bimaxillary surgery. The ESS, snoring intensity and severity significantly improved after surgical intervention. Only, the snoring score did not significantly improve. This may be because this is completed by the patient himself, which may find it difficult to assess his own snoring severity.

Table 3
Paired sample T-test for differences between Epworth sleepiness scale scores, snoring severity and intensity and snoring scores preoperatively versus postoperatively.

	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	*P (two-tailed)*
				Lower	Upper			
Epworth sleepines scale difference	3.71429	4.39280	1.17403	1.17796	6.25061	3.164	13	.007
Snoring severity difference	3.69231	3.01066	.83501	1.87298	5.51163	4.422	12	.001
Snoring intensity difference	4.84615	2.60916	.72365	3.26946	6.42285	6.697	12	.000
Snoring score difference	-.53846	4.70134	1.30392	−3.37945	2.30253	-.413	12	.687

Table 4
Cephalometric measurements preoperative, postoperative and their comparison.

(N = 32)	Minimum	Maximum	Mean	Std. Deviation
Preoperative				
SNA	71	89	81,97	4,06
SNB	64	82	76,42	4,13
ANB	−1	13	5,55	3,13
AXA	55	77	67,10	5,08
AXB	33	70	57,03	8,08
AXPg	32	70	57,42	9,44
Postoperative				
SNA	73	94	85,03	4,56
SNB	68	86	79,90	3,93
ANB	−3	12	5,26	3,16
AXA	52	83	70,32	5,75
AXB	41	76	62,61	7,68
AXPg	40	82	66,10	8,82
Difference Postoperative - Preoperative: achieved advancement				
AXA	−3,00	9,00	3,22	2,96
AXB	−3,00	12,00	5,58	3,50
AXPg	−6,00	17,00	8,67	4,55

The positive impact of maxillary-mandibular advancement surgery on 3D volumetric changes on the upper, middle and lower airway and subsequent improvement in snoring scores have been well established by several other authors [6–10]. Studies showed a correlation between cephalometric data and outcome measures such as severity, apnea-hypopnea index, degree of advancement [11–20]. Newer technologies as 3D volumetrics allow more precise evaluation and should be adopted but require CT or CBCT in pre- and postoperative evaluation. This is not yet the standard of care in many centres. One could argue if a three-dimensional radiographic evaluation is absolutely necessary for all patients if a careful clinical evaluation has preceded the treatment decision. 2D cephalometric analysis is still used by many maxillofacial surgeons in preoperative orthognathic planning and postoperative evaluation. Our study does not support the use of 2D cephalometric analysis. Although we did not perform a comparative study between 2 and 3D, we speculate that 3D planning and evaluation could increase precision on cephalometry and postoperative evaluation of soft and hard tissue landmarks. Consensus should be found on which imaging modality and airway analysis renders the best benefit-risk ratio and predictability. This consensus should also include the required head and mandible position and the moment of acquisition during the respiratory cycle, allowing acquisition standardization [21]. Given these current limitations, other methods are being used to better predict the outcome of MMA surgery. The use of a maxillo-mandibular advancement device or the Esmarch manoeuvre during drug-induced sleep endoscopy (DISE) can partially simulate the postoperative surgical outcome and thus predict surgical need. The role of DISE has been established in treatment planning before [1,22]. Pilaete et al. showed a significant change in treatment planning after implementation of DISE to the diagnostic workflow. Moreover, a multidisciplinary preoperative evaluation yields several benefits for patients, consultants and researchers. Patients benefit from a holistic approach for their disease with multiple etiologies at its base. A multidisciplinary approach is, therefore in our opinion, more cost-efficient. Flowcharts, as proposed in Fig. 1, can aid in decision making during a multidisciplinary evaluation. The drawback of this study is its relatively small sample size and its retrospective nature.

5. Conclusion

We illustrate an OSAS/SDB care pathway used in a Belgian secondary centre and illustrate that careful patient selection and treatment planning allows for clinically significant favourable results in SDB patients undergoing maxillomandibular advancement surgery. Preoperative orthognathic planning is achieved in OSAS/SDB patients and degree of advancement correlated with time of oxygen saturation below 88%. A significant clinically favourable reduction in AHI score was achieved after maxillomandibular advancement surgery. Patient-reported outcomes showed a significant improvement in snoring severity, intensity and sleepiness after surgery. Current 2D cephalometric airway analysis insufficiently predicted the effect of maxillomandibular advancement surgery in patients with OSAS/SDB.

Conflict of interest

The authors have no conflict of interest or financial disclosures.

Appendix 1. snoring questionnaire (translated from Dutch)

1. Snoring intensity

Use the following scale and circle the number that best describes the intensity of your snoring, possibly as indicated by your bed partner.

0: No snoring at all.

1-3: Soft snoring, no influence on your bed partner's sleep.
4-6: Snoring loudly, hinders bed partner.
7-9: Snoring very loudly, hinders people in the vicinity.
10: Bed partner goes to sleep in another room.

0	1	2	3	4	5	6	7	8	9	10
no	soft			loud			Very loud			Sleep separately

2. Snoring severity

Please complete this question together with your bed partner.
Check the box according to the severity of the snoring.

How often do you snore?	○ Rarely or never ○ Some nights (<50%) ○ Most nights (>50%) ○ Every night
How long do you snore?	○ Rarely or never ○ Small part (<50%) of the night ○ Large part (>50%) of the night ○ All night
How audible is snoring? (when the door is closed)	○ Rarely audible ○ Audible in the same room ○ Audible in the adjacent room ○ Can be heard downstairs/in the hall

3. Snoring score

Please indicate the severity of snoring (overall) with a cross on the bar below.

No snoring Extreme snoring.

References

[1] Pilaete K, De Medts J, Delsupehe KG. Drug-induced sleep endoscopy changes snoring management plan very significantly compared to standard clinical evaluation. Eur Arch Oto-Rhino-Laryngol 2014;271(5):1311–9.

[2] Cheng GC, Koomullil RP, Ito Y, Shih AM, Sittitavornwong S, Waite PD. Assessment of surgical effects on patients with obstructive sleep apnea syndrome using computational fluid dynamics simulations. Math Comput Simulat 2014;106:44–59.

[3] Sittitavornwong S, Waite PD, Shih AM, Koomullil R, Ito Y, Cheng GC, et al. Evaluation of obstructive sleep apnea syndrome by computational fluid dynamics. Semin Orthod [Internet] 2009;15(2):105–31. Available from: https://doi.org/10.1053/j.sodo.2009.01.005.

[4] Terryn S, De Medts J, Delsupehe K. Comparative effectiveness of the different treatment modalities for snoring. Otolaryngol Neck Surg 2015;153(3):468–75.

[5] Sabbe A-V, De Medts J, Delsupehe KG. Surgical treatments for snoring. B-ENT [Internet]vol. 13; 2017. p. 1–7. Available from: https://www.b-ent.be/articles/surgical-treatments-for-snoring. 1.

[6] de Ruiter MHT, Apperloo RC, Milstein DMJ, de Lange J. Assessment of obstructive sleep apnoea treatment success or failure after maxillomandibular advancement. Int J Oral Maxillofac Surg [Internet] 2017;46(11):1357–62. Available from: https://doi.org/10.1016/j.ijom.2017.06.006.

[7] Rojo-Sanchis C, Almerich-Silla JM, Paredes-Gallardo V, Montiel-Company JM, Bellot-Arcís C. Impact of bimaxillary advancement surgery on the upper airway and on obstructive sleep apnea syndrome: a meta-analysis. Sci Rep 2018;8(1):1–8.

[8] Kim T, Kim H-H, ok Hong S, Baek S-H, Kim K-W, Suh S-H, et al. Change in the upper airway of patients with obstructive sleep apnea syndrome using computational fluid dynamics analysis. J Craniofac Surg [Internet] 2015 Nov;vol. 26(8). e765–70. Available from: http://www.ncbi.nlm.nih.gov/pubmed/26595001. [Accessed 3 August 2018].

[9] Schendel SA, Broujerdi JA, Jacobson RL. Three-dimensional upper-airway changes with maxillomandibular advancement for obstructive sleep apnea treatment. Am J Orthod Dentofac Orthop [Internet] 2014 Sep;146(3). 385–93. Available from: http://www.ncbi.nlm.nih.gov/pubmed/25172261. [Accessed 3 August 2018].

[10] Canellas JVDS, Barros HLM, Medeiros PJD, Ritto FG. Effects of surgical correction of class III malocclusion on the pharyngeal airway and its influence on sleep apnoea. Int J Oral Maxillofac Surg [Internet] 2016;45(12):1508–12. Available from: http://www.ncbi.nlm.nih.gov/pubmed/27688168.

[11] Lemos Maschtakow PS, Oshiro Tanaka JL, Carlos da Rocha J, Giannasi LC, Leonelli de Moraes ME, Bacci Costa C, et al. Cephalometric analysis for the diagnosis of sleep apnea: a comparative study between reference values and measurements obtained for Brazilian subjects. Dental Press J Orthod [Internet] 2013;18(3): 143–9. Available from: https://liverpool.idm.oclc.org/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=ddh&AN=96336126&site=ehost-live&scope=site%5Cnhttps://www.scopus.com/inward/record.uri?eid=2-s2.0-84887190892&partnerID=40&md5=8abaaf9c89e37f6dd2fb81b77319cc65.

[12] Guilleminault Ch, Riley R, Powell N. Obstructive sleep apnea and abnormal cephalometric measurements. Implications for treatment. Chest [Internet] 1984;86 (5):793–4. Available from: https://doi.org/10.1378/chest.86.5.793.

[13] DeBerry-Borowiecki B, Kukwa A, Blanks RHI. Cephalometric analysis for diagnosis and treatment of absructive sleep apnea. The Laryngoscope 1988;98(2): 226–34.

[14] Narayanan A, Faizal B. Correlation of lateral cephalogram and flexible laryngoscopy with sleep study in obstructive sleep apnea. Int J Otolaryngol [Internet] 2015;2015:127842. Available from: http://www.hindawi.com/journals/ijoto/2015/127842/%5Cnhttp://www.ncbi.nlm.nih.gov/pubmed/26689652%5Cnhttp://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=PMC4672135.

[15] Rose E, Lehner M, Staats R, Jonas IE. Cephalometric analysis in patients with obstructive sleep apnea. J Orofac Orthop der Kieferorthopädie [Internet] 2002;63 (4):315–24. Available from: http://link.springer.com/10.1007/s00056-002-0058-9.

[16] Gungor AY, Turkkahraman H, Yilmaz HH, Yariktas M. Cephalometric comparison of obstructive sleep apnea patients and healthy controls. Eur J Dermatol 2013; 7(1):48–54.

[17] Silva VG, Pinheiro LAM, Silveira PL da, Duarte ASM, Faria AC, Carvalho EGB de, et al. Correlation between cephalometric data and severity of sleep apnea. Braz J Otorhinolaryngol [Internet 2014;80(3):191–5. Available from: https://doi.org/10.1016/j.bjorl.2013.11.001.

[18] Bhardwaj N, Daniel MJ, Srinivasan SV. Digital lateral cephalogram as screening tool for obstructive sleep apnea: a preliminary study. J Dent Res Sci Dev 2016;3: 27–30.

[19] Salles C, Campos PSF, de Andrade NA, Daltro C. Obstructive sleep apnea and hypopnea syndrome: cephalometric analysis. Braz J Otorhinolaryngol 2005;71(55 71):369–72.

[20] Riley R, Guilleminault C, Herran J, Powell N. Cephalometric analyses and flow-volume loops in obstructive sleep apnea patients. Sleep [Internet] 1983;6(4): 303–11. Available from: http://www.ncbi.nlm.nih.gov/pubmed/6665392.

[21] Strauss RA, Wang N. Cone beam computed tomography and obstructive sleep apnoea. Aust Dent J 2012;57:61–71.

[22] DE Corso E, Fiorita A, Rizzotto G, Mennuni GF, Meucci D, Giuliani M, et al. The role of drug-induced sleep endoscopy in the diagnosis and management of obstructive sleep apnoea syndrome: our personal experience. Acta Otorhinolaryngol Ital organo Uff della Soc Ital di Otorinolaringol e Chir Cerv-facc [Internet] 2013;33(6):405–13. Available from: http://www.ncbi.nlm.nih.gov/pubmed/24376297%5Cnhttp://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=PMC3870452.