SYSTEMATIC REVIEW

Lateral teleradiography of the head as a diagnostic tool used to predict obstructive sleep apnea

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Objectives: To (1) assess the relationship between obstructive sleep apnea (OSA) and craniofacial, pharyngeal anatomy and (2) to submit the recommendations for clinicians for increasing the sensitivity in the diagnostics of OSA.

Methods: A review of the relevant literature linking OSA in adults with cephalometric analysis was performed. In total, 11 articles with similar procedural criteria were selected. The data were analysed using the Comprehensive Meta-Analysis Software (Biostat Inc., Englewood, NJ) and Statistica 12.0 (StatSoft Inc., Dell Software, Tulsa, OK).

Results: Adults with OSA did not show statistically significant differences in the sagittal and vertical skeletal planes in comparison with the controls ($p > 0.05$). The patients with OSA had soft palate length, width and area increased accordingly by 4.21, 1.99 mm and 0.86 cm², tongue area increased by 2.02 cm², the upper posterior pharyngeal space (SPAS) and lower posterior pharyngeal space reduced accordingly by 4.53 and 1.32 mm, mandibular plane to the hyoid bone (MP-H) distance increased by 4.14 mm compared with the controls ($p < 0.05$). The SPAS parameter of the patients with OSA did not show statistically significant differences between the studies, with the mean value being 5.69 mm.

Conclusions: Analysed cephalometric data totally supported the concept of soft-tissue abnormalities in subjects with OSA, skeletal—only halfway; MP-H and SPAS being the most reliable parameters. Increased MP-H may serve as a predictor when differentiating normal subjects and patients with OSA. Reduced SPAS width could be a prognostic parameter for suspecting OSA. These two values should be kept in mind by dentists and can also be used as a simple auxiliary method by physicians; nevertheless, it is still underestimated and more studies are needed.

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Introduction

Obstructive sleep apnoea (OSA) is described by episodes of partial or complete obstruction of the upper airway during sleep, interrupting or reducing the flow of air, resulting in oxygen desaturation.^{1–9} It is a common chronic disease and has a negative impact on health and the quality of life of millions of people

throughout the world.^{1,3,10–15} The prevalence of this disorder varies from 2 to 4% among middle-aged males and 1–2% among middle-aged females. However, the majority of the affected individuals often remain undiagnosed.^{3,6,16,17}

Breathing disorders related with sleep are studied and treated in sleep pathology units involving different specialists. The most widely used technique for diagnosing OSA considered to be the goldstandard is

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polysomnography (PSG). While PSG provides a lot of information, to characterize the type and severity of the disorder, it is an expensive technique^{1,6,18–24} and in many locations around the world, patients suspected of having sleep apnoea face challenges accessing diagnostic services and treatment because of the discrepancy between the demand and the capacity of PSG.^{2,25,26} Besides, PSG does not show the specific site of the obstruction. Therefore, the radiographic examination of the craniofacial and pharyngeal anatomical parameters has received attention. One of the methods is lateral telerradiography of the head followed by a cephalometric study.^{6,27} Many studies have assessed the anatomic configuration of orofacial structures with more sophisticated and expensive techniques, including CT, MRI, somnofluoroscopy and acoustic reflection.^{6,8,28–31} As compared with advanced imaging techniques, cephalometry is an easy, low-cost, non-invasive modality that involves reduced radiation exposure and is widely available in the majority of hospitals.^{6,29–32} It has proved to be reliable and reproducible in evaluating the craniofacial and pharyngeal anatomical parameters in normal subjects and patients with OSA.^{18,19,26,29,33–47} Cephalometry can also be used in conjunction with other easy available methods such as the head and neck examination, endoscopic studies identifying where the obstruction is, and can assist with the planning and selection of the appropriate treatment for patients with OSA.^{6,26,27,39–43} For that reason, a complete cephalometric analysis is part of a service protocol in some centres. It is very important for the decision as to which type of surgery should be performed.^{18,44–46} Knowledge of craniofacial features of the subjects with OSA is also important for the prediction of the treatment outcome.^{4,40,47}

In order to determine orofacial anatomical changes in adult patients with OSA, a number of cephalometric studies have been analysed. Although OSA groups do not show identical craniofacial morphology, they have more similarity to each other than to normal subjects.^{25,30,48–51} The available cephalometric data tend to support the concept of both skeletal and soft-tissue abnormalities in subjects with OSA, but the results are inconsistent and limited. The present study was undertaken in an attempt to gain further information in this area and to elucidate the association between craniofacial and pharyngeal anatomical disharmony in adult patients suffering from OSA using lateral telerradiography of the head as a diagnostic tool. Cephalometric variables could aid clinicians by increasing the sensitivity of OSA diagnostics. Therefore, cephalometric data reported in the literature were searched and analysed. The objectives of the present study were (1) to assess the relationship between OSA and craniofacial and pharyngeal anatomy and (2) to submit the recommendations for clinicians for increasing the sensitivity in the diagnostics of OSA, using the method of meta-analysis.

Methods and materials

A thorough review of the relevant literature linking OSA in adults with cephalometric analysis was performed. The literature search was carried out using PubMed, Medline, and ScienceDirect databases for the period from 1996 to 2014 using the following terms: “sleep apnoea” or “sleep disorders” and “cephalometry” and “craniofacial” or “upper airway”, or “hyoid bone”, or “tongue”, or “soft palate”. Two investigators conducted the electronic search independently and in duplicate. In total, 11 articles with similar procedural criteria were selected.

Inclusion criteria for the studies

Inclusion criteria were limited to (1) non-syndromic, not medically compromised adults (≥ 30 years of age) who had not previously undergone surgery (uvulo-palato-pharyngo-plasty) with a diagnosis of OSA by overnight PSG; (2) the use of cephalometric analysis when lateral cephalograms were taken with the subjects in the natural head position; (3) principal outcome measures of craniofacial and oropharyngeal region dimensions of a group of subjects with OSA compared with the values from groups of normal individuals or subjects with OSA who are Caucasians by ethnicity; (4) articles written in English; (5) comparing Caucasians with OSA, only on studies where the number of patients was more than 30 ($n > 30$) were included in order to use the one-way analysis of variance test.

Statistical analysis

All cephalometric variables analysed in each study were expressed as mean $\pm$ standard deviation (SD). The data categories common among the studies comparing patients with OSA and groups of normal individuals were pooled for the analysis using the Comprehensive Meta-Analysis Software (Biostat Inc., Englewood, NJ). Because of the expected variability in the trials, a random effects model was chosen. To identify heterogeneity, the overlap of the 95% confidence intervals for the results of each study was inspected graphically. Heterogeneity across the studies was assessed through the I^2 statistic, with a value $>50\%$ being considered substantial heterogeneity.

The data categories common among the studies analysing Caucasians with OSA were compared using the analysis of variance test. When a significant difference was found, individual means were compared using the Student-Newman-Keuls post test. The data were analysed using statistical software (Statistica 12.0; StatSoft Inc., Dell Software, Tulsa, OK). The level of significance was set at $p < 0.05$.

The results were analysed by comparing craniofacial and pharyngeal anatomical parameters in patients with OSA and groups of normal individuals in order to assess structural changes present in this disease. The same parameters were also analysed only for Caucasians with OSA in order to assess the most important variables present in the selected studies. The variables were considered as

Figure 1 Cephalometric measurements and landmarks used in systemic-review/meta-analysis. A, most concave point of anterior maxilla; ANS, anterior point on maxillary bone; B, most concave point on mandibular symphysis; H, hyoid bone; IPAS, lower posterior pharyngeal space; MP, mandibular plane; N, most anterior point on frontonasal suture; P, lowest part of the soft palate; Pmax, maximal soft palate thickness; PNS, posterior nasal spine; S, midpoint of sella turcica; SPAS, upper posterior pharyngeal space; TgHt, maximal height of the tongue; TgLt, length of the base of the tongue.

strictly related to OSA only if they did not show any statistically significant differences among the articles selected.

Forest plots to calculate the weighted mean differences (MDs) were generated for the cephalometric variables in adults with OSA (Figure 1).

Angular measurements: SNA—sagittal position of the maxilla; SNB—sagittal position of the mandible; ANB—sagittal jaw relationship; SN-MP—mandibular plane angle.

Soft-tissue dimensions: PNS-P—posterior nasal spine to the tip of the soft palate (length of the soft palate); Pmax—maximal soft palate thickness; TgLt—the length of the base of the tongue; TgHt—maximal height of the tongue; SPAS—the upper posterior pharyngeal space (distance between the posterior pharyngeal wall and the

dorsal surface of the soft palate); IPAS—the lower posterior pharyngeal space (distance between the posterior pharyngeal wall and the dorsal surface of the base of the tongue).

Bony dimensions: Mandibular plane to the hyoid bone (MP-H)—perpendicular distance from the hyoid bone (H) to the mandibular plane (MP).

Results

In the initial search, we found 1026 citations across the 3 databases, and 11 eligible studies were finally included in this systematic review and meta-analysis. The search process is shown in Figure 2.

Figure 2 Preferred reporting items for systematic reviews and meta-analyses (PRISMA) flow diagram for studies retrieved through the search and selection processes. OSA, obstructive sleep apnoea; PSG, polysomnography.

Sample sizes in individual studies ranged from 20 to 99, with a total of 559 OSA and 339 control subjects. The characteristics of the 11 included studies are summarized in Table 1.

The present study compared cephalometric variables of 11 publications^{25,30,48–56} considering variables strictly related to OSA. The variables particularly taken into account were sagittal and vertical skeletal parameters: SNA, SNB, ANB and SN-MP angles; oropharyngeal region parameters: the dimensions of the soft palate and the dorsum of the tongue, the position of the hyoid bone, and upper airway width by the soft palate and/or dorsum of the tongue.

Obstructive sleep apnoea and control groups

Six studies investigated sagittal and vertical skeletal parameters.^{25,30,48,49,51,55} Adults with OSA did not show any statistically significant differences in the sagittal and vertical skeletal planes ($p > 0.05$) in comparison with the controls. Eight studies investigated

oropharyngeal parameters.^{25,30,48–51,55,56} The studies identified that adults with OSA had a soft palate length increased by 4.21 mm ($p < 0.0001$), soft palate width increased by 1.99 mm ($p < 0.0001$), soft palate area increased by 0.86 cm² ($p < 0.0001$) and tongue area increased by 2.02 cm² ($p < 0.002$) compared with the controls. The increased weighted MD in soft tissues could be related to the reduced upper airway space: pooled MD for the SPAS was −4.53 mm ($p < 0.0001$) (Table 2) and for IPAS—1.32 mm ($p < 0.031$). Values are given as pooled MDs. There were also significant differences of the hyoid bone distance to the mandibular plane between adults with OSA and the controls—the pooled MD was 4.14 mm ($p < 0.0001$) (Table 3).

Caucasians with obstructive sleep apnoea

Owing to the fact that cephalometric skeletal parameters in sagittal and vertical planes did not differ

Table 1 Distribution by sample size, sex and age between the studies

Study	Total number of subjects		Sex distribution of subjects (F/M)		Mean age of subjects (years) ± SD	
	OSA	Control	OSA	Control	OSA	Control
Battagel et al ²⁵	45	24	45 M/0 F	24 M/0 F	52.3 ± 9.1	41.8 ± 9.0
Battagel et al ⁵²	50	—	50 M/0 F	—	51.7 ± 10.3	—
Sforza et al ⁵³	57	—	57 M/0 F	—	52.0 ± 9.0	—
Lee et al ⁵⁴	74	—	59 M/15 F	—	48.5 ± 11.0	—
Johal et al ⁴⁸	99	99	78 M/21 F	78 M/21 F	48.5 ± 8.4	48.6 ± 8.3
Kurt et al ⁴⁹	20	20	17 M/3 F	8 M/12 F	40.0 ± 8.28	29.6 ± 3.2
Vidović et al ⁵¹	20	20	20 M/0 F	20 M/0 M	53.85 ± 12.95	37.25 ± 14.8
Seto et al ⁵⁵	29	21	36 M/4 F	18 M/3 F	49.0 ± 2.0	40.0 ± 2.0
Takai et al ⁵⁰	95	30	95 M/0 F	30 M/0 F	51.8 ± 12.1	38.3 ± 14.1
Yucel et al ³⁰	20	24	13 M/7 F	2 M/22 F	49.0 ± 10.0	46.0 ± 14.3
Solow et al ⁵⁶	50	100	50 M/0 F	100 M/0 F	50.0 ± 9.4	—

F, female; M, male; OSA, obstructive sleep apnoea; SD, standard deviation.

Table 2 Pooled weighted mean differences (MDs) in the upper posterior pharyngeal space widths between adults with obstructive sleep apnoea (OSA) and the controls

Study	OSA		Control		Weight (%)	MD IV, Random, 95% CI (mm)	MD IV, Random, 95% CI (mm)
	Mean $\pm$ SD (mm)	Total	Mean $\pm$ SD (mm)	Total			
Battagel et al ²⁵	5.4 $\pm$ 3.5	45	8.7 $\pm$ 3.0	24	23.85	-3.3 (-4.95 to -1.65)
Johal et al ⁴⁸	5.4 $\pm$ 2.8	99	8.4 $\pm$ 3.2	99	28.31	-3 (-3.84 to -2.16)	
Kurt et al ⁴⁹	5.17 $\pm$ 2.48	20	11.63 $\pm$ 4.66	20	19.82	-6.46 (-8.77 to -4.15)	
Solow et al ⁵⁶	5.16 $\pm$ 2.34	50	10.9 $\pm$ 2.8	100	28.02	-5.74 (-6.64 to -4.84)	
Total (95% CI)		214		243	100	-4.53 (-6.28 to -2.77)	

CI, confidence interval; SD, standard deviation.

Heterogeneity: $\tau^2 = 2.64$; $\chi^2 = 23.8$; $df = 3$ ($p = 0.000$); $I^2 = 87.4\%$.Test for overall effect: $Z = -5.06$, ($p = 0.000$).

between adults with OSA and the control groups, we did not include these skeletal parameters in the analysis of variance test. Five studies investigated oropharyngeal parameters.^{25,48,52–54} The results were analysed by comparing the dimensions of the oropharyngeal region in Caucasians with OSA in order to assess the most important variables present in the selected studies. The variables were considered as strictly related to apnoea only if they did not show any statistically significant differences among the articles selected. Only SPAS parameters were constant and did not show any statistically significant differences between the studies, with the mean value of 5.69 mm (95% CI = 5.11 to 6.27). The full variables of the studies are given in Table 4.

Discussion

Researchers reported that the oropharyngeal level is the narrowest region of the upper airway, and this level is the most affected part of the pharynx in patients with OSA. The upper airway most of the time collapses at this level during apnoea.^{5,57} The present study compared the cephalometric variables of 11 publications,^{25,30,48–56} considering variables strictly related to OSA.

Skeletal morphology

Aspects of skeletal craniofacial morphology relating to OSA have been investigated in many studies using cephalometric analyses of lateral radiographs. Across the studies, the main characteristics have been found to relate to the presence of OSA. A hypoplastic, more receded mandible and/or maxilla reflected by smaller SNB and SNA angles has been often mentioned as a contributing factor to the severity of OSA.^{6,52,58–60}

However, according to Bacon et al,⁶¹ SNA, SNB and ANB measurements did not demonstrate any influence when comparing patients with OSA and the control group. In our meta-analysis, no statistically significant differences in skeletal anteroposterior relationship between adults with OSA and the controls were found. Only Johal et al detected that SNA and SNB values were significantly reduced in all subjects with OSA, suggesting that the entire face is reduced anteroposteriorly resulting in a short or retro-positioned maxilla and mandible. These anatomical differences put the entire facial complex closer to the cervical spine and thereby contribute to the reduction of airway space in subjects with OSA.⁴⁸ However, knowledge about skeletal craniofacial anatomical disharmony in adults suffering from OSA is inconsistent, and more research needs to be performed.

Table 3 Pooled weighted mean differences (MDs) in mandibular plane to the hyoid bone between adults with obstructive sleep apnoea (OSA) and the controls

Study	OSA		Control		Weight (%)	MD IV, Random, 95% CI (mm)	MD IV, Random, 95% CI (mm)
	Mean $\pm$ SD (mm)	Total	Mean $\pm$ SD (mm)	Total			
Battagel et al ²⁵	26.3 $\pm$ 6.6	45	22.5 $\pm$ 5.7	24	3.84	3.8 (0.68 to 6.92)
Kurt et al ⁴⁹	22.67 $\pm$ 3.95	20	17.97 $\pm$ 4.74	20	5.12	4.7 (2.0 to 7.4)	
Vidović et al ⁵¹	19.84 $\pm$ 5.57	20	15.46 $\pm$ 5.69	20	3.07	4.38 (0.89 to 7.87)	
Seto et al ⁵⁵	18.45 $\pm$ 1.2	29	14.44 $\pm$ 1.23	21	80.71	4.01 (3.33 to 4.69)	
Takai et al ⁵⁰	23.7 $\pm$ 6.5	95	18.4 $\pm$ 7.1	30	5.03	5.3 (2.57 to 8.03)	
Yucel et al ³⁰	20 $\pm$ 8.1	20	15 $\pm$ 5.7	24	2.25	5 (0.91 to 9.09)	
Total (95% CI)		229		139	100	4.14 (3.52 to 4.75)	

CI, confidence interval; SD, standard deviation.

Heterogeneity: $\tau^2 = 0.0009$; $\chi^2 = 1.233$; $df = 5$ ($p = 0.94$); $I^2 = 0\%$.Test for overall effect: $Z = 13.25$, ($p = 0.000$).

Table 4 Comparison of cephalometric oropharyngeal parameters in Caucasians with obstructive sleep apnoea

Parameters	Battagel et al ²⁵ (n = 45)	Battagel et al ⁵² (n = 50)	Sforza et al ⁵³ (n = 57)	Lee et al ⁵⁴ (n = 74)	Johal et al ⁴⁸ (n = 99)	One-way analysis of variance		
						F	p-value	Student-Newman-Keuls post test
PNS-P (mm) ± SD	38.4 ± 5.1	39.1 ± 5.2	47.2 ± 4.9	40.0 ± 4.3	43.2 ± 4.7	30.48	0.000	1 vs 3, 1 vs 5, 2 vs 3, 2 vs 5, 3 vs 4, 3 vs 5, 4 vs 5
Pmax (mm) ± SD	12.4 ± 1.9	12.1 ± 1.6	12.7 ± 1.9	11.4 ± 1.8	10.6 ± 1.7	14.73	0.000	1 vs 5, 2 vs 5, 3 vs 5, 4 vs 5, 1 vs 4
TgLt (mm) ± SD	—	82.4 ± 7.9	87.7 ± 5.2	89.4 ± 7.6	81.2 ± 7.0	24.25	0.000	2 vs 3, 2 vs 4, 3 vs 5, 4 vs 5
TgHt (mm) ± SD	—	—	38.9 ± 4.6	40.0 ± 5.0	31.9 ± 4.8	72.81	0.000	3 vs 5, 4 vs 5
Tg area (cm ²) ± SD	42.5 ± 4.5	34.5 ± 3.9	—	—	33.4 ± 4.1	45.32	0.000	1 vs 2, 1 vs 5
MP-H (mm) ± SD	26.3 ± 6.6	25.4 ± 5.8	25.7 ± 5.7	22.4 ± 6.7	—	5.65	0.000	1 vs 4
SPAS (mm) ± SD	5.4 ± 3.5	5.4 ± 3.2	6.2 ± 0.3	—	5.4 ± 2.8	N.S.	—	—
IPAS (mm) ± SD	8.9 ± 4.4	9.6 ± 4.6	11.2 ± 3.1	10.8 ± 4.5	9.0 ± 3.6	3.69	0.000	1 vs 3, 3 vs 5, 4 vs 5

IPAS, lower posterior pharyngeal space; MP-H, mandibular plane to the hyoid bone; *p*-value, level of significance; N.S., not significant; Pmax, maximal soft palate thickness; PNS-P, posterior nasal spine to the tip of the soft palate; SD, standard deviation; SPAS, upper posterior pharyngeal space; Tg, tongue; TgHt, maximal height of the tongue; TgLt, length of the base of the tongue.

Hyoid bone

Inferiorly positioned hyoid bone or and increased distance from the mandibular plane to hyoid in subjects with OSA is well documented.^{5,6,19,25,27,30,44,50,51,53} Our study confirms this statement. The position of the hyoid bone serves as a central anchorage for the tongue muscles and determines the position of the tongue. A lower hyoid bone might be a reflection of the higher pressure stressed by excess pharyngeal tissues in the craniofacial complex.^{27,62} On the other hand, rather than being a predisposing factor, the position of the hyoid may reflect physiological adaptation to maintain airway patency—*i.e.* to pull out the dorsum of the tongue and the soft palate from the posterior pharyngeal wall in order to alleviate the obstructive condition.^{56,63} According to Paoli et al,⁶⁰ over a long period of time, the repeated pressure at night-time may cause the lengthening of the hyoid ligaments.

Tsai et al²⁷ stated that a hard-tissue hyoid bone that can be easily identified on radiographs might make a better prognostic indicator for differentiating between OSA and control groups, compared with the soft palate and dorsum of the tongue, which sometimes are unclear on routine lateral radiographs. Silva et al⁶⁴ and Yucel et al³⁰ are in agreement with this statement and find MP-H as a reliable parameter to assess OSA. Our results also confirm this. The MP-H parameter was the most constant one across the studies with heterogeneity through the $I^2 = 0\%$ (Table 3). Although when comparing Caucasians with OSA, we did not consider this parameter to be acceptable for OSA diagnostics, it was only between two studies that statistically significant differences were found (Table 4). In order to decrease the error of the measurement, lateral radiographs should be taken when patients are exhaling from a deep breath because in that way the hyoid is fixed in a consistent position.^{25,48,52}

Pharynx

This meta-analysis supports the statement that oropharyngeal dimensions between the soft palate (SPAS), the dorsum of the tongue (IPAS) and pharyngeal wall in subjects with OSA are all markedly reduced. Some authors considered that obstructions in the upper airway are related to a variation in the head posture and an increased cranio-cervical angle in subjects with OSA that forms in order to increase the dimension of the airway. Solow et al suggest that an increased cranio-cervical angle in patients with OSA can be interpreted as a physiological adaptation which serves to lift away the base of the tongue and the soft palate from the posterior pharyngeal wall in order to alleviate the obstructive condition.^{56,65} In this regard, Vidović et al⁵¹ also found that the average cranio-cervical angulation was much larger in the OSA sample than in the control group. Moreover, Solow et al⁵⁶ considered that the compensatory mechanism most efficiently proceeds on more caudal diameters: at the level of the epiglottis and at the base of the tongue, and less so—at the more coronal level—the soft palate region. These findings can explain the differences in the oropharyngeal width narrowing at the levels of the soft palate and the dorsum of the tongue found in our study. We found a significant decrease in the IPAS width ($p < 0.03$) by 1.32 mm and in the SPAS width—by 4.53 mm ($p < 0.0001$) comparing subjects with OSA and the controls. On the basis of these data, we make an assumption that the decrease in the IPAS width could be significantly smaller than the SPAS width because of an increased cranio-cervical angle which enlarges at more caudal airway levels.

Airway dimensions vary with the phase of the respiration: the minimum upper airway area is observed at the end of expiration and enlarges during inspiration in patients with OSA, and the narrowest cross-sectional area is at the level of the uvula. Yucel et al³⁰ stated that

a significant narrowing at the level of the uvula during expiration can be considered as a key point of the obstruction and can be a helpful diagnostic measure in severe OSA.

Moreover, during the Student-Newman-Keuls pairwise comparison between Caucasians with OSA, only SPAS parameters were constant and did not show any statistically significant differences between the studies. These findings suggest that SPAS width could be a prognostic parameter for OSA diagnostics. However, the results should be interpreted with caution because of the heterogeneity across the studies.

Morphology of the soft palate and the tongue

This meta-analysis showed a highly significant increase in soft palate width (1.99 mm), length (4.21 mm) and area (0.86 cm²) in adults with OSA. A significant retro-palatal narrowing in subjects with OSA appears to be a universal finding.^{2,6,19,25,44,48,49,56} However, soft palate length and thickness normally increases with age,⁶⁶ and in most of the studies, control groups were younger than subjects with OSA.^{25,49–51,55} This emphasizes the need for studies that would include age-matched subjects. Similar changes may be important in explaining the increased prevalence of OSA and related disorders with age. Although, Johal et al⁴⁸ found that soft palate length and width remained longer among the subjects with OSA compared with the control groups, even though the groups were age matched. Still, it would be a lower chance of errors if the groups were age matched.

Although Lowe et al⁶⁶ consider the size of the soft palate as an indicator of OSA severity, and we found an increased weighted MD in the soft palate length and width of adults with OSA compared with the controls, due to heterogeneity across the studies ($I^2 > 50\%$), it was not clear from this meta-analysis about the influence of these parameters on OSA.

The meta-analysis also showed a significant increase in the tongue area in subjects with OSA, which would cause the tongue to be placed in a more posterior position.⁶⁷ However, according to den Herder et al,⁶⁸ patients with larger tongues did not have any narrowing at the region of the base of the tongue (IPAS), and 76% of the subjects had obstructions in the retropalatal region (SPAS), which has been shown to be a more reliable parameter among patients with OSA.

In some studies taking lateral radiographs, the researchers place the head orientated with the Frankfort plane, in a horizontal position, because this plane, on the average, is parallel to the true horizontal plane in a normal sample. This procedure is not suitable for studies of natural head posture because the individual variability in posture, which is of particular relevance in patients with OSA and other patient groups with obstruction of the upper airways, is thereby eliminated.⁵⁶ To eliminate this limitation, lateral radiographs were taken in the natural head position in all the included studies.

However, this meta-analysis declared certain challenges because of differences in the designs of the studies. First of all, lack of studies with sufficient study sample and with all or majority of principal outcome measures of craniofacial and oropharyngeal region dimensions, use of various markings describing cephalometric measurements and landmarks, ill-defined lateral telerradiography of the head technique and lack of some specific statistical information. Furthermore, most of the studies did not match for age and sex. So there can be some age- and gender-related morphological changes. 2 of 11 included primary studies did not check for the error of the method that could lead to some cephalometric measurement inaccuracies. Therefore, it was impossible to collect all the appropriate information for this study and so we cannot make accurate and strict conclusions, but some observations can be carried out. Although, further studies about OSA and lateral telerradiography of the head as a diagnostic tool are needed.

Conclusions

Analysed cephalometric data totally supported the concept of soft-tissue abnormalities in subjects with OSA, skeletal—only halfway; MP-H and SPAS being the most reliable parameters. Increased MP-H may serve as a predictor when differentiating normal subjects and patients with OSA. Reduced SPAS width could be a prognostic parameter for suspecting OSA. These two values should be kept in mind by dentists and can also be used as a simple auxiliary method by physicians, but special attention should be paid in the technique of lateral telerradiography of the head. Nevertheless, it is still underestimated and more studies are needed.

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