International Dental Journal 2018; 68: 320–326

doi: 10.1111/idj.12389

Incidental findings in pre-orthodontic treatment radiographs

German Hernández[1], Sonia P. Plaza[2], Diana Cifuentes[2], Lina M. Villalobos[2] and Lina M. Ruiz[2]

[1]*El Bosque University, Bogotá, Colombia;* [2]*CIEO University (UniCIEO), Bogotá, Colombia.*

Objectives: To determine the frequency, radiodensity characteristics, topographic location and number per patient of incidental findings observed in radiographs taken before orthodontic treatment and to evaluate the relationship of the findings with age and sex. **Methods:** This was a cross-sectional study that investigated 1,887 panoramic and lateral cephalogram radiographs from 783 patients (23.31 ± 13.11 years of age; 453 women and 330 men) who were randomly selected from the orthodontics department of a private university. The images were systematically evaluated by an oral pathologist. A chi-square test was applied to evaluate the association between sex and the presence of pathology, radiodensity characteristics and topographic location. The Mann–Whitney *U* and Kruskal–Wallis tests were used to establish the association between age or number of findings per patient with other variables in the study. **Results:** The prevalence of incidental findings was 88.12%. The most frequent finding was maxillary sinus pneumatisation (25.80%). No significant association was detected between frequency or number of findings per patient and either sex or diagnostic hypothesis. A significant association was found between age and the presence of pathology and number of incidental findings per patient ($P < 0.001$), as well as between the type of radiographic image and incidental finding ($P < 0.001$). **Conclusion:** The prevalence of incidental findings in the sample studied was high, and the structures most commonly involved were the maxillary sinuses. The results suggest that both the presence and the number of findings per patient increase with age but there is no association with sex.

Key words: Radiography, incidental findings, diagnostic imaging, maxillofacial abnormalities

INTRODUCTION

It is usual practice in orthodontics to complement the clinical examination with diagnostic images, such as intraoral and extraoral radiographs, including panoramic, lateral cephalogram and periapical radiographs. One of the advantages of panoramic radiographs is that they allow for the detection of pathological lesions, dental anomalies and changes in the mandibular condyle. Pathologic abnormalities may also be identified in profile cephalometric radiographs, taken to study dental and skeletal relationships in orthodontic patients[1].

Incidental findings in panoramic radiographs have been reported[2–6]. The reports include maxillary sinus anomalies[7] and dental anomalies[4]. In lateral cephalograms, altered size and morphology of the sella turcica, cervical vertebrae pathologies, intracranial calcifications, odontoid process anomalies and other findings have been described[8–11]. Sánchez *et al.*[12] reported the prevalence of anomalies and pathologic findings in 516 digital panoramic radiographs, including a high frequency of abnormalities in the maxillary sinuses (47.48%) that was found more commonly in women than men. Bekiroglu *et al.*[3] found, in panoramic films of Turkish children, a high prevalence of mesiodens (3.5%). Although oral and dental anomalies may be related to age and sex, few studies have investigated such relationships[3,12]. In addition, ethnic and population characteristics may affect the prevalence of dentofacial incidental findings.

Although orthodontists frequently use cephalometric films to evaluate dental and skeletal patterns pretreatment, incidental findings can sometimes go unnoticed[8]. If anomalies are missed in the early stages, more invasive treatment procedures may then be required[13,14].

The objective of the present study was to determine the frequency, diagnostic hypothesis, radiodensity characteristics, topographic location and number per patient of incidental findings observed in lateral cephalogram and panoramic radiographs taken before orthodontic treatment and to evaluate the relationship of these findings with age and sex.

METHODS

This was a cross-sectional study based on data available from patients at the Orthodontics Department of the UniCIEO University (Bogotá, Colombia) from January 23 2012 to July 31 2016. The study protocol was approved by UniCIEO University Ethics Committee, and all patients and parents/guardians of patients, in cases where participants were under 18 years of age, gave written informed consent for the use of their orthodontic data for research. The research was conducted in full accordance with the World Medical Association Declaration of Helsinki.

From the initial population of 6,191 subjects with digital radiographic images taken during the 5-year study period, 1,805 subjects seeking orthodontic treatment were selected. After applying the selection criteria, only 1,356 subjects were eligible for inclusion. By simple random sampling, the sample size required [calculated from the data obtained in the pilot study, using the OpenEpi software (Open source epidemiologic statistics for public health version 3.01, AG Dean, KM Sullivan, MM Soe, Atlanta, GA, USA)], of 783 subjects, was obtained. A 95% confidence level was considered and an estimated prevalence of maxillary sinus pneumatisation of 26% was given to establish an estimate within ±2% of this value. The inclusion criteria were lateral cephalogram and/or panoramic digital radiographs of good quality. Patients with facial fissures, head and neck malformations, craniofacial anomalies and a history of maxillofacial surgical treatment were excluded.

All radiographs were obtained, following a standard protocol, with Ortophos XG plus DS/Ceph (Sirona Dental Systems, Bernsheim, Germany) at an adjusted voltage of 60–77 Kv and 8–15 mA, and an exposure time of 9.4–14.1 seconds. The Sirona protocol is adjusted to the patient's age, size and weight. Sociodemographic data were obtained from the clinical records of the patients. In the radiographs, an oral pathology expert (G.H.) determined whether an incidental finding was present (yes/no), the number of incidental findings per patient, a diagnostic hypothesis about the etiology of the incidental finding, its topographic location (cranium, paranasal sinus, neck, maxillary/mandible, teeth, face), and its radiodensity characteristics (radiolucent, radiopaque, radio-mixed). The observer used the same computer (LG-1. E2360; LG Electronics, Seoul, South Korea) with a screen of 23 inches and resolution of 1,920 pixels × 1,080 pixels, in horizontal view, under the same lightning and environmental conditions, with no interruptions during a series of no more than 30 observations per session to avoid visual fatigue of the operator. The radiographs were evaluated using a systematic approach, as recommended by Kantor and Norton[9] and adapted for this research (Appendix 1).

Intra-operator accuracy was calibrated by analysis of 50 pairs of radiographs (panoramic and profile), of the same randomly selected subjects, twice, with a 15-day interval between analyses. The agreement between reports was measured using the Kappa coefficient (presence of finding) and the Bland-Altman plot (number of findings per patient).

Statistical analysis

Statistical analysis was performed using the software STATA14 (version 14; StataCorp, College Station, TX, USA). For nominal variables it was expressed as frequency, and the mean, standard deviation (SD) and median for quantitative results were calculated. A chi-square test was applied to evaluate the association between sex and the presence of pathology, radiodensity characteristics and topographic location. The Mann–Whitney *U* and Kruskal–Wallis tests were used to establish the association between age or number of findings per patient and other variables in the study. For all tests, the level of statistical significance was $P < 0.05$.

RESULTS

Although the intra-observer percentage of concordance was high (95%), the Kappa index was only 0.64 because of the high prevalence of findings that limit the applicability of the Kappa index. The variable 'number of findings per patient' was analysed using the Bland–Altman plot, which indicated high intra-observer agreement with an average error of −0.10; SD of the difference: 0.30 (95% CI: −0.24 to 0.04).

The sociodemographic characteristics of the population and distribution of study variables are shown in *Table 1*. A total of 1,380 panoramic and cephalometric radiographs (783 panoramic, 597 lateral cephalogram) from 783 patients (453 women; 330 men) were studied. The mean age (± SD) of patients in the study was 23.31 ± 13.11 years (range: 3–70 years). The number of findings per patient was between 0 and 9, with the highest frequencies being two (26.31%) and three (22.35%) per patient.

According to the origin of the finding (*Table 2*), the most prevalent were found in airway cavities (maxillary sinus pneumatisation; 25.80%), cervical region (stylohyoid ligament radiopacity; 17.65%), temporomandibular joint (TMJ) anomalies (mandibular condyle flattening; 6.30%), dental anomalies (dental agenesis; 5.77%) and non-neoplastic bone (cemento-osseous dysplasia; 3.92%).

Table 1 Sociodemographic characteristics and distribution of categorical study variables (A), and distribution of continuous study variables (B)

(A) Categorical variables

Variable	*n*	Frequency (%)
Sex		
Women	453	57.85
Men	330	42.15
Incidental findings		
Absence	93	11.88
Presence	690	88.12
Type of radiograph with finding		
Panoramic	596	86.38
Profile	4	0.58
Panoramic + Profile	90	13.04
Topographic location		
Cranium	62	3.29
Paranasal sinus	499	26.44
Neck	346	18.33
Maxillary/mandible	361	19.13
Teeth	356	18.88
Face	263	13.93
Radiodensity characteristics of the finding		
Radiolucent	935	49.55
Radiopaque	635	33.65
Radio-mixed	49	2.60
Unclassified	268	14.20

(B) Continuous variables

	Mean/ Median*	SD	Range	
			Minimum	Maximum
Age	23.31	13.11	3	70
# findings per patient	3*	–	0	9

*Median.

While strong evidence was found for the association of the presence of any finding with age ($P < 0.001$) (*Figure 1*), the association with sex was not significant ($P > 0.05$). No significant association was detected between radiodensity, topographic location or type of radiograph (panoramic or cephalometric) with sex ($P > 0.05$) (*Table 3*).

Strong evidence of association ($P < 0.001$) between age and type of radiograph, topographic location and radiodensity characteristics was observed. In panoramic radiographs, a larger number of findings was detected at a young mean age (25.4 years), whereas in profile radiographs, a larger number of findings was detected at a mean age of 31.91 years. Regarding topographic location, a larger number of cranial findings were found at a mean age of 30.06 years compared with findings at other locations. Radiolucent incidental findings were detected at a younger age (24.93 years) than radiopaque (27.68 years) and radio-mixed (31.10 years) incidental findings. There was also significant evidence of association between age and number of findings ($P < 0.001$) (*Table 4*).

DISCUSSION

The reported prevalence of incidental findings in digital panoramic and profile radiographs is highly variable, ranging from 6.2% to 70%[3,5,6,12,15]. This high range of variability may be related to differences in population, sample size, study design and observer experience, among other factors. In the present study, the prevalence of findings, at 88.12%, was higher than similar values reported previously, probably because of the broader age range (3–70 years) in this study compared with other studies[2,3,6,16] that found a prevalence of findings of 12%–43.38% in subjects with an age range of 2–19 years. Meanwhile, Sánchez *et al.*[12] reported (in subjects with an age range of 6–77 years) a prevalence of nasal cavity abnormalities of 69.18% and of maxillary sinus of 47.48%. Another important variable to explain the high number of incidental findings in the present study, and the difference among studies, is the clinical and radiologic experience of the observer. Rushton *et al.*[17] found that experts diagnosed significantly higher proportions of subjects as having positive radiological findings than the general dentist. In the present study, the observer was an oral pathologist with more than 40 years of experience and expertise in the interpretation of radiographic images.

The airway was the main location for incidental findings detected in the present study (38.84% of findings in this region), including maxillary sinus pneumatisation (25.80%), turbinate hypertrophy (12.88%), mucous retention cyst (0.11%) and sinusitis (0.05%). This result is similar to the 47.48% reported by Sánchez *et al.*[12] for incidental findings at the level of the maxillary sinus.

The second most frequent incidental finding observed in the present study was stylohyoid ligament radiopacity (17.65%), which is similar to the results reported by Macdonald-Jankowski[18], who found a prevalence of stylohyoid ligament radiopacity of 15.8% in a sample of subjects from London. The average length of the stylohyoid ligament is 25 mm. When it is over 30 mm it is considered to be elongated[19]. Garay *et al.*[20] reported a frequency of 8.42% for stylohyoid ligament ossification and stylohyoid process elongation. In the present study, changes in the stylohyoid process were determined only as radiopacity variation at the level of the stylohyoid complex; no direct measurement to diagnose elongation was made.

Another relevant finding in the present study was the relatively high prevalence of TMJ anomalies (6.61%), most frequently represented by mandibular condyle flattening in 119 subjects (76 women and 43 men). This level of prevalence is similar to that reported by Sánchez *et al.*[12].

Table 2 Distribution of findings according to diagnostic hypothesis and to origin of the finding

Diagnostic hypothesis/origin	*n* (%)		*n* (%)
Dental developmental		Non-neoplastic bone developmental	
Agenesis	109 (5.77)	Cemento-osseous dysplasia	74 (3.92)
Taurodontism	33 (1.74)	Palatal torus	55 (2.91)
Supernumerary	22 (1.16)	Torus mandibularis	3 (0.16)
Enamel Pearl	12 (0.64)	Blurred temporal petrous region	13 (0.69)
Microdontia	5 (0.26)	Clinoid apophysis bone hyperplasia	26 (1.37)
Ectopic teeth	3 (0.16)	Frontal bone hyperplasia	11 (0.58)
Pulp calcifications	22 (1.16)	Blurred alveolar bone	8 (0.42)
Hypercementosis	23 (1.22)	Clinoid apophysis fusion	2 (0.11)
Amelogenesis imperfecta	6 (0.32)	Bifid sella turcica	1 (0.05)
Dentinogenesis imperfecta	3 (0.16)	Ectopic position of hyoid bone	1 (0.05)
Total	238 (12.59)	Total	194 (10.26)
Developmental odontogenic		Odontogenic inflammatory	
Dentigerous cyst/Hyperplastic follicle	101 (5.34)	Marginal bone loss	35 (1.85)
Residual lesion	1 (0.05)	Osteitis condensans	22 (1.16)
Developmental odontogenic cyst	8 (0.42)	Endodontic/periodontal injury	9 (0.48)
Compound odontoma	5 (0.26)	Chronic peri-implantitis	4 (0.21)
Periodontal lateral cyst	2 (0.11)	Rarefying osteitis	15 (0.79)
Odontogenic hyperplasia	1 (0.05)	Total	85 (4.49)
Cementoblastoma	5 (0.26)	Vertebral	
Total	123 (6.49)	Cervical vertebrae fusion	8 (0.42)
TMJ		Vertebrae cyst	1 (0.05)
Mandibular condyle flattening	119 (6.3)	Total	9 (0.47)
Condylar hyperplasia	4 (0.21)	Unclassified	
Bifid condyle	1 (0.05)	Anterior nasal spine deviation	14 (0.74)
Osteophyte formation	1 (0.05)	Sella turcica lack of patency	9 (0.48)
Total	125 (6.61)	Chondromatosis	5 (0.26)
Airway cavities		Internal root resorption	3 (0.16)
Maxillary sinus pneumatisation	487 (25.80)	Foreign bodies	3 (0.16)
Turbinate hypertrophy	243 (12.88)	External root resorption	2 (0.11)
Mucous retention cyst	2 (0.11)	Total	36 (1.91)
Sinusitis	1 (0.05)	Cervical	
Total	733 (38.84)	Stylohyoid ligament radiopacity	333 (17.65)
Venous development		Supraspinous ligament calcification	1 (0.05)
Intracranial vascular calcification	10 (0.53)	Total	334 (17.7)
Total	10 (0.53)		

TMJ, temporomandibular joint.

Regarding developmental dental anomalies, in this study a high prevalence of dental agenesis (5.77%) was found, which was similar to the value reported in the meta-analysis of Polder *et al.*[21] for different Caucasian populations, in which significant differences among continents and between genders were detected ($P < 0.05$). The highest prevalence of dental agenesis reported by Polder *et al.* was found in Europe (6.3% women; 4.6% men) and in Australia (women 7.6%; men 5.5%), compared with North America (women 4.6%; men 3.2%). In the present study, agenesis was more frequent in women than in men, but the difference was not statistically significant. Filho *et al.*[4] evaluated the prevalence of dental anomalies in panoramic radiographs, reporting a high prevalence of taurodontism (27.19%). In the present study, the prevalence of taurodontism was 1.74%, lower than the prevalence reported by Saberi and Ebrahimipour[22] (5.38%) but higher than that reported by Kuhlberg and Norton[5] (0.25%). It is likely that these differences indicate differences in ethnic background, but differences in methods should also be considered.

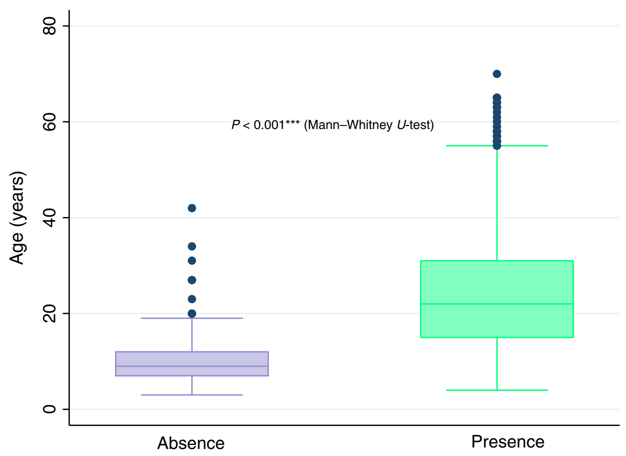

Figure 1. Boxplot of distribution of age according to the presence or absence of findings.

In profile cephalometric radiographs, this study found clinoid apophysis bone hyperplasia in 26 subjects, clinoid apophysis fusion in two subjects and

Table 3 Association between sex and different variables investigated in the study (type of radiograph, topographic location of the findings and radiodensity characteristics)

Variable	Women *n* (%)	Men *n* (%)	*P* value
Topographic location			
Cranium	47 (2.49)	15 (0.79)	0.113†
Paranasal sinus	300 (15.89)	199 (10.54)	
Neck	198 (10.49)	148 (7.84)	
Maxillary/mandible	213 (11.28)	148 (7.84)	
Teeth	204 (10.81)	152 (8.05)	
Face	162 (8.58)	101 (5.35)	
Type of radiograph			
Panoramic	1,039 (55.06)	722 (38.26)	0.078†
Profile	58 (3.07)	23 (1.21)	
Panoramic and profile	27 (1.43)	18 (0.95)	
Radiodensity characteristics			
Radiolucent	565 (29.94)	370 (19.60)	0.375†
Radiopaque	381 (20.19)	254 (13.46)	
Radio-mixed	24 (1.27)	25 (1.32)	
Unclassified	154 (8.16)	114 (6.04)	

†χ^2 test.

Table 4 Association between age of subjects and different variables investigated in the study (type of radiograph, and topographic location, radiodensity characteristics and number of findings observed in radiographs)

Variable	Age (years)			
	n	Mean	SD	*P*
Type of radiograph				
Panoramic	1,761	25.40	12.82	<0.001†,**
Profile	81	31.91	14.70	
Panoramic and profile	45	30.64	15.57	
Topographic location				
Cranium	62	30.06	13.64	<0.001†,**
Paranasal sinus	499	26.06	12.34	
Neck	346	27.11	13.48	
Maxillary/mandible	361	27.52	13.30	
Teeth	356	23.63	13.26	
Face	263	23.19	12.22	
Radiodensity characteristics				
Radiolucid	935	24.93	12.80	<0.001†,**
Radiopaque	635	27.68	13.37	
Radio-mixed	49	31.10	12.90	
Unclassified	268	23.42	12.43	
Number of findings per patient				
0	93	11.10	6.65	<0.001†,**
1	132	21.92	12.66	
2	206	23.77	12.01	
3	175	26.37	12.77	
4	110	27.83	14.01	
5	40	25.52	13.33	
6	17	29.70	13.67	
7	6	21.66	7.03	
8	2	18.5	9.19	
9	2	30	25.45	

†Kruskal–Wallis test.
$^{**}P < 0.001$.

bifid sella turcica in one subject. Tetradis and Kantor[15] observed calcification of diaphragma sellae (bridged sella) in 11% of their sample. Kucia el al.[11] reported a higher prevalence of sella turcica anomalies (46.9%), but that study was designed to evaluate sella turcica structure, which was observed in more detail. Pérez *et al.*[10] observed a 4.3% frequency of bridged sella turca and clinoid apophysis elongation.

In the present study, the percentage of incidental findings was higher in women (57.98%) than in men (41.88%), but the difference was not statistically significant for the presence of findings ($P = 0.836$) or diagnostic hypothesis ($P = 0.119$).

One of the most important outcomes of our study was the significant association between age and presence or number of incidental findings ($P < 0.001$). This is probably because the development of more complex lesions is expected, and the probability of incidental findings is increased, in patients with advancing age. In recent years, the demand for orthodontic treatment and therefore orthodontic imaging has increased in adults[23,24]. As this study has shown that incidental findings increase with age it is very important for routine methodical radiographic evaluation and interpretation to be performed for patients of any age.

A higher proportion of radiolucent incidental findings (49.55%) were detected than radiopaque or mixed incidental findings. This observation is similar to that in the study by Sánchez *et al.*[12] In this study, we found significant association between the radiodensity of the finding and age ($P < 0.001$). Radio-mixed pathological findings were most common at a mean age of 31.10 years, and radiopaque pathological findings were most common at a similar mean age (27.68 years), both of which were higher than the mean age for radiolucent incidental findings (24.93 years). A possible explanation for this finding could be that some of the radiolucent lesions are the result of acute processes while radiopaque lesions could be the result of slower or chronic processes.

As the prevalence of incidental findings is very high (88%), orthodontists and dentists who assess these images regularly should review the images systematically, paying careful attention to the image seen and not solely focusing on the teeth (panoramic) and skeletal relationships (cephalogram) in order to extract all the important information from the diagnostic images. Although many of our findings do not affect the clinical management of patients because they are nonpathological variants or physiological changes[8], others require more attention or referral for further evaluation. Regarding orthodontic management, dental anomalies, rarefying osteitis, dentigerous cysts, marginal bone loss and odontoma usually require specialist care before orthodontic treatment. Edwards *et al.*[25] evaluated the frequency and need for follow-up of incidental findings on cone-beam computed tomography (CBCT) in orthodontic patients and found that only 11.2% of the findings required follow-up.

One limitation of this study was the observation of incidental findings in two-dimensional (2D) images, while three-dimensional (3D) images, with CBCT, provide further information for diagnostic hypothesis and location of anomalies. Some studies[25–27] have reported a frequency, of up to 92%, of incidental findings observed in CBCT. Although CBCT imaging is increasingly utilised in diagnosis and treatment planning in orthodontics, it is not yet a routine diagnostic tool. The American Academy of Oral and Maxillofacial Radiology has developed some clinical recommendations regarding use of CBCT in orthodontics[28] in which they suggest that the use of CBCT on an individual basis, based on clinical presentation, can be justified. These recommendations were made in order to minimise the patient's exposure to ionising radiation and to follow the ALARA (as low as reasonably achievable) principle[29]. A conventional imaging protocol in orthodontics diagnosis (panoramic, lateral cephalogram) could have a radiation average effective dose of 47.2 μSv, while in a CBCT imaging protocol, this dose could be between 107.2 and 249 μSv, depending on the field of view used[28]. It is important to take this into account, mainly to reduce the radiation hazard in orthodontic treatment of children and young adults.

Another limitation of the present study was that only one observer evaluated the findings; therefore, inter-reliability data were not available. This could lead to observer bias because of the possibility of a subjective evaluation. It would have been better if a second observer, perhaps an oral maxillofacial radiologist, had participated in the study.

CONCLUSIONS

A significant association between age and presence or number of findings ($P < 0.001$), as well as between number of findings and radiodensity characteristics of the finding ($P < 0.001$), was found. No statistically significant association was found between presence or number of findings and diagnostic hypothesis *versus* sex.

Acknowledgements

The authors of this paper would like to thank Dr Ivonne Barrero (oral maxillofacial radiologist) for her advice.

Conflict of interest

The authors exclusively financed the present research article, with no any external sponsors. Therefore, the authors declare the study is free of conflict of interests.

REFERENCES

1. Proffit WR, White RP, Sarver DM. *Contemporary Treatment of Dentofacial Deformity*. St. Louis, MO: Mosby; 2003.
2. Asaumi J-I, Hisatomi M, Yanagi Y *et al*. Evaluation of panoramic radiographs taken at the initial visit at a department of paediatric dentistry. *Dentomaxillofac Radiol* 2008 37: 340–343.
3. Bekiroglu N, Kargul B, Mete S *et al*. Evaluation of panoramic radiographs taken from 1,056 Turkish children. *Niger J Clin Pract* 2015 18: 8–12.
4. Filho AG, Moda L, Oliveira R. Prevalence of dental anomalies on panoramic radiographs in a population of the state of Pará, Brazil. *Indian J Dent Res* 2014 25: 648–652.
5. Kuhlberg AJ, Norton LA. Pathologic findings in orthodontic radiographic images. *Am J Orthod Dentofacial Orthop* 2003 123: 182–184.
6. Bondemark L, Jeppsson M, Lindh-Ingildsen L *et al*. Incidental findings of pathology and abnormality in pretreatment orthodontic panoramic radiographs. *Angle Orthod* 2006 76: 98–102.
7. Vallo J, Suominen-Taipale L, Huumonen S *et al*. Prevalence of mucosal abnormalities of the maxillary sinus and their relationship to dental disease in panoramic radiography: results from the Health 2000 Health Examination Survey. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2010 109: e80–e87.
8. Tetradis S, Kantor ML. Prevalence of skeletal and dental anomalies and normal variants seen in cephalometric and other radiographs of orthodontic patients. *Am J Orthod Dentofacial Orthop* 1999 116: 572–577.
9. Kantor L, Norton LA. Normal radiographic anatomy and common anomalies seen in cephalometric films. *Am J Orthod Dentofac Orthop* 1987 1987: 414–426.
10. Pérez IE, Chávez AK, Ponce D. Frequency of sella turcica bridge and clinoid enlargement in lateral cephalometric plain film radiography from Peruvians. *Int J Morphol* 2013 31: 373–377.
11. Kucia A, Jankowski T, Siewniak M *et al*. Sella turcica anomalies on lateral cephalometric radiographs of Polish children. *Dentomaxillofac Radiol* 2014 43: 20140165.
12. Sanchez T, De la Fuente H, Diaz A. Alterations and pathologies prevalence in panoramic radiographs in patients attending the University Dental Clinic. *Int J Odontostomat* 2013 7: 47–52.
13. Ellis E, Hupp JR. Section III surgical pathology. *J Oral Maxillofac Surg* 2015 73: 30–56.
14. Najjar T. Surgical oral and maxillofacial pathology. *J Oral Maxillofac Surg* 2004 62: 103–104.
15. Tetradis S, Kantor ML. Anomalies of the odontoid process discovered as incidental findings on cephalometric radiographs. *Am J Orthod Dentofacial Orthop* 2003 124: 184–189.
16. Genc A, Namdar F, Goker K *et al*. Taurodontism in association with supernumerary teeth. *J Clin Pediatr Dent* 1999 23: 151–154.
17. Rushton VE, Horner K, Worthington HV. Screening panoramic radiology of adults in general dental practice: radiological findings. *Br Dent J* 2001 190: 495–501.
18. MacDonald-Jankowski DS. Calcification of the stylohyoid complex in Londoners and Hong Kong Chinese. *Dentomaxillofacial Radiol* 2001 30: 35–39.
19. Okabe S, Morimoto Y, Ansai T *et al*. Clinical significance and variation of the advanced calcified stylohyoid complex detected by panoramic radiographs among 80-year-old subjects. *Dentomaxillofac Radiol* 2006 35: 191–199.

20. Garay I, Olate S. Osificación del Ligamento Estilohioideo en 3.028 Radiografías Panorámicas Digitales. *Int J Morphol* 2013 31: 31–37.

21. Polder BJ, Van't Hof MA, Van Der Linden FPGM *et al.* A meta-analysis of the prevalence of dental agenesis of permanent teeth. *Community Dent Oral Epidemiol* 2004 32: 217–226.

22. Saberi E, Ebrahimipour S. Evaluation of developmental dental anomalies in digital panoramic radiographs in Southeast Iranian Population. *J Int Soc Prev Community Dent* 2016 6: 291–295.

23. Zachrisson BU. Global trends and paradigm shifts in clinical orthodontics. *World J Orthod* 2005 6(Suppl): 3–7.

24. Keim RG, Gottlieb EL, Nelson AH *et al.* JCO, Orthodontic Practice Study. Part 1. Trends. *J Clin Orthod* 2013 47: 661–680.

25. Edwards R, Alsufyani N, Heo G *et al.* The frequency and nature of incidental findings in large-field cone beam computed tomography scans of an orthodontic sample. *Prog Orthod* 2014 15: 37.

26. Rheem S, Nielsen IB, Oberoi S. Incidental findings in the maxillofacial region identified on cone-beam computed tomography scans. *J Orthod Res* 2013 1: 33–39.

27. Lopes IA, Tucunduva RM, Handem RH *et al.* Study of the frequency and location of incidental findings of the maxillofacial region in different fields of view in CBCT scans. *Dentomaxillofac Radiol* 2017 46: 20160215.

28. American Academy of Oral and Maxillofacial Radiology. Clinical recommendations regarding use of cone beam computed tomography in orthodontics. [corrected]. Position statement by the American Academy of Oral and Maxillofacial Radiology. *Oral Surg Oral Med Oral Pathol Oral Radiol* 2013 116: 238–257.

29. National Council on Radiation Protection & Measurements. Radiation Protection in Dentistry (Report No. 145). Bethesda, MD: NRCP Publications; 2003.

30. Kundel HL, Nodine CF. A visual concept shapes image perception. *Radiology* 1983 Feb; 146(2): 363–368.

Correspondence to:
Sonia P. Plaza,
CIEO University (UniCIEO),
Cra 23 # 124-70 Bogota,
Colombia.
Email: orthoplaza@hotmail.com

APPENDIX 1

Guide to systematic review of the lateral cephalogram and pananoramic radiographs

This guide is based on the study of Kantor and Norton[9] and has been adapted for the research 'Incidental findings in pre-orthodontic treatment radiographs' with the aim of establishing a methodological criteria for the systematic review of diagnostic images and aid in achieving consistency in the observer's evaluation.

- The radiographs are will be evaluated by the observer(s) under standardised conditions with reduced ambient lighting, quiet surroundings, and the elimination of peripheral light in order to improve visual acuity
- The pair of images of the same patient (lateral cephalogram and the panoramic) will be observed consecutively in order to avoid duplication of the findings
- No more than 30 pairs of radiographs will be observed per day to avoid biases in the evaluation caused by fatigue
- One or two other investigators will accompany the expert observer to insure that the protocol will be followed and record the findings in the database
- When there is a doubt regarding a finding, an interconsultation will be held with another expert evaluator in order to reach an agreement
- The observer will be seated comfortably in front of the screen with conditions properly and carefully adjusted regarding light intensity, focus and contrast
- We will first use the global (top-down)[30] theory of visual perception resulting from rapid parallel processing of the entire retinal image by means of pattern recognition and rapid association with previously acquired visual concepts. Then we will use the analytic (bottom-up) theory[30] to extract features from the incoming visual data and use logical rules to combine them in meaningful ways. This implies a gradual buildup of the perception, particularly in the features that must be acquired by the foveal vision (center of the field of vision is focused in this region)
- The observer will start with the lateral cephalogram radiography reading from the top of the radiograph to the bottom, and after a global visualisation of the image is made (global perception), the observation will be done by topographic location consecutively in cranium, paranasal sinus, maxillary/mandible, teeth, face and neck (analytic perception)
- At the moment that the observer establishes a finding, the researcher entering information into the database should be given the diagnostic hypothesis and the characteristic of the radiodensity of the finding
- Later, after a global visualisation of the image (global perception) is established, the observer will continue with the panoramic radiograph, going left to right, down and clockwise (analytics perception)
- At the moment that the observer makes a finding, the researcher entering information into the database should be given the diagnostic hypothesis, topographic location and the characteristic of radiodensity of the finding.

