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Screening panoramic radiographs in children: prevalence data and implications

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Abstract

The purpose of this paper was to review the rationale for the radiographic screening of asymptomatic pediatric patients and to report the prevalence of selected pathologic and developmental conditions using panoramic radiographs. Three observers participated in this retrospective study that utilized panoramic radiographs from 849 subjects, aged 3–9 years, chosen randomly from the School of Dentistry treatment records of the University of North Carolina at Chapel Hill. Findings indicated that 2.4% of the subjects had supernumerary teeth, 7.8% were missing permanent teeth, 9.1% had ectopic eruption, 0.1% had radiolucencies of the jaws, and 0.1% had radiopacities of the jaws. These prevalences are discussed in light of recent evidence concerning the risk/benefit ratio of the panoramic radiograph. We conclude that the panoramic radiograph is a poor projection for screening the dental needs of asymptomatic healthy children; alternative screening protocols should be examined.

To provide a context for this investigation's necessity, results, and implications, this section will review: 1) the utility of screening radiographs; 2) the utility of screening panoramic radiographs in children; and 3) selected pathologic and developmental conditions and their treatment implications that may warrant screening panoramic radiographs in children.

Radiographs are vital in the treatment of pediatric dental patients, but concern in the public and professional sectors recently has escalated because of the unknown risks associated with ionizing radiation exposure (Brooks and Joseph 1985). Human epidemiologic studies (National Academy of Sciences-National Research Council 1980) suggest that even at extremely low doses, a positive relationship exists between ionizing radiation dose and cancer induction. Of equal concern is the possibility that the effects of ionizing radiation are additive (Valachovic and Lurie 1980). It is important to acknowledge that the minimum dose of radiation causing genetic or somatic damage has not been determined (Fabrikant 1982). Pediatric populations warrant heightened concern, because children are more susceptible to ionizing radiation than adults (Goepp 1982).

Radiographic Screening

Various radiographic protocols have been proposed to screen for asymptomatic pathologic and developmental conditions that are not apparent from a clinical examination. The logic in screening radiographs is that the radiation risk will be justified by the early identification of a significant number of treatable conditions, and, therefore, morbidity and mortality will be reduced. An example of a widely used and accepted screening radiographic protocol is the posterior bite-wing radiograph, used to detect interproximal dental caries. Because we assume the bite-wing radiograph has a low radiation burden, and the discovery of dental caries usually is followed by treatment, screening with bite-wing radiographs appears sound and defensible.

Screening radiographs have been recommended for asymptomatic dental developmental and pathological conditions in the early mixed dentition years (AAPD Conference Proceedings 1982; Joseph 1987). Regrettably, the efficacy of this practice is unknown.

Radiographic screening is not accepted universally without question. Valachovic and Lurie (1980) argued that radiographic screening is an inappropriate, low-yield procedure with an unfavorable risk/benefit ratio. They argued that specific conditions should exist before any projection can be justified. In many instances, a positive finding on a screening panoramic radiograph must be confirmed with a subsequent film, because the original finding was poorly imaged due to inherent distortion. Furthermore, they contend that a thorough review of the patient's medical and dental histories and a clinical examination, would have revealed the indications for the subsequent radiograph initially.

Similarly, Lervik and Cowley (1983) considered the data available for numerous conditions together with their treatment implications for children. They concluded that the appropriate number and type of screening radiographs for children have not been established, nor is there sufficient evidence to claim that radiographic screening contributes to improved dental health in a significant part of the population.

In summary, except for bite-wing radiographs, there is no consensus that screening radiographs are justified in pediatric patients, whether the target of the diagnostic inquiry is occult pathology or developmental anomalies.

Screening Panoramic Radiographs in Children

The conference sponsored by the AAPD (1982) that endorsed radiographic screening during the early mixed dentition years suggested this examination could consist of bite-wing radiographs plus a panoramic radiograph. Several other investigators concur with the conference's position concerning panoramic radiographic screening. Buenviaje and Rapp (1984) suggested that the panoramic radiograph improved the possibility of early detection of dental anomalies and potentially reduced the number of intraoral films exposed and radiation delivered. Khanna and Harrop (1973) studied several alternatives to determine a satisfactory radiographic survey for children ages 2–13 years. They recommended a 5-film radiographic examination consisting of 2 bite-wing radiographs, a maxillary occlusal, a mandibular occlusal, and a panoramic radiograph. Although Cherrick (1982) stated that screening radiographs in children are generally nonproductive except for bite-wing radiographs, he advocated that a child probably should have a screening panoramic radiograph during the initial visit and another when the permanent dentition erupted.

Further support for the screening panoramic radiograph was provided by Bergstrom (1976) who stated that nearly 11% of children had anomalies or pathologic conditions, and approximately 8% had conditions that were important to diagnose using the panoramic radiograph. Rolling (1978) stated that the panoramic radiograph was used for diagnostic purposes and timing of treatment planning in 84% of the 9 to 10-year-olds examined. Unfortunately, only the presence or absence of malocclusion was reported.

Not all clinicians favor the panoramic radiograph as a screening survey. Barrett et al. (1984) examined screening panoramic radiographs and found that only 4.8% of their sample required definitive treatment as a result of this projection, and none had a serious condition. Approximately 25% of their sample was 10 years of age or younger, but no analysis was performed to determine if age was a significant variable.

Other investigators have questioned the efficacy of screening panoramic radiographs. Valachovic and Lurie (1980) stated that in many cases a thorough history and clinical exam could have eliminated the need for a panoramic radiograph, and they contended that the vast majority of panoramic radiographs taken in the United States today are unnecessary, potentially inaccurate, and confusing.

White and Weissman (1977) examined the rationale often cited for exposing screening panoramic radiographs; that is, the expectation that a significant number of lesions will be revealed by the panoramic radiograph that will not be revealed by intraoral projections. They determined that in 3059 sets of panoramic and full-mouth radiographs for patients of unidentified ages, the panoramic radiograph revealed conditions not revealed by the intraoral projections in only 5.3% of the subjects. However, treatment was required for only 0.1% of the subjects. Similar low prevalences of positive findings and need for treatment have been found by Kogon and Stephens (1982) and White et al. (1982).

Zeichner et al. (1987) investigated the efficacy of dental radiographs for the detection of intraosseous lesions in asymptomatic patients. Their study utilized health insurance records from 30 million adults and calculated the prevalence of asymptomatic malignant and benign intraosseous lesions to be less than 5 cases per 1 million subjects per year and less than 100 cases per 1 million subjects per year, respectively. Zeichner et al. (1987) concluded that dental radiography is not an efficacious method for screening for occult intraosseous pathology, emphasizing that panoramic radiography is a particularly poor method for this purpose. Although this study used adults, it is likely that these findings are applicable to children.

In summary, the rationale for screening radiographs, with the exception of bite-wing radiographs, appears questionable. The panoramic radiograph appears to be a particularly poor projection for screening.

Data Available from Panoramic Screening in Children

This section will consider the data available concerning developmental and pathological conditions in children revealed by panoramic radiographs. Special attention will be given to the prevalence of the condition and the treatment implications following discovery of the condition.

Supernumerary teeth have been reported by most panoramic radiographic studies. These teeth are limited almost exclusively to the maxillary anterior region and have a low prevalence of 0.46–1.7% (Ravn and Nielsen

1973; Bergstrom 1977; Alattar et al. 1980; Locht 1980; Buenviaje and Rapp 1984; Pilo et al. 1987). Inverted supernumerary teeth and those affecting the eruption of adjacent teeth have treatment implications even prior to permanent tooth eruption (Primosch 1981).

The prevalence of congenitally missing teeth has been reported to be 7.4–8.6% (Ravn and Neilsen 1973; Bergstrom 1977; Alattar et al. 1980; Locht 1980; Pilo et al. 1987). Depending upon the treatment philosophy of either orthodontic space closure or prosthetic replacement of the missing teeth, the relevance of the finding, and therefore the treatment implications, can vary.

Fusion and gemination have a reported prevalence of 0.3% (Pilo et al. 1987). This prevalence makes screening for these problems very difficult to justify, even though discovery of the condition could lead to a treatment decision.

Problems of abnormal shapes and their prevalence have been reported as: hypoplastic teeth and microdontia 1.6–5.7% (Locht 1980; Pilo et al. 1987), dens invaginatus 0.57% (Pilo et al. 1987), and taurodontism 1.0% (Pilo et al. 1987). Pilo et al. (1987) determined that the panoramic radiograph was inferior to periapical views for detecting these problems. Treatment decisions are rarely made prior to eruption but, rather, following eruption when crown morphology can be evaluated. Therefore, screening for these conditions may be irrelevant.

Ectopic eruption is another developmental anomaly reported commonly. The prevalence of posterior (permanent maxillary first molar) ectopic eruption has been found to be 3.1% by Pulver (1968) and Young (1957), both of whom included teeth in the "jump" and "hold" categories. Kimmel et al. (1982) reported ectopic eruption of the permanent first molar to be 3.8% in a sample of 5277 subjects. Bjerklin and Kurol (1983) noted that prevalences have been reported ranging between 2 and 5.99%. Ectopic eruption of anterior teeth has been reported by O'Meara (1962) and Byrd (1954) to be more prevalent than for posterior teeth. None of these data were obtained from panoramic radiographs but, rather, bite-wing and periapical views. The panoramic radiograph never has been systematically used to detect ectopic eruption. Ectopic eruption can have great impact on treatment decisions regarding interceptive tooth movement, primary tooth extraction, and evaluation of mixed dentition crowding status.

The panoramic radiograph has been used to screen for other asymptomatic conditions with more serious implications including malignant or benign osseous lesions, which can manifest as radiolucencies or radiopacities. The literature offers little information concerning the prevalence of asymptomatic osseous lesions in pediatric patients. Using oral examinations, full-mouth intraoral radiographs, panoramic radiographs, and follow-up diagnostic procedures (biopsy evaluation), Balis (1981) determined the prevalence of osseous lesions in 711 subjects 9–11 years old. The panoramic radiograph revealed 4 odontomas, 1 primordial cyst, 1 dentigerous cyst, 1 localized fibrous dysplasia, 1 radiopacity, and 2 "cysts," or a prevalence of approximately 1.5%. Locht (1980) examined panoramic radiographs from 704 apparently healthy Danish children age 9–10 years and reported less than 10 cases of odontogenic/nonodontogenic tumors and nonodontogenic cysts, or a maximum prevalence of 1.1%. He reported 42 cases of dentigerous cysts in this population, or an approximate prevalence of 6%. A dentigerous cyst was defined as a space of more than 3 mm around the tooth germ visualized on the radiograph, and no biopsy evaluations were reported. Of interest, 79% of these conditions were located in the anterior maxilla. These lesions can have serious treatment and health consequences, but have a low prevalence. The prevalence could be lower or higher in the early mixed dentition, but no data from panoramic radiographs are available.

This review of the literature has demonstrated that radiographic screening, and specifically panoramic screening, are not uniformly advocated or accepted. It also is clear that only a handful of conditions merit screening evaluation based on prevalence and/or treatment implications. These include: supernumerary teeth, congenitally missing teeth, ectopic eruption, and radiolucencies and radiopacities of nonodontogenic origin. Prevalences of the latter three conditions have not been demonstrated in children using this projection.

Critical evaluation of the screening panoramic radiograph is warranted because it has been recommended for use in the mixed dentition years (AAPD Conference Proceedings 1982; Joseph 1987) and often is used for screening younger children. Data collected from randomly chosen active general practitioners in North Carolina indicate that nearly 30% screen patients 6 and younger using a panoramic radiograph (HW Fields and DCH Dilley, unpublished data 1984). A national survey of general dentists, pediatric dentists, and periodontists found that 21% would obtain a panoramic radiograph as an initial film in the primary dentition and 42% would obtain this radiograph as an initial film in the transitional dentitions (K Atchison, unpublished personal communication, 1988). It is apparent that because of the ease of obtaining a panoramic radiograph and the global survey it provides, many practitioners have extended its use as a screening film beyond currently recognized indications.

The purpose of this study was to determine the prevalence of the conditions noted above in the pre- and early mixed dentition age groups as revealed by the screening panoramic radiograph and to review the usefulness of this screening procedure as recommended

and practiced. Previous studies have not investigated the usefulness of the screening panoramic radiograph for this set of conditions in this age group or emphasized conditions with treatment implications.

Methods and Materials

This retrospective study examined screening panoramic radiographs from 849 subjects chosen randomly from School of Dentistry treatment records of the University of North Carolina at Chapel Hill. Each subject had an initial radiograph exposed without regard to the treatment needs as institutional policy. Subjects ranged in age from 3 years 1 month to 9 years 11 months. The distribution of ages is displayed in Fig 1. All had at least

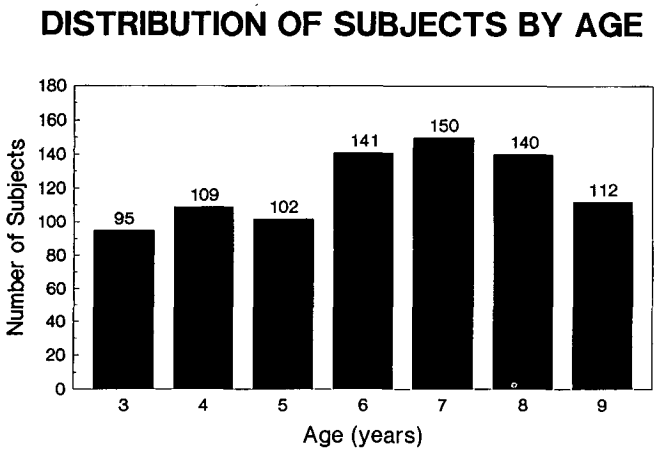

Fig 1. Age distribution of the 849 subjects examined in this study.

1 panoramic radiograph available for inspection. These radiographs were exposed on a Panorex (S.S. White Dental Products International, Penwalt Corporation, Philadelphia, PA, USA) unit.

A screening radiograph is defined as one that examines the field of exposure for problems not suspected from history or examination. The conditions chosen in this study were selected because they are discernable radiographically and because of their treatment implications; they are of relevance to the clinician who treats children. The conditions included supernumerary and missing permanent teeth, ectopic eruption of permanent molars and incisors with concomitant resorption, and radiopacities and radiolucencies of the jaws not attributable to an infectious process of odontogenic origin.

Three observers participated in a training/calibration session in which 25 radiographs known to contain the conditions of interest were viewed. Each observer viewed the radiographs independently, and then all 3 observers viewed the radiographs together. The independent sessions were scored, and standard diagnoses were made during the group sessions. Two additional sessions were held to determine intraobserver reliability. In these 2 sessions (held 1 week apart), 40 radiographs known to contain the conditions of interest and control radiographs not including the conditions of interest were viewed by each observer. Intraobserver agreement was determined for each observer using the Kappa statistic.

During the study each radiograph was reviewed independently by two observers. All were examined for the conditions of interest on a radiographic viewbox in a dark room where extraneous light was eliminated. Interexaminer discrepancies were resolved by a consensus of the three observers.

Specific rules applied to specific conditions. Teeth were considered missing bilaterally if complete crown formations should have occurred by the identified dental age of the patient. In instances when a single tooth was suspected missing, it was considered missing only when there was at least complete crown formation of the contralateral tooth. Records of patients with missing anterior teeth were reviewed to determine that overlying primary teeth were present or that there was no history of trauma. Radiopacities were considered supernumerary when they had identifiable tooth form; otherwise they were classified as radiopacities of the jaw. Radiolucencies less than 5 mm in diameter associated with unerupted maxillary canine crowns were considered normal developmental phenomenon (Worth 1963) and were not counted as radiolucencies. Ectopic eruption was counted only if the erupting tooth was in contact with an erupted tooth that demonstrated resorption. Residual effects of ectopic eruption were not counted.

Prevalence values were calculated by dividing the number of subjects with the condition of interest by the total number of subjects.

Results

Using the Kappa statistic, intraexaminer reliability during the prestudy sessions was calculated to be 0.88, 0.96, and 0.98 for the 3 reviewers. Mean intraexaminer reliability was calculated to be 0.94.

The prevalence of the conditions of interest were: supernumerary teeth—2.4%; missing permanent teeth—7.8%; ectopic eruption by permanent incisors or molars with concomitant resorption—9.1%; radiolucencies in the jaws not attributable to an infectious process of odontogenic origin—0.1%; and radiopacities in the jaws—0.1% (Table 1). The conditions discovered and the age of diagnosis are displayed in Fig 2.

Discussion

The Kappa values for training intraobserver reliability (0.88–0.98) were well above the 0.76 level that indi-

cates excellent agreement beyond the chance level. Interobserver reliability was not calculated, because all interexaminer discrepancies were resolved by a consensus of the 3 observers.

The prevalence values in this study compare favorably with those reported in the literature. The literature reports a prevalence of 0.46–1.7% for supernumerary teeth in the pediatric population using the panoramic radiograph (Locht 1980; Buenviaje and Rapp 1984). The prevalence of congenitally missing permanent teeth has been reported to range from 3.7 to 10.0% when determined radiographically (Pilo et al. 1987). Our prevalence findings for supernumerary and missing permanent teeth, 2.4% and 7.8%, respectively, are near the ranges of those reported by others. The higher prevalence of supernumerary teeth approximates the values found by Parry and Iyer (1961) who surveyed a group of patients referred for orthodontic care using intraoral radiographs. Prevalence values for missing teeth in this study would be expected to be low because the lower one-third of the sample age group would not be expected to demonstrate missing premolars.

TABLE 1. Prevalences of the Conditions of Interest Discovered Using Screening Panoramic Radiographs (N = 849)

Condition of Interest	*Prevalence (%)*
Supernumerary Permanent Teeth	2.4
Missing Permanent Teeth	7.8
Ectopic Eruption (molars and incisors)	9.1
Radiolucencies	0.1
Radiopacities	0.1

Prevalence values for ectopic eruption of permanent first molars in this study exceed those usually cited (Young 1957; Pulver 1968; Kimmel et al. 1982; Bjerklin and Kurol 1983). These reports do not include ectopic eruption in the anterior area, so these prevalences are expected to be lower than the 9.1% found in this study.

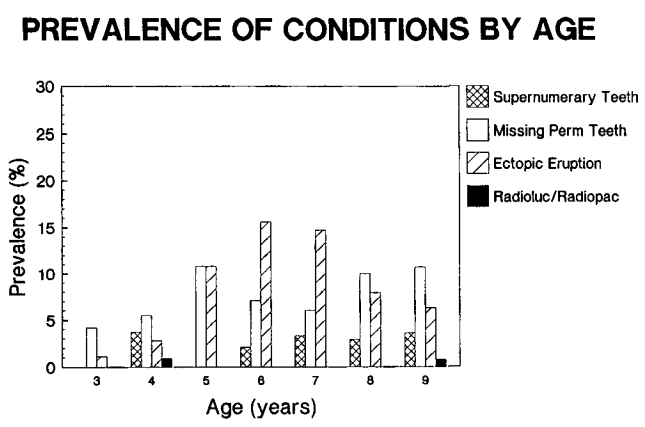

Fig 2. Distribution of the conditions of interest among the ages investigated in this study.

Interestingly, younger subjects could not demonstrate this problem which should have reduced the prevalence of ectopic eruption in this sample. It is an extremely difficult task to diagnose ectopic eruption with a great deal of confidence when viewing a panoramic radiograph. It is possible that the distortion produced by this tomograph has inflated the prevalence of the ectopic eruption.

The prevalence values for radiolucencies and radiopacities of the jaws, 0.1% for each, represent one positive finding of each condition in a sample of 849 subjects. The values for radiolucencies are lower than those previously reported by other studies (Locht 1980; Balis 1981). Locht (1980) interpreted any radiolucency greater than 3 mm associated with an unerupted tooth to be a dentigerous cyst, while Worth (1963) would have considered a radiolucency less than 5 mm to be a normal developmental phenomenon. Other explanations for this difference may be that the sample examined in this investigation had a low prevalence of intraosseous lesions; the age differences between the two studies may account for the differences; or that the panoramic radiograph failed to image the lesions. Based on the data of this investigation, it appears that occult intraosseous lesions in children 3–9 years are rare.

If one were to screen in the pre- and early mixed dentition years for pathologic or developmental problems with a panoramic radiograph, supernumerary and congenitally missing teeth would be discovered. Ectopically erupting teeth may be difficult to diagnose accurately and may demonstrate an inflated prevalence. Based on their prevalence, asymptomatic radiolucencies and radiopacities probably would not be worthy screening objectives in this age group.

Another point to note is that the data from this study seem to suggest that the prevalence of the conditions of interest are not the same at all ages (Fig 2). This may have occurred either because the sample sizes for each age were not equal, or the conditions do not have equal prevalence at each age. It is almost certain that the diagnostic yield of radiographs changes with age; however, the size of our data set did not allow further investigation of this point.

Another significant issue to be considered is the radiation burden associated with the panoramic radiograph. Because of their shorter head height, children may have certain radiosensitive anatomic structures (thyroid gland and the hematopoietic tissues of the mandible) positioned directly within the radiation beam (Myers et al. 1978). The panoramic radiograph (using high-speed rare earth screens and orthochromatic green-sensitive films) was compared to a 21-film, full-mouth series and to 4 bite-wing radiographs (using rectangular collimation and E speed film) in terms of risk (probability of stochastic effect) for young adult

females by Gibbs et al. (1988a; 1988b). Stochastic effect is defined as a lethal cancer or mutation expressed in the first two postirradiation generations. These estimates represent the state of the art in risk determination for dental radiography. In essence they estimated patient risk from a single panoramic radiograph to be "somewhat" less than that from a 21-film, full-mouth series, but greater than 4 interproximal radiographs. Logic would dictate that the risks would be increased when these state-of-the-art exposure techniques are not utilized.

Other findings from the dosimetric literature estimated the risk of causing a radiation-induced malignancy with screening panoramic radiographs to be 2–17 cases per 1 million subjects per year (Zeichner et al. 1987). More importantly, these authors calculated the prevalence of asymptomatic benign intraosseous lesions to be less than 100 cases per 1 million subjects per year and the prevalence of asymptomatic malignant intraosseous lesions to be less than 5 cases per one million subjects per year. Thus, the possibility exists that the benefits of screening for occult malignant pathology in adult patients may be outweighed by the damage imparted by ionizing radiation. Because children are more susceptible to ionizing radiation, these findings are especially relevant.

It is possible that other projections or combinations of projections are more efficacious in terms of their diagnostic capability and radiation burden. The bite-wing radiograph will be used to screen for interproximal caries in many of these pre- and early mixed dentition children. Coincidentally, the bite-wing radiograph also appears to be the best projection to screen for permanent molar ectopic eruption with no increased radiation burden. Some bite-wing radiographs will provide coverage of the unerupted premolars and will obviate the need for panoramic or periapical radiographs to diagnose missing teeth in this region.

Substitution of a maxillary occlusal radiograph for a panoramic radiograph may be a reasonable alternative that should be examined. Most of the supernumerary and anterior positional problems, including ectopic eruption, are in the anterior maxilla and by our determination and others (Pilo et al. 1987) probably not best viewed on a panoramic radiograph. Therefore, with more clarity and less radiation than a panoramic radiograph (Gibbs et al. 1988a,b), the maxillary occlusal radiograph is capable of revealing the most common supernumerary teeth, the most commonly missing anterior teeth, anterior positional problems, and uncommon occult pathology that exists in this region.

Further study is needed to corroborate the prevalence of radiolucencies and radiopacities found in this investigation and to establish the location and age of onset of these lesions. The objective of using radiographs should be to maximize diagnostic information while minimizing the radiation burden. This study suggests that the panoramic radiograph is a poor projection for assessing the dental needs of healthy asymptomatic children and that other alternatives warrant objective examination.

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Alattar MM, Baughman RA, Collett WK: A survey of panoramic radiographs for evaluation of normal and pathologic findings. Oral Surg 50:472-78, 1980.

American Academy of Pediatric Dentistry: Conference proceedings, Radiation exposure in pediatric dentistry. Pediatr Dent 3:461-63, 1982.

Balis SJ: Error and accuracy rates of panoramic radiography as a screening method for mass surveying of children. J Public Health Dent 41:220-34, 1981.

Barrett AP, Watson BE, Griffiths CJ: A critical evaluation of panoramic radiographs as a screening procedure in dental practice. Oral Surg 57:673-77, 1984.

Bergstrom K: Rontgenortopantomogram av skolbarn. Tandlakartidningen (Stockholm) 68:1201-207, 1976.

Bergstrom K: An orthopantomographic study of hypodontia, supernumeraries and other anomalies in school children between the age of 8–9 years. Swed Dent J 1:145-57, 1977.

Bjerklin K, Kurol J: Ectopic eruption of the maxillary first permanent molar. Am J Orthod 84:147-55, 1983.

Brooks SL, Joseph LP: US Dept. of Health and Human Services. Basic concepts in the selection of patients for dental X-ray examinations. FDA Publication 85-8249, September 1985.

Buenviaje TM, Rapp R: Dental anomalies in children: A clinical and radiographic survey. ASDC J Dent Child 51:42-6, 1984.

Byrd WM: Prevalence of ectopic eruption of the permanent teeth in children between 5 and 10 years of age. Master's Thesis, University of North Carolina, 1954.

Cherrick HM: Radiology in the diagnosis of oral pathology in children. Pediatr Dent 3:423-32, 1982.

Fabrikant JI: Risk estimation and decision making: The health effects on populations of exposure to low levels of ionizing radiation. Pediatr Dent 3:400-13, 1982.

Gibbs SJ, Pujol Jr A, Chen TS, James Jr A: Patient risk from intraoral dental radiography. Dentomaxillofac Radiol 17:15-23, 1988a.

Gibbs SJ, Pujol A, McDavid WD, Welander U, Tronje G: Patient risk from rotational panoramic radiography. Dentomaxillofac Radiol 17:25-32, 1988b.

Goepp RA: Risk/benefit considerations in pedodontic radiology. Pediatr Dent 3:437-40, 1982.

Joseph LP: US Dept. of Health and Human Services. The selection of patients for X-ray examinations: dental radiographic examinations. FDA Publication 88-8273, October 1987.

Kimmel NA, Gellin ME, Bohannan HM, Kaplan AL: Ectopic eruption of maxillary first permanent molars in different areas of the United States. ASDC J Dent Child 49:294-99, 1982.

Khanna SL, Harrop TJ: A five-film oral radiographic survey for children. ASDC J Dent Child 40:42-8, 1973.

Kogon SL, Stephens PG: Selective radiography instead of screening pantomography—a risk/benefit evaluation. Can Dent Assoc J 48:271-75, 1982.

Lervik T, Cowley G: Dental radiographic screening in children. ASDC J Dent Child 50:42-7, 1983.

Locht S: Panoramic radiographic examination of 704 children aged 9–10 years. Community Dent Oral Epidemiol 8:375-80, 1980.

Myers DR, Shoaf HK, Wege WR, Carlton WH, Gilbert MA: Radiation exposure during panoramic radiography in children. Oral Surg 46:588-93, 1978.

National Academy of Sciences–National Research Council: The effects on population of exposure to low levels of ionizing radiation. Committee on the Biological Effects of Ionizing Radiation. Washington, DC, 1980.

O'Meara W: Ectopic eruption pattern in selected permanent teeth. J Dent Res 41:607-16, 1962.

Parry RR, Iyer VS: Supernumary teeth amongst orthodontic patients in India. Br Dent J 111:257-58, 1961.

Pilo R, Kaffe I, Amir E, Sarnat H: Diagnosis of developmental dental anomalies using panoramic radiographs. ASDC J Dent Child 54:267-72, 1987.

Primosch RE: Anterior supernumerary teeth-assessment and surgical intervention in children. Pediatr Dent 3:204-15, 1981.

Pulver F: The etiology and prevalence of ectopic eruption of the first permanent molar. ASDC J Dent Child 35:138-46, 1968.

Ravn JJ, Nielsen LA: En orthopantomografisk undersogelse af overtal og aplasier hos 1.530 kobenhavnske skoleborn. Tandlaegebladet (Copenhagen) 77:12-21, 1973.

Rolling S: Orthodontic examination of 2301 Danish children aged 9-10 years in a community dental service. Community Dent Oral Epidemiol 6:146-50, 1978.

Valachovic RW, Lurie AG: Risk-benefit considerations in pedodontic radiology. Pediatr Dent 2:128-46, 1980.

White SC, Forsythe AB, Joseph LP: US Dept. of Health and Human Services. High-yield criteria for panoramic radiography. FDA Publication 82-8186, June 1982.

White SC, Weissman DD: Relative discernment of lesions by intraoral and panoramic radiography. J Am Dent Assoc 95:1117-121, 1977.

Worth HM: Principles and Practice of Oral Radiographic Interpretation. Chicago: Yearbook Medical Publishers, 1963 pp 76.

Young DH: Ectopic eruption of the first permanent molar. ASDC J Dent Child 24:153-62, 1957.

Zeichner SJ, Ruttiman UE, Webber RL: Dental radiography: Efficacy in the assessment of intraosseous lesions of the face and jaws in asymptomatic patients. Radiology 162:691-95, 1987.

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