

**Prescription of Bitewing and Panoramic Radiographs in Pediatric Dental Patients:
An Assessment of Current Trends and Provider Compliance**

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Abstract

Purpose: To evaluate prescription patterns for bitewing and panoramic radiographs (PR) for pediatric and adolescent dental patients following the implementation of the most recent ADA/FDA guidelines. **Methods:** Paid insurance claims data for all 50 states were accessed from January 1, 2013 to June 30, 2019 for patients age 18 years and younger; a 5% random sample population was extracted. Statistical analyses were performed to evaluate various imaging metrics for pediatric dentists (PD) and general practitioners (GP). **Results:** A total of 2,123,735 bitewing images were prescribed during 4,734,249 office visits. The average time interval between bitewing exams ordered by GPs was 13.9 (\pm 7.4) months, and for PDs this average was 13.0 (\pm 6.7) months ($p < .0001$). When divided by age group, 3.5% of all bitewings were taken on patients age 0-4 years. For PRs, 286,824 images were included in the present study. The average time interval between PRs ordered for the same patient was 3.4 (\pm 1.3) years for PDs and 3.3 (\pm 1.4) years for GPs. One percent of all PRs were prescribed for patients age 0-4, with 403 images attributed to PDs and 2348 to GPs. **Conclusions:** PDs were more likely to comply with the guidelines on radiograph prescriptions for pediatric and adolescent patients than GPs. **Practical Implications:** Inclusion of individual caries risk with insurance claims data could be considered for more appropriate administration of dental radiography. Future guidelines should be developed to include more explicit recommendations for prescribing PRs. **Key Words:** Dental radiographs; pediatric dentistry; bitewing; panoramic radiograph; guidelines

Introduction

Radiographs are an adjunct tool utilized by dental professionals when examining patients and comprehensively assessing their oral health status.¹ Imaging of interproximal surfaces provides dentists with a tool for indirect visualization that can assist with the detection of dental caries that may be otherwise overlooked from a clinical exam alone.² Previous studies have shown that clinical examination without the use of radiographic imaging can lead to a significant underestimation of caries detection.² The American Dental Association (ADA) guidelines for dental radiographic examinations state that bitewing examination is the most effective means for detecting carious lesions located on interproximal surfaces.³ Dentists generally begin prescribing bitewings for pediatric patients once the posterior mesiodistal contacts are closed and they are unable to directly visualize the interproximal surfaces of primary dentition.³ Individual risk factors, including caries susceptibility, should be considered when determining the need for radiographs.³ Intraoral images capture only a small region of the mouth and should be analyzed in conjunction with larger extraoral images to obtain a more comprehensive overview of the patient's oral health status.⁴

A panoramic radiograph (PR) is an extraoral image that includes the anatomic structures making up a large region of the oral and maxillofacial complex.⁴ These images are useful in assessing both individual tooth development and the general developmental stage of the growing pediatric patient, in addition to signs of pathosis or inflammation, periodontal status, ankylosis, caries and potential abnormalities of teeth and bone.⁵ PRs are indicated when considering orthodontic treatment and 3rd molar extraction, and are often prescribed in the mixed dentition phase to assess developmental status or investigate clinical abnormalities.^{1,3} A combination of bitewing images and PRs is commonly recommended by dentists during routine examination.¹

Clinical justification for obtaining radiographs is essential for dentists, as they must weigh the risks of exposing patients to an effective dose of radiation with the potential sequelae of undiagnosed and untreated dental caries.⁶ Children are especially susceptible to the effects of radiation because of the rapid mitotic processes at work during growth, in addition to the location of the thyroid gland being in closer proximity to the oral cavity in younger patients.^{7,8} The current ADA guidelines, developed in conjunction with the Food and Drug Administration (FDA), state that radiographs should only be obtained after reviewing a patient's medical history and performing a thorough clinical exam.³ However, a recent nationwide survey of dental hygienists regarding radiography prescription in their offices revealed that 82.4% of patients did not have a clinical examination prior to having radiographs exposed, and 69.9% of respondents reported that radiographs were ordered based on pre-determined schedules.⁹

The most recent ADA/FDA guidelines were published in 2012 and have been adopted by the American Academy of Pediatric Dentistry (AAPD) as recommendations for best practices for prescribing radiographs for pediatric patients and those with special healthcare needs. Different recommendations are provided for patients in primary dentition, mixed dentition and permanent dentition, which are further divided into those undergoing new patient exams and those for recall exams. The guidelines distinguish between recall patients with no clinical caries/at a lower risk for decay and those with clinical decay/at a higher risk for developing caries.^{10,11} There have been only a handful of studies performed that analyze the radiographic prescription patterns of dental professionals specifically for patients 18 years old and younger, however many of these are surveys of practitioners rather than analyses of actual imaging data.¹²⁻¹⁵ Utilizing insurance claims data provides concrete information regarding radiograph prescription trends amongst providers. Whether insurance reimbursement plays a significant role in determining the

frequency of radiograph prescription amongst pediatric dentists and GPs remains inconclusive at this time. This will be the first study that looks specifically at bitewing and PR prescription patterns for pediatric patients following the implementation of the 2012 ADA/FDA guidelines.

The present study hypothesizes that PDs and GPs are not following the 2012 ADA/FDA guidelines on prescribing radiographs for infants, children and adolescents; GPs are less likely to follow the guidelines than PDs when prescribing bitewing radiographs and PRs for patients 18 and younger. The objectives of the present study included (1) assessing dental professional compliance with the ADA and AAPD recommendations for prescription of bitewing and panoramic radiographs for patients 18 and younger; (2) evaluating if differences in prescription trends exist between PDs and GPs; and (3) outlining current trends in dental radiography for pediatric and adolescent patients in the United States.

Methods

The data for the present study was obtained following the standards set forth by the [Omitted] University Institutional Review Board conditions (IRB #1508889495) and the Health Insurance Portability and Accountability Act (HIPAA) from a private data warehouse. Paid commercial insurance claims from all 50 states and the District of Columbia were accessed for claims made from January 1, 2013 to June 30, 2019 for patients age 18 years or younger. Due to the large number of claims included in the total data set, approximating over 156 million individual claims, a 5% random sample population was extracted. Each individual patient identifier in the data set was assigned a random number using the RANUNI function of SAS

software, and then sorted by the computer program using the assigned number; the first 5% of the patient identifications were selected for inclusion in the analyses for the present study. Data collection, randomization and extrapolation were performed by P&R Dental Solutions, LLC, prior to transfer to [Omitted] University for analysis. Calibration of investigators was not required for this study.

The procedure codes include specific Current Dental Terminology (CDT) codes related to 2-, 3- and 4-image bitewing radiographs and PRs. Data for patients 18 years old and younger was abstracted without personal identification markers. Information including patient age at the time of radiographic survey, date, dental practice zip code location, procedure code and a unique identifying number were retained for the purposes of analysis for the present study. The prescribing provider information for each radiograph claim was identified as either a GP or PD. Once collected digitally, the data was transferred to [Omitted] University via Secure File Transfer Protocol with specific login information and encrypted following industry standards. The data was securely stored in a Microsoft SQL server relational database.

The following CDT codes were included in the study: D0272 (bitewings – two radiographic images), D0273 (bitewings – three radiographic images), D0274 (bitewings – four radiographic images), and D0330 (panoramic radiographic image). These codes were selected to represent image modalities most commonly ordered for routine dental examination. Additionally, the following codes for dental examinations were included in the analyses of the radiographic imaging codes: D0120 (periodic oral evaluation – established patient), D0140 (limited oral evaluation – problem focused), and D0150 (comprehensive oral evaluation – new or established patient). While D0140 (limited oral evaluation – problem focused) is often associated with emergency examination and may not technically fall under the category of routine assessment, it

was included in the present study because this examination code is regularly applied to patients being treated in the operating room under general anesthesia who are receiving radiographs.

Separate analyses were performed for panoramic and bitewing radiographs. Summary statistics were calculated for the number and percentage of radiographs prescribed by patient age and provider type (PDs and GPs) and number and percentage of radiographs that are associated with dental examinations by provider types. Claims were standardized by provider specialty to account for differences in the number of GPs and PDs. Chi-square tests were used to test the association between prescription and provider type for each age group. For patients who have received multiple radiographs, frequency intervals were summarized by provider types (mean, standard deviation, and range for interval). Generalized linear mixed effects models were used to test for differences in the prescription pattern between provider types. The models account for correlation among patients treated by the same provider and correlation between visits within a patient.

Results

A total of 2,123,735 bitewing images ordered over the course of 4,734,249 office visits to GPs and PDs comprised the data set included in this analysis (Figure 1). The average time interval between bitewing radiographic exams ordered by GPs was 13.9 (\pm 7.4) months, and for PDs this average was 13.0 (\pm 6.7) months ($p < .0001$) (Table 1a). Time between bitewing exams was divided into intervals of 6 months, and 50.8% (381,960) of all bitewing images ordered by GPs fell into the 12-18-month range; 49.9% (167,524) of all bitewings prescribed by PDs were

ordered within this same 12-18-month interval. While 26.8 % (201,059) of bitewing exams were ordered by GPs and 30.9% (103,667) were ordered by PDs within the 6-12-month range, less than 10% of the bitewing radiographs were prescribed at intervals of 0-6 months, 18-24 months or greater than 24 months (Figure 3).

When divided by age group, 3.5% of all bitewings were taken on patients age 0-4 years, with 42,404 images ordered by PDs and 31,151 by GPs. 31.5% of patients in this youngest age group that visited PDs received bitewings, while only 20.8% of those patients seen by GPs did ($p < .0001$) (Table 2). PDs prescribed more bitewings than GPs on all patients until age 7; after age 9, there was a decline in total bitewings from PDs yet a consistent increase from GPs.

PRs were ordered less frequently than bitewings, and a total of 286,824 images were included in the present study. Between the ages of 7-10 and 17-18, both PDs and GPs saw a notable increase in the number of PRs ordered, with another slight increase around age 13 for GPs (Figure 2). One percent of all PRs were prescribed for patients age 0-4, with 403 images attributed to PDs and 2348 to GPs; when comparing standardized prescription rates within this youngest age group, GPs ordered PRs at a rate of 6 times greater than PDs (Table 3). The average time interval between multiple PRs ordered for the same patient by PDs and GPs were 3.4 (± 1.3) years for PDs and 3.3 (± 1.4) years for GPs ($p < .0001$) (Table 1b). Interval ranges for prescribing multiple PRs for an individual patient were divided by year, and 55.9% of all PRs ordered by PDs and 47.4% of PRs ordered by GPs fell within the 3-4-year time interval (Figure 4).

The vast majority of all bitewings and PRs were ordered by providers along with either a D0120, D0140 or D0150 exam code. Only 2.5-7.3% of all bitewing claims were submitted

without a corresponding dental exam claim within a 7-day time frame; 6.1-9.9% of image claims for PRs were paid without a corresponding exam within one week's time.

Discussion

PDs were more likely to order bitewing radiographs for younger patients than GPs. For patients between the ages of 0-4, PDs prescribed bitewings at a rate of three times greater than their GP counterparts. The guidelines do not recommend bitewing imaging in the primary dentition unless interproximal surfaces cannot be directly visualized, yet the age at which the contacts are approximated may vary based on developmental status. Obtaining intraoral images on younger patients can be inherently more difficult, and may require the advanced behavior management techniques employed by PDs. Additionally, PDs routinely provide care in the operating room and will obtain bitewing radiographs for the purposes of treatment planning while a patient is under general anesthesia. While GPs receive some training in dental school treating pediatric patients, they may choose not to see very young patients in their office and refer them to a specialist for routine care. As patient behavior and compliance likely improved between the ages of 7-9, GPs began prescribing bitewings at a relatively similar standardized rate as PDs.

The vast majority of patients included in the present study had bitewings taken with a corresponding dental examination code administered within 7 days. For patients who received multiple bitewing examinations during the interval considered in the present study, the average time interval of 13.0 months for PDs and 13.9 months for GPs was relatively consistent with insurance reimbursement schedules. The guidelines state that patients considered low-risk for developing caries may be recommended for bitewings at 12-24-month intervals in the primary

and transitional dentition and up to 18-36-month intervals in the permanent dentition.¹⁰ Typical commercial dental insurance plans pay for a set of bitewing radiographs every 12 months, and some premium plans may even offer coverage at 6-month intervals.¹⁶⁻¹⁹ While the guidelines note that the decision for prescribing radiographs is based on a clinical examination and patient risk factors, individual caries risk is not included in a commercial dental claim. The majority of patients prescribed bitewings fell into the 12-18-month interval category for both PDs and GPs, and only very low percentages of patients fell into the 0-6 month or greater-than-18-month ranges. Based on the data, it appears that insurance reimbursement plans play a role in bitewing prescription trends for pediatric and adolescent patients.

The guidelines for prescribing PRs are less clearly outlined than those for bitewings. Children with transitional dentition are recommended for a PR after the eruption of the first permanent tooth; adolescents with permanent dentition prior to the eruption of 3rd molars are recommended for a PR to assess them.³ However, there are no recommendations provided for frequency intervals between PRs or indications other than the assessment of dentofacial growth and dental/skeletal relationships. Most commercial insurance plans pay for a PR every 3-5 years, depending on the insurance provider and plan selected.¹⁶⁻¹⁹ For patients included in the present study that received multiple PRs, the average time interval between extraoral imaging was 3.3 years for GPs and 3.4 years for PDs. While the difference observed between GPs and PDs with regards to PR frequency interval appears clinically insignificant, the similarity promotes the notion that insurance reimbursement has an effect on PR administration. There is a potential correlation between insurance reimbursement and PR prescription frequency, which may be due in part to the vague guidelines regarding extraoral imaging.

The ages at which patients received PRs revealed certain trends from the data set that were distinguishable between PDs and GPs. PDs were more likely to order PRs for patients in the 5-9-years-old age range, as this is when patients enter the mixed dentition stage and is consistent with the guidelines. Both GPs and PDs prescribed PRs at relatively similar rates between the ages of 10-14, which generally coincides with the ages most adolescent patients are evaluated for orthodontic referral and/or treatment. The uptick in PRs at age 17-18 is likely related to 3rd molar observation and treatment planning, however it is important to note that most PRs at this age were ordered by GPs.

PRs are not indicated between the ages of 0-4 because these patients are not yet in transitional dentition. One percent of all the paid insurance claims for PRs fell outside the guidelines, and GPs were significantly more likely to order these images than PDs in this youngest age group. Previous research has found that GPs utilize PRs to evaluate acute problems more frequently than PDs.¹⁵ From a clinical standpoint, the logistics of obtaining a diagnostic PR on a pre-cooperative child remain questionable. The risks of exposing very young patients to higher levels of radiation for extraoral imaging must be considered when the option for lower-irradiating intraoral imaging, such as periapical and bitewing radiographs, is available. Based on paid claims data, GPs were more likely to deviate from the guidelines on radiograph prescriptions with regards to PRs than pediatric specialists.

There are some limitations in our study design or the data available to research. The omission of individual caries risk from dental claims presents one such limitation. The data set only included paid private insurance claims, excluding patients with publicly-funded insurance or those who are self-pay. Many patients enrolled in publicly-funded insurance programs like Medicaid are characteristically classified in lower socioeconomic groups, therefore these results

may be more relative to middle- and upper-income level patients. Private insurance policies and their inclusion criteria vary by company, and differing state regulations contribute to additional nuances. Coverage schedules included in the present study were determined based on the policy examples available, with the understanding that patients may have selective access to different policies.¹⁶⁻¹⁹ Submitted insurance claims are subject to an array of potential errors related to data entry and subsequent auditing; all claims included in the present study were paid by the insurance companies.

Conclusions

Based on the findings of the present study, the following conclusions can be made:

1. Overall, most providers are following the American Dental Association and American Academy of Pediatric Dentistry guidelines on radiograph prescription for patients 18 years and younger.
2. GPs were more likely than PDs to deviate from the guidelines, specifically with regards to PRs.
3. Insurance reimbursement rates may influence when GPs and PDs order routine radiographs for pediatric and adolescent dental patients, therefore inclusion of individual caries risk with insurance claims data should be considered for more appropriate administration of dental radiography.
4. Future guidelines should be developed to include more explicit recommendations for prescribing PRs.

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Tables

Table 1: Time intervals between repeat imaging for individual patients

1a. Bitewing radiographs (months)

	Office Visits	Mean \pm SD (month)	Median (IQR) (month)	95% CI (month)	P-value
General Practitioners	751571	13.9 (\pm 7.4)	12.8 (5.6)	(13.9, 14.0)	<.0001
Pediatric Dentists	336014	13.0 (\pm 6.7)	12.6 (7.0)	(12.9, 13.0)	

1b. Panoramic radiographs (years)

	Office Visits	Mean \pm SD (year)	Median (IQR) (year)	95% CI (year)	P-value
General Practitioners	7782	3.3 (\pm 1.4)	3.4 (1.2)	(3.2, 3.3)	0.0190
Pediatric Dentists	3219	3.4 (\pm 1.3)	3.4 (0.9)	(3.3, 3.4)	

Table 2: Rate of patients receiving bitewings (standardized by provider type)

Image Type	Age (years)	Image	General Practitioners Patient n (%)	Pediatric Dentists Patient n (%)	P-value
Bitewing	0-4	with	27091 (20.8%)	36238 (31.5%)	<.0001
		without	103040 (79.2%)	78800 (68.5%)	
	5-9	with	247195 (70.7%)	169084 (76.8%)	<.0001
		without	102484 (29.3%)	51060 (23.2%)	
	10-14	with	338324 (78.4%)	128269 (77.8%)	<.0001
		without	93363 (21.6%)	36549 (22.2%)	
15-18	with	310649 (76.7%)	53086 (76.1%)	0.0003	
	without	94222 (23.3%)	16677 (23.9%)		

Table 3: Rate of patients receiving panoramic radiographs (standardized by provider type)

Type	Age (years)	Image	General Practitioners Patient n (%)	Pediatric Dentists Patient n (%)	P-value
Panoramic Radiograph	0-4	with	2343 (1.8%)	402 (0.3%)	<.0001
		without	127788 (98.2%)	114636 (99.7%)	
	5-9	with	56559 (16.2%)	43698 (19.8%)	<.0001
		without	293120 (83.8%)	176446 (80.2%)	
	10-14	with	64565 (15.0%)	26680 (16.2%)	<.0001
		without	367122 (85.0%)	138138 (83.8%)	
15-18	with	77613 (19.2%)	11810 (16.9%)	<.0001	
	without	327258 (80.8%)	57953 (83.1%)		

Figure 1: Total procedures – bitewing radiographs

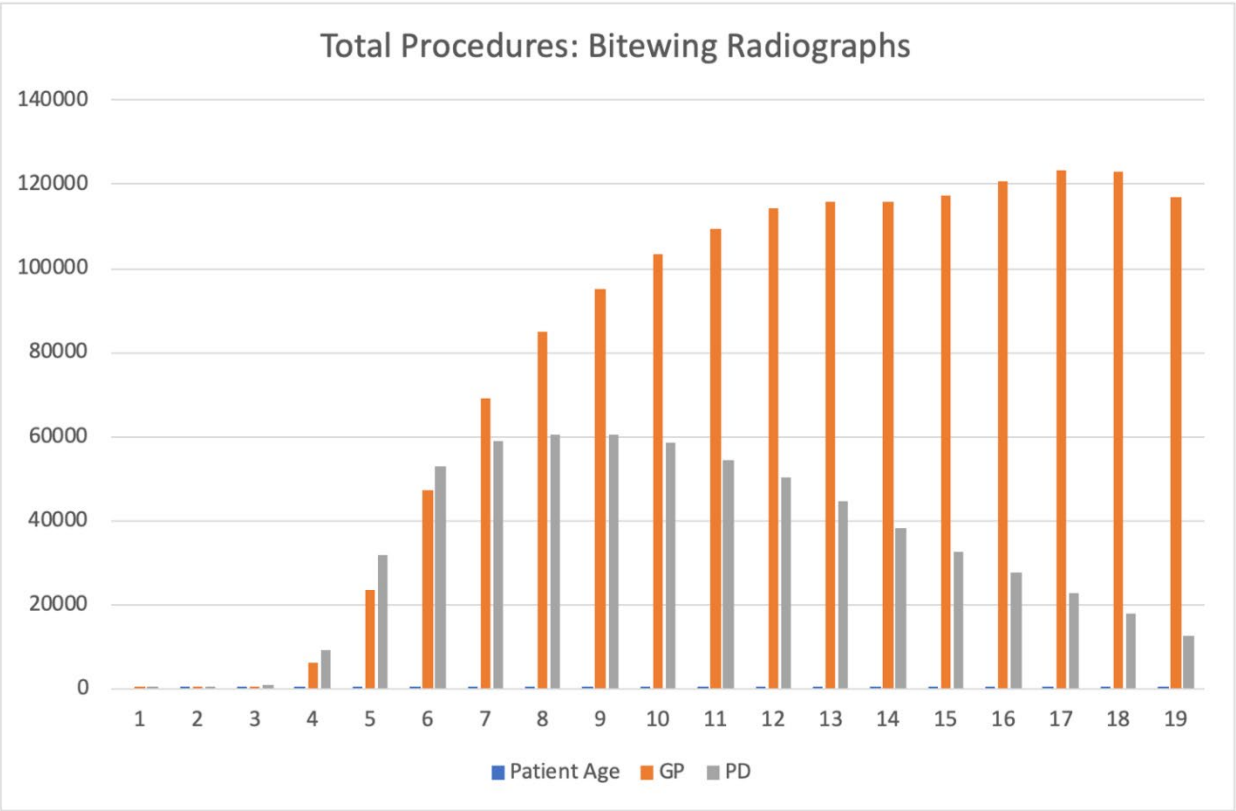


Figure 2: Total procedures – panoramic radiographs

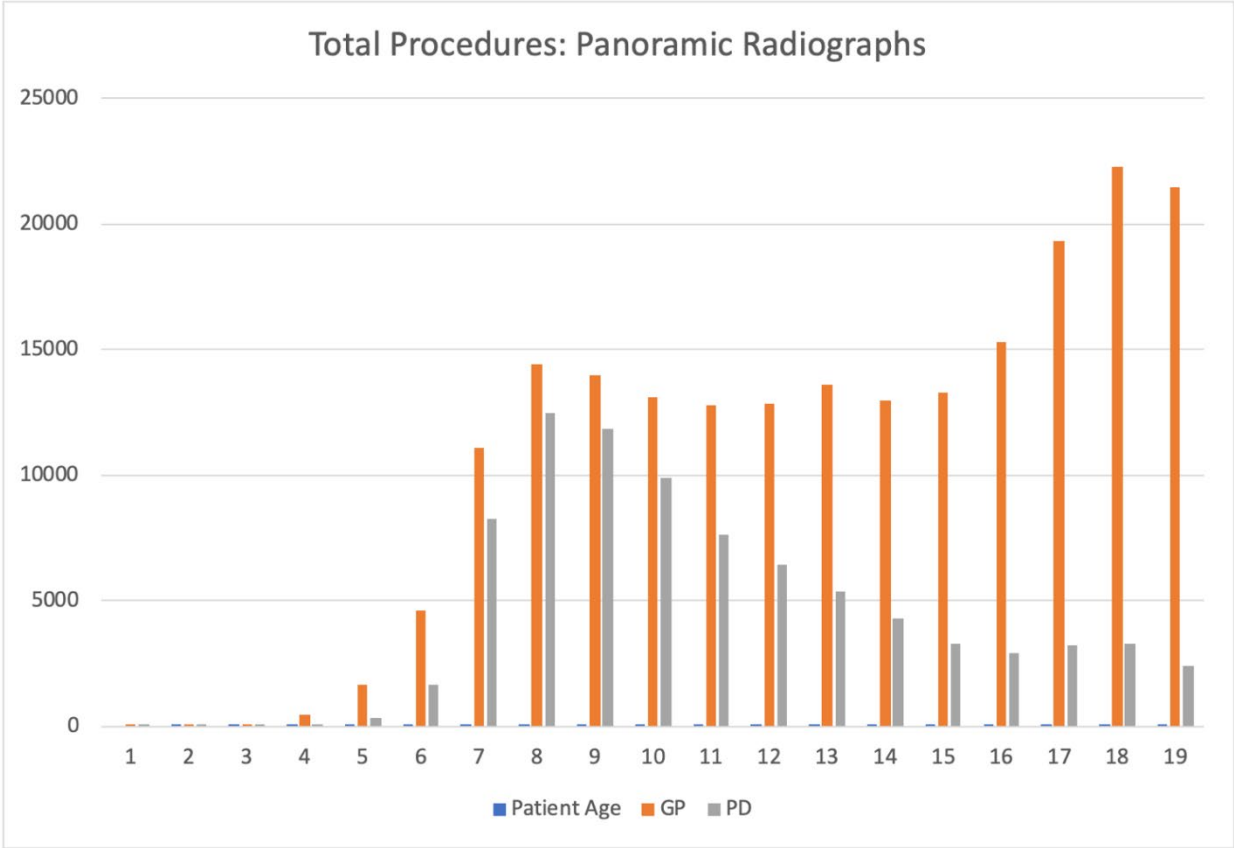


Figure 3: Time intervals between bitewing radiographs for individual patients

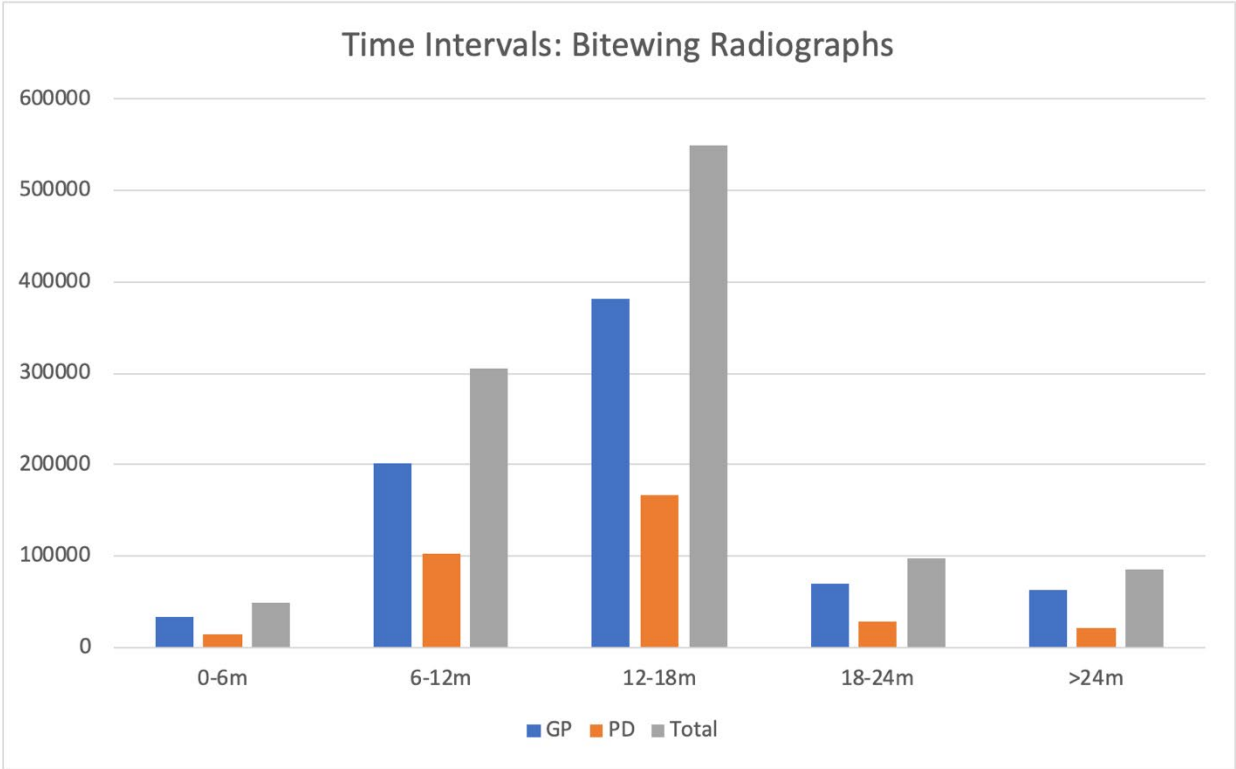


Figure 4: Time intervals between panoramic radiographs for individual patients

