



An investigation in to the impact of acquisition location on error type and rate when undertaking panoramic radiography



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ABSTRACT

Introduction: Panoramic radiography is a common radiographic examination carried out in the UK. This study was carried out to determine if acquisition site has an impact on image quality.

Methods: An image quality audit was carried out in South Wales across a number of dental and general radiology settings. The image quality was assessed retrospectively against national standards. A total of 174 radiographs were assessed from general radiology departments and 141 from dental radiology units. Chi-squared analysis was used to investigate whether there were differences in the grading between dental radiology units and general radiology departments. Differences between the two settings in terms of the number of errors in the radiographs was analysed using the Mann–Whitney test. Chi-squared analysis was used to see if there were differences between the types of errors in the two clinical settings. **Results:** There was a significant association ($p = 0.021$) between the quality of the radiograph grading and type of radiology department. However when excellent and diagnostically acceptable radiographs were grouped together there was no significant difference between the two clinical settings. Although the vast majority of radiographs were diagnostic (89% for general radiology and 92% for dental radiology units), neither reached the required standards. The most common errors were patient positioning errors (54.6% radiographs affected) and preparation/instructional errors (47.9% radiographs affected).

Conclusion: Errors in panoramic radiography are relatively high and further instruction to staff undertaking these procedures is required to ensure the targets are reached.

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Introduction

Panoramic radiography is the most common extra-oral radiograph carried out in dentistry.¹ Although individual patient dose is low from dental radiographs, these investigations represent one of the most frequently undertaken radiographs in the UK.¹ Over 500,000 panoramic radiographs are acquired in the hospital setting each year.¹

Operators, whether they are dental professionals or radiographers, must ensure consistent high image quality is obtained to ensure maximum diagnostic yield, whilst keeping radiation dose “as low as reasonably practicable”.²

The implementation of a quality assurance programme is mandatory.^{2,3} A previous study has shown that panoramic image quality in a general practice setting falls below national standards, but image quality in other settings has not been analysed before.⁴ A retrospective assessment of panoramic image quality was carried out as part of an audit project in South Wales general radiology departments (those within a hospital setting) and dental teaching units (those that form part of a dedicated dental facility such as a dental teaching hospital or dental outreach centre). The aim of this audit was to determine if the acquisition site had any effect on the final image quality along with identifying common errors so that image quality could be improved.

Method

Four general radiology departments and three dental teaching units within three Health Boards in South Wales (Cardiff and Vale University Health Board, Cwm Taf and Abertawe Bro Morgannwg

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University Health Board) took part in the audit. No ethics committee approval was sought as it was an audit which went through the local audit groups at the relevant sites. At each site a minimum of 50 images were evaluated. The images were evaluated by two consultant Dental and Maxillofacial Radiologists, one consultant evaluating images at two Health Boards and one evaluating images at the other Health Board. All the images had been acquired digitally and had either been viewed on the reporting station or, in the case of 2 of the dental teaching units, on a dedicated high resolution PC. The viewing monitors were a Barco E360 with a resolution 1536 × 2048 (Barco n.v., Kortrijk, Belgium), an Eizo RX340 with a resolution of 1536 × 2048 (Eizo Hakui, Japan), a Coronis Fusion 6MP DL with a resolution of 1536 × 2048 (Barco n.v., Kortrijk, Belgium), and a NEC MDview 213 with a resolution of 1600 × 1200 (NEC Display Solutions Europe GmbH, Munich, Germany). The panoramic imaging units used in the general radiology sites were Instrumentarium OC100 (Instrumentarium, Tuusula, Finland), Proline XC (Planmeca, Helsinki, Finland), Instrumentarium OC200 (Instrumentarium, Tuusula, Finland), Instrumentarium OP100 (Instrumentarium, Tuusula, Finland) and the Orthopantomograph™ OP30 (Instrumentarium, Tuusula, Finland). The panoramic imaging units used in the dental radiology units were Orthophos 3 (Sirona Dental Systems GmbH, Bensheim, Germany), Orthophos CD (Sirona Dental Systems GmbH, Bensheim, Germany) and the Sirona Orthophos XG (Sirona Dental Systems GmbH, Bensheim, Germany).

Consecutive images were reviewed from 1st June 2015. In two of the dental teaching units it was not possible to obtain sufficient numbers so the database was searched further back in time until 50 images were collected. In total 356 images were reviewed. All paediatric radiographs (aged <16 years old) were excluded as two of the dental units only saw adult patients. Only full panoramic radiographs were evaluated and sectional panoramic radiographs were excluded. Therefore in total 315 images were evaluated. The images were viewed and an assessment of their quality was made. Each radiograph was quality rated as per the National Radiological Protection Board guidelines as excellent, diagnostically acceptable or unacceptable.⁵ The results were compared against the standards set out by the NRPB (Table 1).⁵ If a radiograph did not meet the standard of excellent, the fault(s) that had caused this were documented.

Faults were categorised into preparation/patient instruction errors, positioning errors, exposure errors, handling errors, machine operational error and digital processing errors. The frequencies of these faults on radiographs were calculated to identify common sources of error and the data was also analysed for both 'general radiology departments' and 'dental radiology units'. Table 2 shows how the errors were further subdivided. In addition, the average number of faults per image was calculated. The general radiology departments reviewed in this audit take approximately 10,100 per year (across 4 sites) and dental radiology units take 7700 per year (across 3 sites). The operators at the general radiology

Table 1
Subjective quality rating of radiographs and the minimum targets for radiographic quality.⁵

| Rating | Quality | Target |
|--------|---|----------------------|
| 1 | Excellent – no errors of patient preparation, exposure, positioning, processing or film handling | Not less than 70% |
| 2 | Diagnostically acceptable – some errors of patient preparation, exposure, positioning, processing or film handling, but do not detract from the diagnostic utility of the radiograph | Not greater than 20% |
| 3 | Unacceptable – errors of patient preparation, exposure, positioning, processing or film handling, which render the radiograph diagnostically unacceptable | Not greater than 10% |

Table 2
Subdivision of errors within an error category.

| Error category | Error subdivision |
|--|--|
| Preparation/patient instruction errors | Tongue not in contact with palate Overlap of upper and lower teeth Patients not biting on bite block Patient movement Jewellery/removable oral appliance being worn |
| Positioning errors | Patient rotated Patient positioned too far back in the unit Patient positioned too far forward in the unit Patient chin up Patient chin down Patient tipped to one side Slumped position |
| Exposure errors | Under exposed Over exposed |
| Image receptor handling errors | |
| Machine operational errors | Rotational problem with unit |
| Digital processing error | Computer reconstruction error |

departments were radiographers and radiography students under radiographer supervision. The operators at the dental radiology units were radiographers, dental students, dental care professionals and radiographers under radiographer supervision, and dental nurses with a radiography qualification.

Data analysis

Contingency tables were analysed using Chi-squared analysis and continuity corrections were used to account for the limiting case of 2 × 2 tables. Where more than 20% of elements of the contingency table contained expected counts that were less than 5, exact methods were used to calculate p-values, which should be more accurate than "asymptotic" estimates in this limit. Differences between the general and dental departments in terms of the number of errors in the radiographs was analysed using the Mann–Whitney test due to non-normality of the data. Normality was investigated by examination of normal plots, histograms, and also by the application of the Kolgorov–Smirnov and Shapiro–Wilk tests. The mean (and associated 95% Confidence Interval of the mean) and median number of errors are presented for the number of errors in the radiographs. All calculations were carried out using SPSS V23 (IBM, New York, USA).

Results

A total of 315 adult panoramic radiographs were reviewed. At least 38 full panoramic radiographs were reviewed from each unit (174 from general radiology and 141 from dental radiology). Comparisons were then made between the general radiology departments and dental radiology units. General radiology departments are those that are part of a hospital whilst a dental radiology unit was part of a dedicated dental facility such as a dental teaching hospital or dental outreach centre.

Only 64 of the 315 radiographs (20%) taken in this sample had no errors and were therefore classified as "excellent" using the NRPB standards. 221 (70%) were "diagnostically acceptable", containing errors that did not detract from the diagnostic utility of the radiograph. The remaining 30 radiographs (10%) were deemed diagnostically "unacceptable".

Table 3 shows the total number of excellent, diagnostically acceptable and unacceptable radiographs taken in general radiology departments and dental radiology units. Chi-squared analysis of the contingency table indicates a significant association ($p = 0.021$)

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