Comparison of panoramic and bitewing radiography for the detection of dental caries: a systematic review of diagnostic tests

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Authors' objectives
To evaluate the effectiveness of panoramic radiography (orthopantomogram) in place of, or in addition to, the use of bitewing radiography for the detection of occlusal and proximal dental caries in the posterior teeth of the deciduous and permanent dentition.

Searching
MEDLINE (from 1966 to February 2002), CINAHL (from 1982 to February 2002) and EMBASE (from 1980 to February 2002) were searched; the search strategies were reported. Internet search engines were also used and specific Internet sites were searched. Citations were checked and experts in the field were consulted. No language restrictions were applied.

Study selection
Study designs of evaluations included in the review
Studies of any design were eligible for inclusion. The included studies were prospective or retrospective cohort or case-control studies of test accuracy.

Specific interventions included in the review
Studies in which panoramic radiography, or the combination of panoramic radiography plus bitewing radiography, was compared with bitewing radiography for the detection of occlusal and proximal dental caries in the posterior teeth of the deciduous and permanent dentition were eligible for inclusion. Studies were excluded if they did not compare standard radiography and bitewing radiography. None of the included studies were of the combination.

Reference standard test against which the new test was compared
The reference standard was required to be standard panoramic and bitewing radiographs with a clinical examination and follow-up where possible, or histologically confirmed caries for extracted teeth. Other reference standards were considered where empirical evidence that such a reference standard test was validated was available; the only other such reference standard in the included studies was one that used an electronic conductance meter.

Participants included in the review
Studies of deciduous or permanent teeth, in vivo or in vitro, were eligible for inclusion. The studies had to have investigated individual teeth (molars or pre-molars) or surfaces of teeth. Studies in which the unit of assessment was a person were excluded.

Outcomes assessed in the review
The primary outcome of effectiveness was test accuracy, as measured by sensitivity, specificity or other measures of test accuracy. Studies were excluded where accuracy was not measured or could not be calculated. Other outcomes considered were reliability, acceptability and clinical effectiveness. All of the included studies assessed the presence or absence of caries, although one assessed only occlusal caries. Other studies also assessed the severity of caries. In the included studies, test accuracy was reported in terms of receiver operating characteristic curves, sensitivity and specificity, sensitivity alone, critical ratio analysis of maximum likelihood areas, and intra-observer variability.

How were decisions on the relevance of primary studies made?
Two reviewers independently applied the inclusion criteria. A kappa score was calculated to test inter-rater agreement. Full references were obtained where necessary and any disagreements were resolved through discussion.

Assessment of study quality
Study validity was assessed according to a published checklist (reference cited in the review). The checklist covered study design, selection of the population, description of the tests, blinding of assessors to the test and reference standard results, and the proportion of radiographs excluded. The validity assessment was performed by one reviewer and checked by another, with any differences resolved through consensus. A structured form was used.

**Data extraction**
A series of standard forms were used to extract data on study characteristics and results. The data were extracted by one reviewer and checked by another, with any differences resolved through consensus.

**Methods of synthesis**
How were the studies combined?
It was not possible to combine the findings in a meta-analysis because of the different populations and various reference standards used. Instead, a narrative synthesis of the results was undertaken.

How were differences between studies investigated?
Differences between the studies were described and discussed in the text.

**Results of the review**
Five studies were included. The number of teeth included could not be calculated because the studies variously reported teeth, surfaces, or both. The largest study included 8,709 teeth, while the smallest included only 64 teeth.

The studies identified for the review were of various populations and used different reference tests. The studies were of reasonable quality, although only one study selected the population randomly. An important proportion of the radiographs were of poor quality. Also, the teeth or surfaces were not viewed in isolation and knowledge of the condition of the surrounding teeth might have affected the results of this subjective test.

Bitewing radiographs appeared superior to panoramic radiography for the detection of dental caries overall, with superior sensitivity for proximal caries and caries overall. There may be little difference between bitewing and panoramic radiography for the detection of incipient or advanced caries. Most of the studies used patients with a greater number and variety of carious lesions than is encountered in the ‘average’ patient in the UK. Thus, the test accuracy might have been overestimated in these studies. The intra-observer repeatability of both tests ranged from moderate to good. Inter-observer repeatability was poor in one study, but good in another.

**Cost information**
A cost-consequences analysis identified the costs of two bitewing radiographs (£4.55) and one panoramic radiography (£10.15), but it was not possible to determine which diagnostic test was most cost-effective.

**Authors’ conclusions**
All included studies found bitewing radiography to be superior to panoramic radiography on some measure of test accuracy. There was no conclusive evidence that panoramic radiography is superior to bitewing radiographs for the detection of any type of dental caries, both in terms of place (proximal or occlusal) or severity (incipient, enamel, dentine or pulpal).

**CRD commentary**
This was a well-conducted systematic review. It used clear, well-defined inclusion criteria and the methods used in the review were appropriate and fully reported. The searches appeared thorough and it is unlikely that any studies have been missed. The review employed a narrative synthesis, which was appropriate given the clinical diversity of the included studies. The authors’ conclusions are supported by the review findings and are limited only by the data available for the primary studies. The authors pointed out that further research is needed to substantiate the conclusions drawn in this review.
Implications of the review for practice and research

Practice: The authors stated that tighter control over the use of panoramic radiographs may be needed to prevent their unwarranted use.

Research: The authors stated that further research is needed to substantiate the conclusions drawn in this review. A study comparing panoramic radiography, bitewing radiography (E-speed) and panoramic radiographs plus bitewing radiography with a suitable reference standard for the UK is required. A clinical examination should always be included in the study design. Any study should include consecutively or randomly drawn patients from a representative UK population.

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