

# Diagnostic efficacy of direct and indirect digital imaging for approximal caries

## Abstracted from

**Winand C, Shetty A, Senior A et al.**

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## Question: Are direct and indirect digital imaging systems effective for diagnosis of approximal caries?

**Data sources** Medline, Embase, LILACS, PubMed, The Cochrane Library and Web of Science databases. A grey literature search was conducted through Google Scholar, where abstracts from the top 100 results (as sorted by search engine relevance) were examined. Hand searching of reference lists only. No language restrictions were imposed.

**Study selection** Studies that evaluated the efficacy of bitewing and periapical images produced by photostimulable phosphor plate (PSP) and direct digital sensor (DDS) systems for the diagnosis of approximal dental caries in extracted human teeth. Studies were required to have used histologic analysis as the gold standard comparison. Primary outcomes were sensitivity and specificity regarding detection of dental caries.

**Data extraction and synthesis** Two reviewers independently evaluated the titles and abstracts of studies identified through the search, selecting articles according to established inclusion criteria. The selected articles were subsequently reviewed full-text by the same two authors. Disagreements regarding article inclusion were resolved by consensus with an additional third reviewer. One reviewer performed initial data extraction using a customised data extraction form based on the PICOS principle, with two other authors independently verifying collected information. Risk of bias was assessed independently by three reviewers using the QUADAS-2 checklist. A meta-analysis was performed on the grouped studies that presented suitably homogeneous data to evaluate diagnostic capability for approximal caries in dentine. Results were presented with 95% confidence intervals.

**Results** Six studies were included, with four being used for meta-analysis. Methodologies of all studies were considered low risk of bias. Only one study reported a significant difference between PSP and DDS technologies; remaining studies determined that PSP and DDS were comparable in the clinical detection of caries. The meta-analysis sample total was 668 tooth surfaces. All studies reported poor sensitivity and high specificity. For PSP, sensitivity ranged from 15 to 54%, and specificity from 84 to 100%. For DDS, sensitivity varied from 16 to 56%, and specificity from 90 to 100%.

**Conclusions** DDS and PSP systems are excellent at identifying caries-free surfaces, but both lack sufficient sensitivity to reliably identify surfaces with caries. There is no significant difference between performances of DDS and PSP digital systems for caries detection.

## Commentary

As a key investigation for the detection and diagnosis of caries, intraoral dental imaging has seen a shift from conventional film to digital radiography. The two main digital imaging modalities are direct digital sensors (DDS) and indirect photostimulable phosphor plates (PSP). While digital systems have advantages such as shorter working times, reduced processing errors and convenient image storage, the diagnostic capability of each modality is the most important indicator when selecting for purposes of caries detection. The aim of this systematic review and meta-analysis was to compare the diagnostic efficacy of direct and indirect digital imaging, elucidating the capability of DDS and PSP in the detection of approximal caries. For inclusion, studies were required to have used histologic analysis as the gold standard.

The review authors conducted a thorough search. Six articles met the authors' inclusion criteria for quantitative/qualitative synthesis. Out of these six, only four studies were included in the meta-analysis due to data availability (that is, the authors deemed that two articles did not present enough data to conduct a meta-analysis to answer the question). A concern about these studies was the lack of a uniform histopathology method between studies.

The primary outcomes were sensitivity and specificity with regard to detection of dental caries, and secondary outcomes were other accuracy measurements, such as positive predictive value (PPV), negative predictive value (NPV), likelihood ratio (LR) and odds ratio (OR).

Sensitivity is the proportion of people with a disease who are correctly identified as having that disease by the diagnostic test. Specificity is the proportion of people without a disease who are correctly identified as not having that disease by the diagnostic test.<sup>1</sup> The ideal test would correctly identify all patients with a disease and all patients without a disease. The meta-analysis found all the DDS and PSP systems tested had similarly high specificity (84-100% for PSP; 90-100% for DDS) but low sensitivity (15-54% for PSP; 16-56% for DDS). This means that for PSP, between 0 and 16 out of 100 non-carious proximal surfaces were incorrectly diagnosed as carious, and between 0 and 10 out of 100 for DDS. But only between 15 and 54 out of 100 were correctly identified as carious for PSP, and between 16 and 56 out of 100 for DDS. A low sensitivity was expected due to the recognised limitations of radiographic methods in early carious lesion detection. This is because a significant amount of demineralisation has to occur to be radiographically distinguishable.

Examining the individual studies, the results seem to fall

into two different groups. For both PSP and DDS, Abesi *et al.*<sup>2</sup> and Senel *et al.*<sup>3</sup> report sensitivity around 50%, while the other included studies report lower sensitivity around 20%. The review authors recognise that since the studies with higher sensitivity have been performed more recently (2012 and 2010 respectively), these results might be due to improved current technologies that produce better sensitivity. Regarding the secondary outcomes, the positive predictive value (PPV) is useful for considering the value of a test to a clinician and is dependent on the prevalence of the disease in the population of interest.<sup>4</sup> PPV is the likelihood of a positive test result indicating that a patient has a disease. Similar to the primary outcomes, there seem to be two groups; one study (Abesi *et al.*, 2012) demonstrates a PPV value of 100% for both DDS and PSP, while other studies report values of 45-84%. Therefore, we expect all radiolucencies in the first group to be caries, but in the second group between 45% and 84% of them would be caries. However, it is important to reiterate that PPV is related to the prevalence of the disease.

It is also important to consider a finding of the study conducted by Abesi *et al.* that included separate data for detection of caries only in enamel (excluding lesions that extended into dentine); reported sensitivity and specificity for PSP was 23% and 98%, and for DDS 15% and 96%, respectively. If preventive interventions such as fluoride varnish applications are only delivered to those surfaces where caries has been radiographically diagnosed (using a diagnostic method with sensitivity of 23%), this practice would miss 77% of caries surfaces.

Intraoral radiographs are also routine components of oral health check-ups. Recall frequency is partly determined from the estimated level of caries susceptibility. An overreliance on imaging methods with low sensitivity could underestimate the level of caries susceptibility, which could lead to patients not being seen as regularly as they ought to be.

This review selected histological analysis on extracted teeth as its gold standard, thereby automatically excluding other articles examining a similar question but using alternative reference standards. In translation to clinical applications, the interference of anatomical structures, sensor positioning and operator experience are just a few considerations that would affect test efficiency in the clinic but are not applicable in laboratory studies on extracted teeth. Consequently, using these imaging methods intraorally could produce even lower sensitivity than that of extracted teeth.

### Practice point

- DDS and PSP systems lack sufficient sensitivity to reliably identify all surfaces with caries
- An absence of radiolucency does not necessarily exclude the presence of caries
- Overreliance on standalone use of radiography risks underestimating the diagnosis of early approximal lesions.

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