Higher Voltage Influence on Optimal Caries Diagnosis in Digital Radiography

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ABSTRACT

It has previously been shown that caries diagnostics is improved when performed on radiographs exposed with a voltage of 60 kV compared to 70 kV. This is because low voltage provides higher subject contrast.

The aim of the present study was to investigate whether the tube voltage used when exposing bitewings, influence the possibility to diagnose caries when using a new digital system with CMOS-sensors.

Extracted teeth were mounted and bitewings exposed with both 60 and 70 kV and varying exposure times, using a digital system with CMOS-sensors. Observers with different experience in dentistry evaluated the radiographs for caries. CBCT of each single tooth was used as golden standard.

There was no significant difference between the results of diagnosing caries between radiographs exposed with 60 kV compared to 70 kV. All radiographs that were exposed to an acceptable level of brightness gave similar result, independent on voltage.

In conclusion; there was no significant difference between radiographic caries diagnosis performed with radiographs exposed with 60 compared to 70 kV, given that the exposure time was optimized. This indicates that 70 kV can be used for all intraoral examination if a correct decreased exposure time is used and that lowering to 60 kV is not necessary when intraoral examinations for caries evaluation are performed.

INTRODUCTION

Before exposing a patient for a radiographic examination, it is necessary to formulate a question that cannot be answered by other clinical examination methods. When the task is to detect new carious lesions and progression of previous detected caries, to check existing restorations and evaluate the periodontal status, bitewing examinations are often used. When assessing restorations and caries, it is optimal that the radiograph has high contrast, and when assessing the periodontal status the radiograph should not be overexposed to make sure that the bone is accurately reproduced (Whaites, 2002).

Caries can be diagnosed in radiographs when the demineralization of the tooth is great enough to result in an attenuation difference in the diseased area compared to the healthy mineralized parts of the tooth (Pontual *et al.*, 2010).

The standard method for diagnosing approximal caries is bitewings exposed with a voltage of 60 kV combined with a clinical examination (Pontual *et al.,* 2010).. To be able to detect small details as caries, the contrast has to be high. Caries diagnostics in analogue radiographs has been reported to be more accurate when the radiographs have been exposed with a lower voltage compared to higher voltages, this is due to the increased subjects contrast with decreased voltage (Svenson *et al.*, 1985).

In a digital system, the sensor is exposed with the same equipment as analogue film. The sensor is linked to a computer *e.g.* by a cord and it consists of a large amount of pixels that each are assigned a coordinate in a grid and a shade of gray dependent on how many photons that have reached each pixel in the sensor. The x-rays that reach the sensor are transformed into light, which in turn is transformed into an electric charge and sent to the computer. The data is processed and displayed as an image on the screen (Whaites, 2002). The subject contrast is always the same as in an analogue system, but the receiver (sensor compared to film) and the possibilities to improve the quality with image processing differs.

The quality of the intraoral radiograph is dependent on a number of factors including the contrast, the brightness and the resolution and sharpness of the image. The object, the type of sensor and its position, the angle of the beam and the teeth position are also very important for optimal imaging (Svenson *et al.*, 1994; Whaites, 2002). The number of pixels and the amount of shades determine how much information the radiograph contains. Digital radiographs displayed on a high resolution screen, has similar or higher resolution than analogue radiographs (Whaites, 2002).

The radiographs presented on the monitor only comprise the chosen window of exposure i.e. Value Of Interest (VOI). The grades of shade are presented with a specific LUT transformation, which is either linear or non-linear. The LUT transformation influences the contrast, and thereby the sensitivity for differences in exposure. To our knowledge, the studied CMOS-system (Complementary Metal Oxide Semiconductor-system) does not change window width automatically depending on exposure and has a standard LUT transformation.

In the computer, the digital radiographs can be altered in different ways *e.g.* by altering the contrast and brightness, which can improve the possibility to diagnose (Wenzel, 1998; Pontual *et al.,* 2010). It is important to understand that the computer cannot add information to a badly exposed radiograph. Even if the radiograph gets an acceptable brightness after processing, important information can be lost, or the radiograph never had enough information *e.g.* due to underexposure which leads a noisy radiograph. These alterations can jeopardize the diagnostics (Whaites, 2002).

It has previously been suggested that there is no difference in caries diagnostics between radiographs exposed with 60 versus 70 kV when using digital sensors (Hellén-Halme, 2011). In that study different exposure times were not studied. Instead calculations were used to determine the different exposure time that turned out to be similar for 60 and 70 kV. Our hypothesis was that diagnosing caries in bitewings exposed with 60 and 70 kV, respectively, would have similar results and that the exposure time could be lowered to a greater extent than earlier suggested for 70 kV and without hazarding the diagnostic accuracy.

The aim of the present study was to investigate whether the exposure of bitewings with different tube voltage and time, using a digital system with CMOS-sensors, influences the possibility to diagnose caries.

MATERIALS & METHODS

Materials

Forty extracted premolars were collected from different departments, primarily from the department of orthodontics, at the school of dentistry at Umeå University. The teeth where visually inspected and selected with caries at approximately 50% of the approximal surfaces. Teeth with natural lesions were used since the odds of detecting man made lesions are greater than natural lesions (Wenzel, 1998). The teeth were kept in a solution of chlorhexidine to keep them aseptic and hydrated without resolving ink marks on the teeth.

Ethical considerations

No ethical conflict was found since the teeth used in the study were extracted and no tracking of whom the teeth originated from was possible. Therefore, the teeth were not a biobank and not limited by ethical regulations.

The Ethics Forum at the department of odontology found that the ethical considerations for this degree project were appropriate.

Radiographs

The teeth were mounted four and four in a straight line in clay and placed in a rig made of gypsum. The teeth were positioned according to normal anatomy, with the approximal surfaces in contact and with the buccal surfaces facing the beam in a standardized manner. The digital sensor was also mounted in the rig, behind the teeth in relation to the beam at a distance of 36 mm. Between the beam and the teeth a 19 mm, acrylic block, for attenuation equivalent to soft tissue, was mounted in accordance with earlier studies (Hellén-Halme, 2011)(Fig 1a).

The mounted teeth were exposed with 60 and 70 kV, with all the available exposure times. Then all the radiographs were evaluated and the radiographs that could be determined as too light or too dark to be used for any diagnostics were excluded. To reduce the number of radiographs that the observers had to evaluate, every second exposure time for radiographs exposed with 70 kV where excluded (Fig 2b). The tube current was constantly 7 mA. The x-ray machine used was a Focus 50720 (GE Healthcare, Tuusula, Finland) and the sensor used was a CMOS-APS sensor, Schick CDR Elite (Schick technologies long island city, NY, USA). When evaluating the radiographs, all the observers used the same program from SCHICK CDR.

Observers

A total of 15 dentists completed the study, eleven dentists with various experience of general dentistry, working in different clinics in the county council of Västerbotten and four specialists in oral and maxillofacial radiology. The observers started the study by filling out a questionnaire about their experience, the equipment and conditions when evaluating radiographs. The bitewings were randomly mounted the same way for all the observers and distributed to the observers in batches of approximately 32 bitewings per week over a period of 6 weeks. Plus a collection week at the end of the observing period. The observers received study protocols to fill out for each week where each tooth's approximal surfaces was evaluated for caries. The caries lesions were rated from 0-4. 0 = No caries, 1 = Caries in the outer half of the enamel, 2 = Caries in more than half of the enamel; not in the dentin, 3 = Caries in the outer half of the dentin, 4 = Caries in more than half the dentin thickness (Fig 1b) as previously described (Billie and Thylstrup, 1982).

CBCT examination

The CBCT Morita 3D Accuitomo XYZ Slice View Tomograph model
MCT-1 (J. Morita Mfg. Corp., Kyoto, Japan) was used as golden standard when evaluating whether the tooth surfaces were healthy, and if not, the depth of the carious lesion. All the teeth were mounted separately in clay and exposed in the CBCT (30.8sec, slice thickness 0.240mm, 80 kV, 8mA). The CBCT images were examined and the "true" lesion depth was determined according to the above mentioned rating scale. Lesions visible as demineralization in the images were defined as caries. Consensus for the golden standard was reached by assessing the CBCT examinations together, three dental students and one specialist in Oral and maxillofacial radiology.

Literature search

Literature was searched in the database PubMed. The following keywords were used in different combinations during search: caries, approximal, radiograph, radiography, digital, voltage, exposure, time, 60 kV, 70 kV, CBCT, cone beam computer tomography, x-ray, screen, compensation, diagnosis, tube potential, periodontal bone. No MeSH terms were used.

Additional literature was found among references in the articles as well as among articles suggested as “related citations in PubMed”. Several books on the subjects were used.

Statistical methods

The results are presented as receiver operating characteristic (ROC) curves and box-plots made with Cohen’s kappa values.

Programs used for the statistical methods were Excel, IBM SPSS statistics (v22.0.0). R-studio used for box-plots (v.09.8.501)

The ROC curve is a plot of the true- (y-axis) and false positive (x-axis) results, which is used to graphically compare them (Dawson and Trapp, 2004). In this study, it was used to compare the result depending on the different lesions depth, the voltages and to compare the general practitioners to the specialists. When interpreting a ROC-curve, the area under the curve (AUC) is 0.5 when the agreement between the observers and the golden standard is equal with chance, and if the AUC is 1.0 the agreement is complete.

The Cohen’s kappa was used to calculate the agreement (Dawson and Trapp, 2004) between the golden standard and each observer. The Cohen’s kappa was calculated for every surface and exposure parameters. The kappa value is estimated taking agreement by chance into account. To estimate the optimal range of voltages and exposure times the kappa values were used through visual evaluation of the boxplot. A Cohen’s kappa of one means total agreement with the golden standard and a kappa of zero means that the agreement is equal with chance (Viera and Garrett, 2005).

RESULTS

Golden standard

When examining the CBCT examinations of the teeth it was determined that the number of sound surfaces was 47, and the number of surfaces with caries was 33. The number of surfaces with caries in the outer half of the enamel was 15, the number of surfaces with caries in more than half of the enamel but not in the dentin was 12, the number of surfaces with caries in the outer half of the dentin was six and no caries in more than half of the dentin was found.

Observers

Of the 25 observers that were asked to participate in the study there were 10 dropouts prior to or during the study. Observer number 10 was excluded from the study since the results from this observer was worse than chance and the observer probably had misunderstood the instructions (Fig 2a).

Among the 14 observers there were four specialists in oral and maxillofacial radiology. The specialists in oral and maxillofacial radiology, observer number 2, 3, 5 and 7, had a mean kappa value that was higher than the overall mean kappa value (Fig 2a). The observers had an experience from 9 months to 35 years as dentists with a median experience of 23 years. Twelve observers had education in digital radiography. There was no correlation between poorer results and less experience as a dentist.

Ten of the observers reduced the lighting when evaluating the radiographs. The observers that did not reduce the light, observer number 1, 9, 11 and 12, had a mean kappa value that was lower than the overall mean kappa value (Fig 2a). Image processing was never used by three of the observers. All observers but one adjusts the exposure time depending on the size of the patient. Eleven observers used 60 kV when exposing bitewing radiographs and 70 kV when exposing apical radiographs; while three did not adjust the tube voltage. Eight observers did not expose a new radiograph if the image was to dark and six did. Seven observers exposed a new radiograph if the image was to light and seven did not.

There was a great variation in kappa values within each observer. There was also a great variation between observers (Fig 2a).

Optimal exposure

The exposure times with the best result among the observers was 0.125-0.5 sec for 60 kV and 0.05-0.25 sec for 70 kV.

There were no significant differences in caries diagnostics performance between 60 and 70 kV when comparing the ROC-curves and the corresponding area under the curve. For the specialists a small difference in performance was seen when the lesion reached the dentin, but the number of extensive carious lesions was small (Fig 4e-f).

DISCUSSION

This study shows that there is no difference in detecting approximal carious lesions when comparing the results after evaluation of digital radiographs exposed with 60 compared to 70 kV. Radiographs exposed with 60 and 70 kV have previously been suggested to perform equal when the goal is caries diagnostics (Hellén-Halme, 2011). Further, no significant difference in diagnostic accuracy was found when comparing several levels of voltage (Svenson and Petersson, 1991; Sogur *et al.* 2011).

When using a higher voltage the mean energy of the x-ray photons is higher than compared to lower voltage. Photons with high energy result in lower absorption in the surrounding tissue. Higher voltage also leads to more photons than lower. To get the same exposure of a radiograph using a higher voltage as in a radiograph exposed with lower voltage, the exposure time has to be shortened. Altogether, this means that the dose to the patient is lower when radiographs are exposed with higher voltage (Whaites, 2002; Kaeppler *et al.,* 2007a; Kaeppler *et al.,* 2007b). This is in accordance with our findings where the caries diagnostics was unaffected when the bitewings were exposed with 70 kV and the exposure time was lowered to less than half the time compared to 60kV. The shorter exposure time also means that the possible distortion due to patient movement is less likely to occur.

One of the benefits if only one voltage is used when exposing both bitewings and apical radiographs is that there will be no exposure of radiographs with the wrong voltage. This will limit the number of overexposed radiographs that might need to be re-exposed, and reduce the dose to the patients.

In this study, CBCT was used as golden standard. CBCT is superior to conventional radiographs in detecting carious lesions and assessing the size of the lesions (Wenzel *et al.,* 2013). When we performed our first test CBCT exposures, the teeth were mounted five together in clay, first in one row and then in a circle. However, the artifacts from the adjacent teeth were obvious and the radiographs not usable the for caries diagnostics (Fig 1c-d). Therefore, to optimize the method, all the teeth were exposed separately, one at a time. Fillingmaterial lead to artifacts in CBCT imaging. There was only one tooth with a filling included in the study and thereby the impact of artifacts from filling material was minor.

Diagnostic accuracy correlates with the depth of the carious lesion (Svenson *et al.* 1994; Sogur *et al.* 2011). This explains why the detection accuracy is quite low in this study where most of the lesions haven't reached the enamel-dentine junction. When diagnosing caries in the outer half of the enamel, the result got very close to chance. This is consistent with previous studies examining carious lesions in the enamel (Pontual *et al.*, 2010). The result for diagnosing carious lesions in the outer half of the enamel got very close to chance independent on use of voltage (Fig 4a, b). Consistent with what have previously been shown, lesions in the inner half of the enamel had a much higher detection rate compared to the lesions in the outer half of the enamel (Espelid and Tveit, 1986).

The results show that it is difficult to diagnose caries in the enamel, especially in the outer half of the enamel. The carious lesions that reached into the dentin were quite shallow and few in number, which explains why the detection rate of these lesions only where somewhat better. However, this is not an uncommon situation when examining Swedish patients. In the present study, 7.5 % of the surfaces of the teeth had a carious lesion in the dentin, which is a higher frequency than what is found in Swedish children by the age of 12 (Malmö University, 2011). The amount of caries lesions is similar to that found in Swedish adolescents and young adults (Stenlund *et al.* 2003)

Studies made in a laboratory setting like this study, is applicable in the clinical situation (Hintze and Wenzel, 1996). This means that the present result could be used in the clinic situation when bitewing examinations are performed.

There was a great variation in kappa values for all the observers. This is due to the fact that both the radiographs that were suitable for caries diagnosis and radiographs where it was very difficult to diagnose caries were included in the study (Fig 2a). There was also a great inter-observer variation (Fig 2a), which is normal when evaluating caries (Gröndahl, 1979). The kappa values where never over 0,5 and in some cases they where even negative. This suggests that the agreement only was fair (Viera and Garrett, 2005).

The accuracy when evaluating caries in radiographs is never as high as we would like it to be. As in this study, many carious lesions were missed. That is why it is important, when possible, to include a visual inspection of the teeth. The visual inspection combined with digital radiographs has been shown to have the highest accuracy when evaluating carious lesions (Chawla *et al.* 2012).

The study showed that there was a difference between the observers who are practicing general dentistry and the specialists in oral and maxillofacial radiology considering the sensitivity and specificity. This could be a result of how they are working in daily clinic. The specialists only evaluate if there are any caries lesions and how extensive they are when interpreting the radiograph, all without considering therapy. If the carious lesion has just reached the dentin the specialist will diagnose it as a 3 according to the scale used in this study. The general practitioner must simultaneously take all the patient's risk factors for caries into consideration when they assess the x-rays. Based on this and the risk of progression, they assess if it is necessary to treat the lesion operationally or not and may in some cases diagnose a lesion that has just reached the dentin as a 2 instead of a 3. This results in higher sensitivity for the specialists and could increase the specificity for the general dentists (Fig 4a-f).

In the questionnaire answered by the observers they were asked what type of monitor they were using when examining the radiographs. Some studies have shown that monitors have no effect on diagnostic accuracy when assessing carious lesions (Isidor *et al.* 2009; Pakkala *et al.,* 2012). In the present study, only two observers used medical monitors, which are why this factor was not taken into consideration when evaluating the results.

The observers were also asked if they regularly dimmed the light or shielded of incoming light when evaluating radiographs, however we did not ask if the light had been dimmed of during the evaluation of the studied radiographs. Therefore this was not considered when evaluating the results in caries diagnosis in this study. Room illumination had no statistically significant effect on the overall accuracy in a study by Pakkala *et al.* (2012), However, dimmed light has also been proven to be important while diagnosing caries lesions, particularly when the caries lesion has progressed into the dentin (Hellén-Halme *et al.,* 2008; Hellén-Halme and Lith, 2012). The observers were asked to perform the examination under the same conditions for all the radiographs that were examined, including shifting lighting conditions. Thus, lightning should not have influenced the comparison between different exposures.

It has been suggested that the absorbed dose is much higher when 70 kV is used compared to 60 kV in digital radiographs, and therefore 60 kV should always be used when exposing bitewing radiographs (Hellén-Halme and Nilsson, 2013). In that experimental study the exposure time for 70 kV was only reduced with 20% compared with 60 kV, to keep the estimated signal-to-noice ratio equal. If applied in the clinic, this would result in radiographs with very different brightness, as can be seen in Fig 3a and b. The first radiograph (Fig. 3a) is exposed with 60 kV and an exposure time of 0.32 sec and the second radiograph (Fig. 3b) is exposed with 70 kV and an exposure time of 0.25 sec, which corresponds to 20% reduction of exposure time, 3b is much darker than 3a. To expose a radiograph with 70 kV equally to a radiograph exposed with 60 kV, the exposure time needs to be decreased with at least 50%. Comparing the radiograph exposed with 60 kV (Fig. 3a) and the exposure time of 0.32 sec to the radiograph (Fig. 3c) exposed with 70 kV and the exposure time of 0.125 sec, a similar brightness can be observed (Fig 3a, c). In the present study, the caries diagnostic performance did not differ significantly between radiographs exposed like 3a and 3c.

It has been shown that CBCT radiographs are as accurate as or better than conventional digital radiographs in detecting caries in the enamel (Qu *et al.* 2011; Wenzel *et al.*, 2013). Previously it has not been acceptable to use CBCT or any other radiographic method as a golden standard in these kinds of studies (Wenzel, 1998) but that is mainly due to the artifacts that the surrounding teeth and tissues causes (Kayipmaz *et al.*, 2011; Haiter-Neto, 2008). Since the teeth were exposed one at a time, there were no such artifacts.

In the everyday clinical situation a compromise between caries diagnostics and periodontal diagnostics is considered to avoid too much exposure of the patient (Whaites, 2002). In this study no consideration was given to how useful the radiographs would be if the purpose had been to assess the alveolar bone, but previous studies have shown that bitewings exposed with 63 and 70 kV is equal when it comes to evaluating the alveolar bone (Vandenberghe and Jacobs, 2010). One disadvantage that comes with more exposed radiographs is that the risk of overexposed areas of the interdental bone gets higher, which makes it harder to evaluate the patient's periodontal status (Whaites, 2002). That is why it is important to determine what the bitewing should be used for, usually for both. If the purpose is to evaluate the patient's approximal surfaces for caries alone, the radiograph can be exposed more than if the purpose is to examine the periodontal status as well, then the exposure time should be kept lower to make sure that there are no areas of the bone that gets overexposed. It was very individual at what exposure time the observers performed the best. The overall result was however, that for the study chosen exposure times, caries was easier to diagnose in the radiographs that were more exposed (Fig 2b).

The automatic image processing that occurs when the signal from the sensor is transformed into a radiograph on the monitor may have affected the outcome, but we do not know because we do not have detailed data on how the observers processed the images and what exactly happens during transmission to the monitor.

Conclusion

There was no significant difference between radiographic caries diagnosis performed with radiographs exposed with 60 compared to 70 kV, given that the exposure time was optimized. This indicates that 70 kV can be used for all intraoral examinations if a correct decreased exposure time is used and, that lowering to 60 kV is not necessary when intraoral examinations for caries evaluation are performed.

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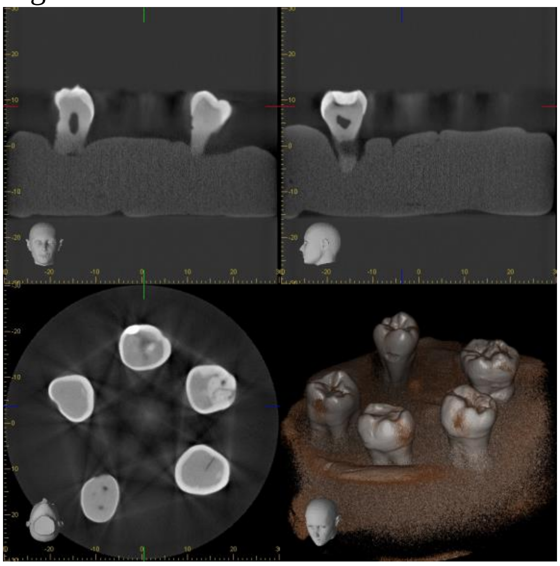
Fig 1a. Fig 1b.



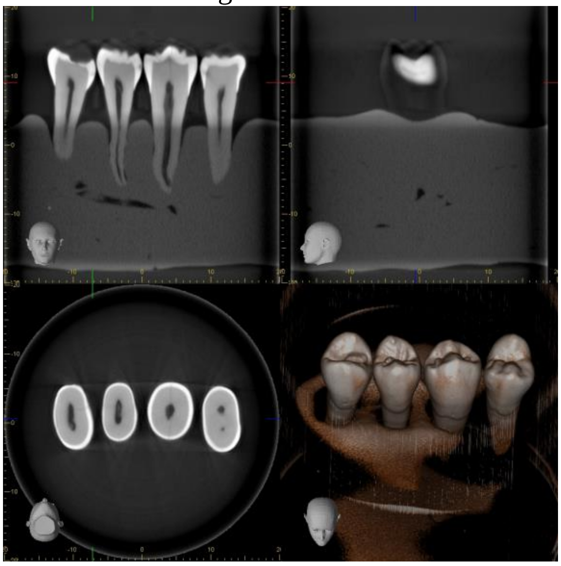


Fig 1c. Fig 1d.

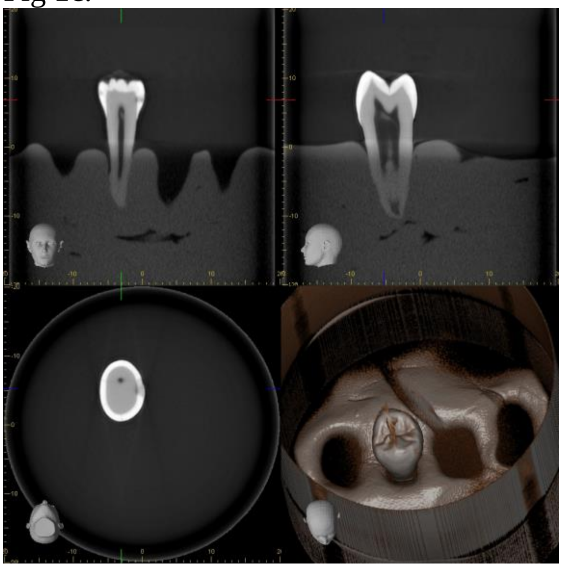


Fig 1e.

Fig 1. a. The arrangement when exposing the radiographs. **b.** Criteria for assessing the depth of the carious lesions. 0 = No caries 1 = Caries in the outer half of the enamel 2 = Caries in more than half of the enamel; not in the dentin 3 = Caries in the outer half of the dentin 4 = Caries in more than half the dentin thickness. **c. d.** Test radiographs using the CBCT and showing artifacts by neighbour teeth. **e.** Final arrangement for optimal CBCT radiographs.

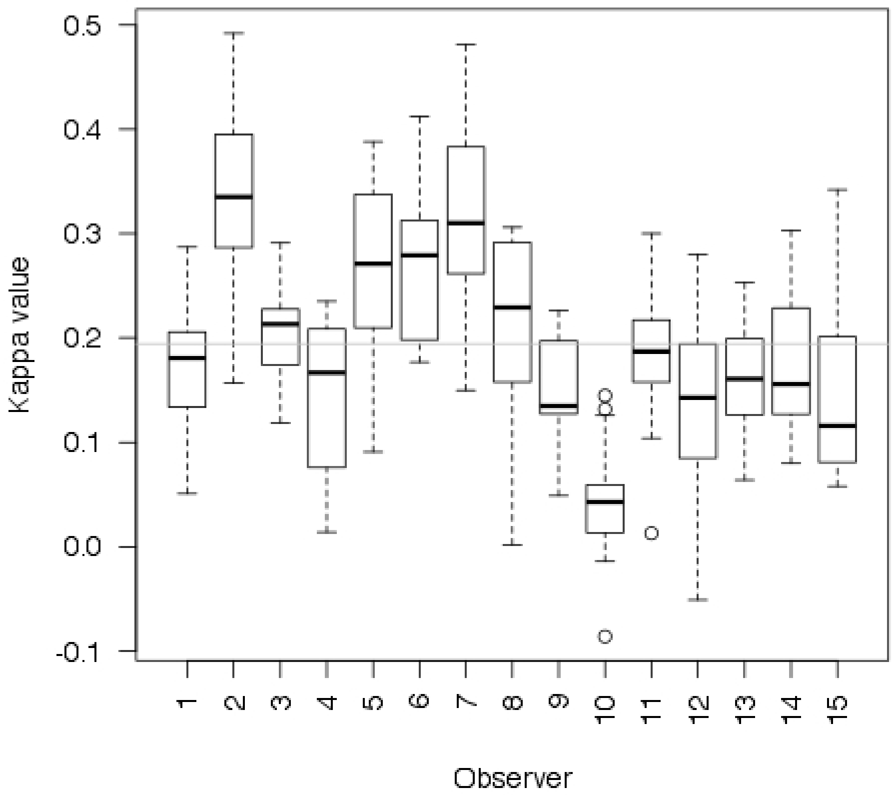


Fig 2a.

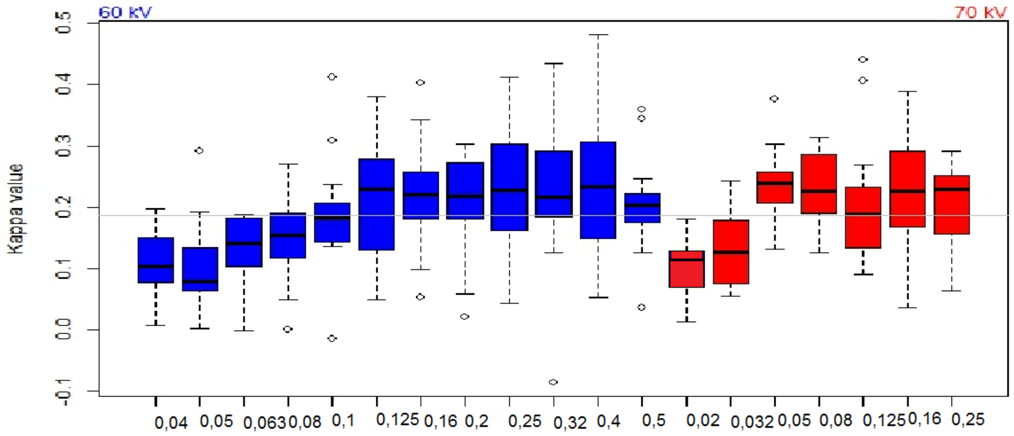


Fig 2b.

Fig 2. Kappa calculations. **a.** Kappa values for the different observers participating in the study. **b.** Kappa values for the different exposure times and voltages.

Fig 3a. Fig 3b.

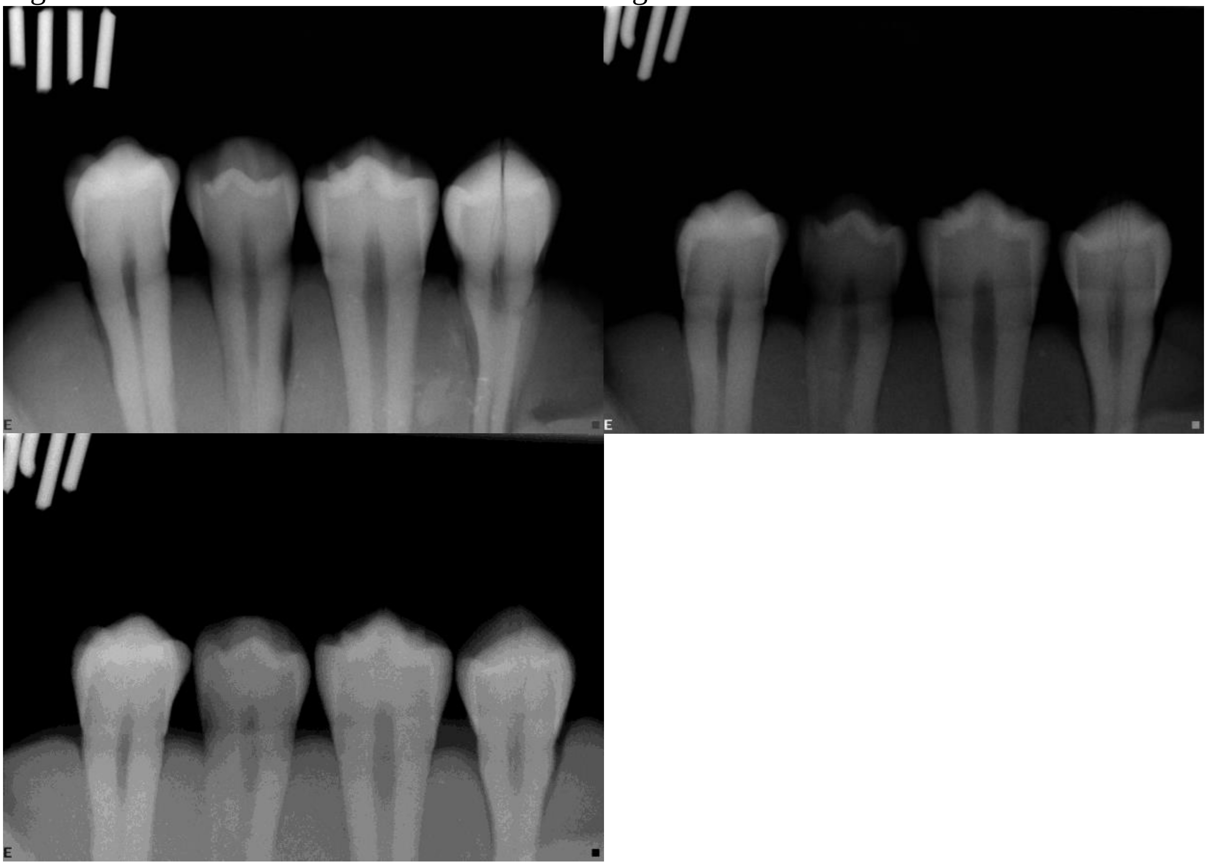


Fig 3c.

Fig 3. Radiographs exposed with different voltage and exposure time **a.** 60 kV 0,32s **b.** 70 kV 0,25s (time decreased by 22%) **c.** 70 kV 0,125s (time decreased by 61%)

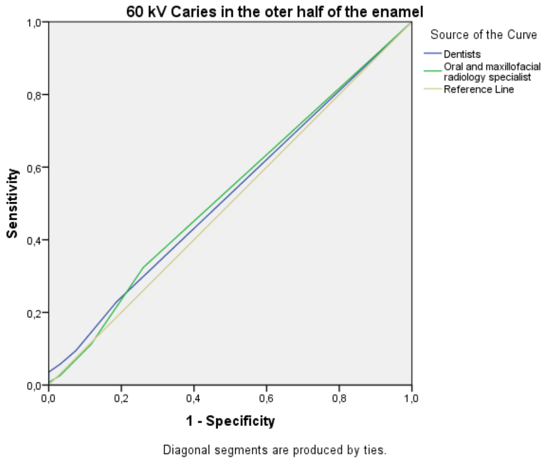


Fig 4a.

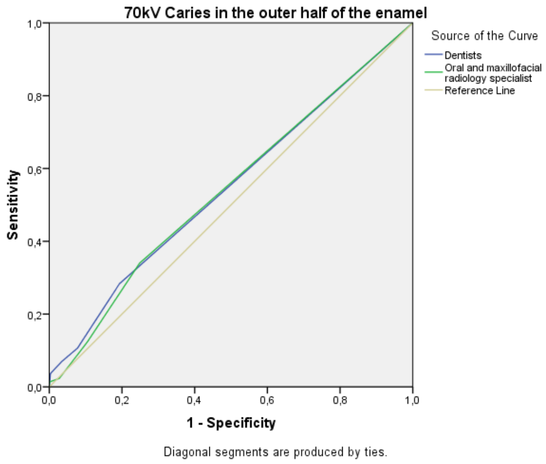


Fig 4b.

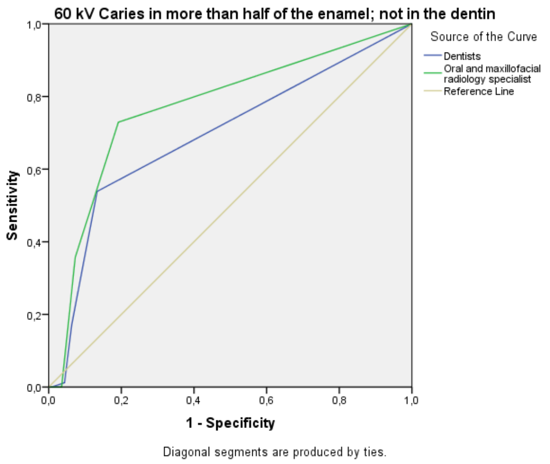


Fig 4c.

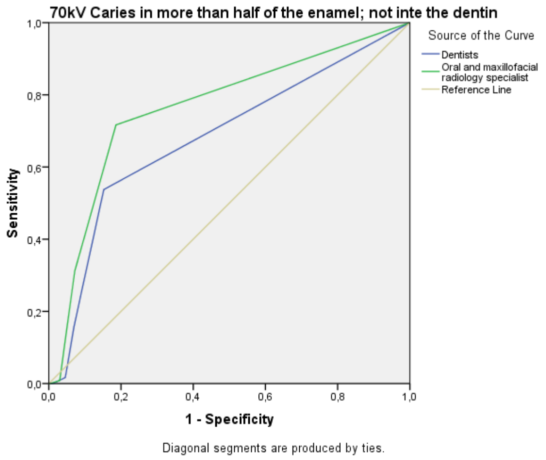


Fig 4d.

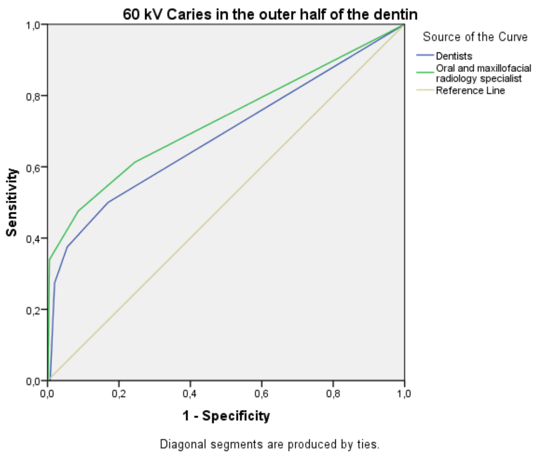


Fig 4e.

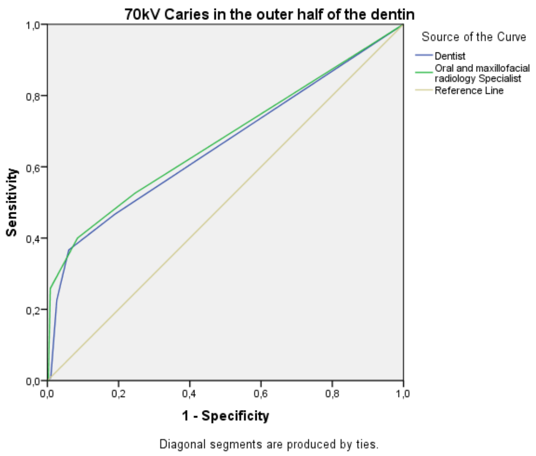


Fig 4f.

Fig 4. ROC curves comparing 60 and 70 kV and how well the observers diagnosed the different sized carious lesions. **a.** Dentist **(**A_z**)**: 0,523 Specialist **(**A_z**)**: 0,527 **b.** Dentist **(**A_z**)**: 0,546 Specialist **(**A_z**)**: 0,543 **c.** Dentist **(**A_z**)**: 0,694 Specialist **(**A_z**)**: 0,770 **d.** Dentist **(**A_z**)**: 0,683 Specialist **(**A_z**)**: 0,764 **e.** Dentist **(**A_z**)**: 0,686 Specialist **(**A_z**)**: 0,729 **f.** Dentist **(**A_z**)**: 0,660 Specialist **(**A_z**)**: 0,676

APPENDIX

Anvisningar till granskare i undersökning av exponeringsparametrars påverkan på kariesdiagnostik.

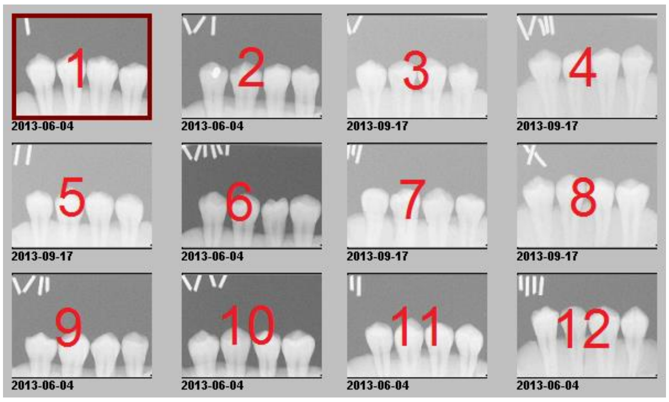
Under **6 veckor** kommer Du att granska **3 bildkartor/vecka** med totalt 32 bilder, 4 tänder/bild. Du kommer att få tillgång till nya bilder varje vecka. Om du missar en vecka kommer vi att göra samtliga bilderna tillgängliga efter att 6 veckor har gått.

Det tar ca 30-40 minuter att granska första gången då du måste läsa och följa instruktionerna. Därefter tar det 15-20 min per omgång när du vet hur granskningen går till.

”Patienten” du ska granska första veckan finns i student-CDR och heter i efternamn:
Vecka 1: Brusson 1

1. Börja granska bilderna på bildkartan i den vänstra fliken.
2. Börja alltid med bilden högst upp till vänster som i frågeformuläret benämns bild 1 och gå sedan till höger i den översta raden (se figur 1).
3. Granska sedan radvis från vänster till höger.
   OBS! Det är viktigt att du granskar bilderna i rätt ordning!
4. När du har granskat samtliga bilder i den första bildkartan (vänstra fliken) fortsätter du på samma sätt med den mittersta fliken (bildkarta).
5. Avsluta med att granska bilderna i fliken längst till höger
6. När du granskat veckans bilder skickar du in ditt svar i ett av de bifogade kuverten.

Frågeformuläret om arbetserfarenhet etc. skickar Du in i ett eget kuvert. Det hanteras separat och du kommer att vara helt anonym.
Det är viktigt att du granskar alla bilder som ingår i studien. Du kommer att få tillgång till eventuellt missad omgång bilder efter 6 veckor.

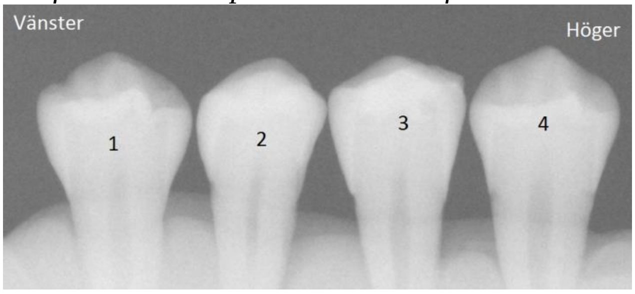


Figur 1.

Bedömning av karies:

1. Vid diagnostik av karies får Du använda alla typer av bildbehandling och verktyg som finns i Schick. OBS! Du får INTE SPARA ändringarna eftersom alla granskar samma ”patient”.
2. Du ska enbart diagnostisera karies på approximalytorna.
3. Diagnostisera ytorna från vänster till höger i bilderna.
4. Kontrollera att du granskat alla tandytor innan du skickar tillbaka formuläret.

Ex. första tanden på bilden nedan från vänster sida = tand nummer 1



Så här bedömer du ett kariesangrepp:
0 = Frisk
1 = Karies i yttre halvan av emaljen
2 = Karies i mer än halva emaljen; ej i dentin
3 = Karies i yttre halvan av dentinet
4 = Karies i mer än halva dentinets tjocklek

OBS! Denna gradering av karies är inte samma som man vanligen använder i kliniken (D1, D2 och D3)

Exempel: Tand 2 har ett kariesangrepp på höger sida som sträcker sig till yttre halvan av dentinet så sätt ett kryss enligt exemplet nedan.

Bild 1

	Tand 1		Tand 2		Tand 3		Tand 4	
	Vä	Hö	Vä	Hö	Vä	Hö	Vä	Hö
0								
1								
2								
3				X				
4								

Frågeformulär till granskare i undersökning av exponeringsparametrars påverkan på kariesdiagnostik.

(Skicka ditt svar i separat kuvert)

1. Hur länge har du arbetat som tandläkare?
   ____

2. Brukar du dämpa belysningen vid granskning av röntgenbilder?

   ☐ Nej ☐ Ja

3. Vilken skärm använder du vid granskningen (Ange märke och modell)
   ____

4. Använder du annat hjälpmedel för att skärma av ljus vid granskning av röntgenbilder? Om ja, vad?

   ☐ Nej ☐ Ja,_______________________

5. Har du någon utbildning i digitalröntgen (ex. i grundutbildningen eller externa kurser)?

   ☐ Nej ☐ Ja,_______________________

6. Använder du regelbundet bildbehandling eller verktyg vid granskning av digitala röntgenbilderna?

   Om ja, vilken/vilka funktioner?

   ☐ Nej ☐ Ja,_______________________

7. Är du specialist eller disputerad inom odontologi? Om ja, i vilket ämne?

   ☐ Nej ☐ Ja,_______________________

8. Brukar du välja olika exponeringstider beroende på patientens storlek, ålder etc?

   Om ja, ge exempel

   ☐ Nej ☐ Ja,_______________________

9. Brukar du välja olika spänning beroende på om du tar bitewing eller apikalbilder?

   ☐ Nej ☐ Ja, Bitewing ________kV, apikalbilder __________kV

10. Om du upplever att en bild blir mörk brukar du då ta om den?

    ☐ Nej ☐ Ja

11. Om du upplever att en bild blir ljus brukar du då ta om den?

    ☐ Nej ☐ Ja Eventuell kommentar_______________________