The Use of Radiation Dose-Reduction Techniques in the Practices of Dental Faculty Members


Abstract: X-ray exposure to dental patients has been significantly reduced by the introduction of speed group E intraoral film, rectangular beam limitation, long position indicating devices (PIDs), and rare-earth intensifying screens for extraoral radiography. Research indicates that many dentists do not use these techniques. However, schools of dentistry have implemented them to varying degrees for many years, so this investigation was conducted to determine the extent to which dental school faculty members use these materials and techniques in their own practices. Comparisons were made between full- and part-time instructors, those in practice for fifteen years or less and those in practice for more than fifteen years, and those with postgraduate education versus those with no formal education beyond dental school. The significance of differences was measured with chi-square analysis. The results indicate that dentists with faculty appointments utilize dose-reducing techniques to degrees that are comparable to or greater than reported usage by non-dental faculty practitioners. Faculty dentists in practice fifteen years or less are more likely than their older colleagues to use E-speed film (p = 0.001), whereas those in practice more than fifteen years are more likely to use longer PIDs (p = 0.049). Greater acceptance of these practices by faculty may lead to reinforcement of their use in the clinical education of dental students.

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Key words: dental radiography, dental faculty, clinical practice

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Technical advances in x-ray equipment and imaging systems have allowed significant reductions in radiation doses to patients during intra- and extraoral radiography. The use of E-speed film1-8 and the recently introduced film in speed group F9-11 permits significant exposure reductions compared to the slower D-speed film. Rectangular collimation of the x-ray beam decreases the amount of tissue exposed, thereby lowering the absorbed dose to the patient.1,2,8,12 Greater source-film distance, determined by position indicating device (PID) length, produces a similar effect by absorbing more of the diverging photons than short PIDs.2,13,14 Similarly, extraoral radiographic doses have been markedly reduced with the use of rare-earth intensifying screens and compatible films, compared to calcium tungstate screen-film combinations.1,15-20

Despite this evidence, surveys of practicing dentists have shown fairly little acceptance of some of these dose-reducing practices.21-27 Many dental schools in the United States and Canada have used these techniques for years, so dentists who hold full- or part-time faculty appointments in schools of dentistry may be familiar with the advantages of using fast film, rectangular beam limitation, long PIDs, and rare-earth screen-film systems. This raises the question of whether dental faculty members use them in their own practices. Clinical faculty can have great influence on students, and the degree to which they reinforce these concepts when instructing students may be related to their confidence in and use of them in their own offices. The purpose of this investigation was to assess the use of dose-reducing film and equipment by dentists who are affiliated with dental schools.

Methods

Dentists who hold full-time (FT) or part-time (PT) faculty appointments and who maintain extra-
mural private practices were surveyed at two dental
schools regarding their use of radiation dose-reduc-
ting techniques. The survey questionnaire asked the
respondents to indicate:
1) full- or part-time faculty status;
2) number of years in practice;
3) advanced education program(s) completed and
year(s) of completion (including GPR and AEGD
programs);
4) speed(s) of intraoral radiographic film used in
their practices;
5) type(s) of beam limitation used on their x-ray
machines (round, rectangular, or pointed PID);
6) length(s) of PIDs (i.e., 8”, 12”, or 16”); and
7) type(s) of intensifying screens used for extraoral
radiography (where applicable).

Chi-square analysis was applied to data regard-
ing film speed, shape of beam limitation, PID length,
and intensifying screens to measure the significance
of differences in these criteria between full- and part-
time faculty, between dentists in practice fifteen years
or less and those in practice longer than fifteen years,
and between general dentists and those with post-
graduate clinical training. The level of significance
was determined a priori at p = 0.05.

Results

Questionnaires were returned by 101 of the 140
faculty members surveyed, for a 72.1 percent re-
response rate. Table 1 lists the distribution of the re-
spondents regarding faculty status, length of prac-
tice, and advanced dental education. Tables 2 through
5 list the data for each radiation dose reduction crite-
rian, arranged by the three categories of respondents.
The total number of responses differs between crite-
ria because of lack of applicability of each criterion
to all respondents or because some respondents did
not answer all applicable questions.

E-speed intraoral film is used exclusively by
thirty-seven (38.6 percent) of the respondents and in
combination with D-speed film by twenty-five fac-
ulty members (26.0 percent). Overall, E-speed film
is used in the practices of 64.6 percent of faculty
dentists. Film in speed group D is the only film used
by thirty-four respondents (35.4 percent). When the
data are analyzed by grouping those who use E-speed
film for all or some of their patients versus those
who do not choose this film, faculty members who
have practiced fifteen years or less are significantly
more likely to employ E-speed film than those in

Table 1. Characteristics of faculty members
completing the survey

<table>
<thead>
<tr>
<th>Faculty Status</th>
<th>Full-Time Appointment</th>
<th>Part-Time Appointment</th>
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<tr>
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<td>54</td>
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<table>
<thead>
<tr>
<th>Years in Practice</th>
<th>15 Years or Less</th>
<th>1–4 Years</th>
<th>5–10 Years</th>
<th>11–15 Years</th>
<th>More than 15 Years</th>
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<td>21</td>
<td>9</td>
<td>59</td>
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<td>6</td>
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<tr>
<td></td>
<td>7</td>
<td>9</td>
<td></td>
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<table>
<thead>
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<th>Dental Education</th>
<th>Dental School Only</th>
<th>Additional Education</th>
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<tr>
<td></td>
<td>35</td>
<td>66</td>
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<tr>
<td>AEGD/GPR</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>Endodontics</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Oral Diagnosis/Radiology</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Oral Surgery</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Orthodontics</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Pediatric Dentistry</td>
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<td>7</td>
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<tr>
<td>Periodontics</td>
<td>9</td>
<td>8</td>
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<td>Prosthodontics</td>
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<tr>
<td>Multiple/Other</td>
<td>10</td>
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</table>

Table 2. Film speed selection, with the p value
derived from the chi-square test

<table>
<thead>
<tr>
<th></th>
<th>D</th>
<th>E+/-D</th>
<th>p</th>
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</thead>
<tbody>
<tr>
<td>Full-Time Faculty</td>
<td>17</td>
<td>26</td>
<td>0.465</td>
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<tr>
<td>Part-Time Faculty</td>
<td>17</td>
<td>36</td>
<td>0.001*</td>
</tr>
<tr>
<td>15 Years or Less</td>
<td>7</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>More Than 15 Years</td>
<td>27</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>Advanced Education</td>
<td>19</td>
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</tr>
<tr>
<td>Dental School Only</td>
<td>13</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
D = use of D-speed film only
E+/-D = use of E-speed film with or without D-speed film
* = significant difference

practice more than fifteen years (p = 0.001). E-speed
film is used by thirty-four of the forty-one younger
faculty members (83.0 percent), whereas only twenty-
eight of the fifty-five older respondents (50.9 per-
cent) include E-speed film in their practices. Greater
numbers of dental faculty members with advanced
education use E-speed film compared to those with
no advanced training (68.9 percent vs. 57.1 percent),
and the percentage of part-time faculty utilizing E-
speed film (67.9 percent) is greater than full-time
instructors (60.5 percent), but these findings fall short of significance (p > 0.05).
The use of rectangular beam limitation is more common among full-time faculty (8/45, or 17.8 percent) than part-timers (3/52, or 5.8 percent). Dentists in practice more than fifteen years indicated greater use of this technique than those with experience of fifteen years or less (12.7 percent vs. 9.5 percent), and faculty with advanced education more frequently utilize rectangular beam limiting devices than those with no advanced training (12.9 percent vs. 8.6 percent). None of these findings is statistically significant.

Table 3. Beam limitation, with the p value derived from the chi-square test

<table>
<thead>
<tr>
<th></th>
<th>Round</th>
<th>Rectangular +/− Round</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full-Time Faculty</td>
<td>37</td>
<td>8</td>
</tr>
<tr>
<td>Part-Time Faculty</td>
<td>49</td>
<td>3</td>
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<tr>
<td>15 Years or Less</td>
<td>38</td>
<td>4</td>
</tr>
<tr>
<td>More Than 15 Years</td>
<td>48</td>
<td>7</td>
</tr>
<tr>
<td>Advanced Education</td>
<td>54</td>
<td>8</td>
</tr>
<tr>
<td>Dental School Only</td>
<td>32</td>
<td>3</td>
</tr>
</tbody>
</table>

Notes: Rectangular +/− Round = use of at least one x-ray unit with rectangular beam limitation with or without round limitation

Table 4. PID length, with the p value derived from the chi-square test

<table>
<thead>
<tr>
<th></th>
<th>8”</th>
<th>12”/16” +/− 8”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full-Time Faculty</td>
<td>20</td>
<td>24</td>
</tr>
<tr>
<td>Part-Time Faculty</td>
<td>26</td>
<td>23</td>
</tr>
<tr>
<td>15 Years or Less</td>
<td>25</td>
<td>16</td>
</tr>
<tr>
<td>More Than 15 Years</td>
<td>21</td>
<td>31</td>
</tr>
<tr>
<td>Advanced Education</td>
<td>27</td>
<td>32</td>
</tr>
<tr>
<td>Dental School Only</td>
<td>19</td>
<td>15</td>
</tr>
</tbody>
</table>

Notes: 8” = use of x-ray unit with 8” PID
12”/16” +/− 8” = use of at least one x-ray unit with a 12” or 16” PID length, with or without the use of 8” PID
* = significant difference

Table 5. Intensifying screen use, with the p value derived from the chi-square test

<table>
<thead>
<tr>
<th></th>
<th>RE</th>
<th>CaW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full-Time Faculty</td>
<td>21</td>
<td>9</td>
</tr>
<tr>
<td>Part-Time Faculty</td>
<td>25</td>
<td>9</td>
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<tr>
<td>15 Years or Less</td>
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<td>5</td>
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<td>More Than 15 Years</td>
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<td>12</td>
</tr>
<tr>
<td>Dental School Only</td>
<td>13</td>
<td>6</td>
</tr>
</tbody>
</table>

Notes: RE = rare earth
CaW = calcium tungstate

Rare-earth intensifying screens are widely used by all of the respondents. The survey found that 71.9 percent of faculty members use rare-earth screens: 70.0 percent of full-time faculty (twenty-one out of thirty) and 73.5 percent of part-time members (twenty-five out of thirty-four). More dentists in practice fifteen years or less (twenty out of twenty-five, or 80.0 percent) utilize rare-earth screens than older faculty members (twenty-six out of thirty-nine, or 66.7 percent). Use of these screens occurs in the practices of 73.3 percent of those with advanced education (thirty-three of forty-five), and in 68.4 percent of the other faculty members (thirteen of nineteen). There are no statistically significant differences in any of these findings.

**Discussion**

The finding that 64.6 percent of practicing dentists with faculty appointments use E-speed film dif-
fers from results in earlier investigations. Surveys over the past ten years in Michigan,21 Ontario,22 Sweden,23,24 and North Carolina,25 as well as investigations of dental offices nationally26 and in New York,27 revealed that the percentage of dentists working with speed group E film, either exclusively or in combination with D-speed film, ranged from 10 percent to 53 percent. It is possible that faculty dentists might be aware of the benefits of the faster film because E-speed film has been used exclusively for the past decade in both dental schools involved in this survey.

E-speed film is more likely to be used by faculty dentists in practice less than fifteen years (83.0 percent) than by their older colleagues (50.9 percent). This may be related to the original formulation of speed group E film by Eastman Kodak. Although the diagnostic accuracy of the original E-speed film, Ektaspeed®, was comparable to D-speed film, the image was grainier, had greater fog density and lower film contrast,3-6,28-30 and suffered more variability in quality with fluctuations in processing conditions.31 As a result, many dentists subjectively preferred the slower D-speed film.32,33 In fact, surveys of U.S. dental34 and dental hygiene35 programs in 1986 revealed that E-speed film was used in less than half of these institutions. For this reason, we decided to use the fifteen-year practice length as the dividing line when analyzing the use of E-speed film, since many dentists who were in practice more than fifteen years ago may have declined to use what was perceived to be an inferior product.

By 1990 the percentage of hygiene programs using E-speed film had increased to 70 percent,36 and it is likely that the number of dental schools utilizing it also increased. Eastman Kodak changed the physical properties of Ektaspeed in 1994 and renamed it Ektaspeed Plus®, a film with contrast, sharpness, and processing characteristics comparable to D-speed film.3-7 It is therefore possible that many dentists in practice less than fifteen years are more likely to have used E-speed film as students and may be familiar only with the improved film, leading to fewer reservations about using it.

Since this survey was completed, intraoral film in speed group F has appeared on the market. Eastman Kodak Insight® is categorized as an F-speed film when processed in roller-type automatic processors. It has been found to be approximately 25 percent faster than Ektaspeed Plus with virtually equal contrast.9-11 Future research will be required to determine how well this film is accepted.

Only 11.3 percent of faculty dentists use rectangular beam limitation. This is higher than the findings in other surveys, where the percentage of U.S. and Canadian dentists using rectangular beam limiting devices ranged from 5 percent to 9 percent,21,22,25 but lower than the 29 percent and 36 percent figures reported in Sweden.23,24 In addition to allowing a radiation dose reduction of at least 60 percent compared to round PIDs,1,2,12,14 the use of rectangular PIDs has been shown to produce images on speed group E film that are subjectively better than D-speed radiographs exposed with circular PIDs.8 Research in dental and dental hygiene schools indicates that the use of rectangular PIDs is not difficult to learn, and whereas the frequency of errors requiring re-exposure is somewhat greater with rectangular beam limitation compared to round PIDs, the increase is minor and the patient radiation dose is still considerably reduced.37-39

Our findings indicate greater use of rectangular beam limiters among full-time faculty (17.8 percent) than part-time instructors (5.8 percent), although the results fall short of significance (p = 0.063). The reasons for this result are not clear, but we speculate that they may be related to the possibility that FT faculty have more opportunities to examine radiographs exposed with rectangular beam limitation by virtue of their full-time status. We also discovered that a slightly greater percentage of dentists in practice more than fifteen years (12.7 percent) use rectangular beam limitation compared to less-experienced practitioners (9.5 percent). Whereas this result was not statistically significant, it is consistent with the findings of Bohay et al. who reported in 1994 that dentists who had graduated more than twelve years earlier were significantly more likely to use rectangular beam limitation than more recent graduates.22

One of the problems impeding the use of rectangular PIDs is the difficulty of obtaining them. Intraoral x-ray units are routinely shipped to purchasers with short round PIDs, and very few manufacturers offer rectangular PIDs as an option. Dentists can create rectangular beam limitation by purchasing metal inserts for the round PID that have rectangular windows or by using film positioners with an attached metallic shield with a rectangular window, but use of these devices is not widespread.21,25 Part of the responsibility may rest with dental schools, which have not employed rectangular beam limitation in great numbers.34-36 A recent
survey of North American schools of dentistry revealed that 47 percent use rectangular beam limitation, which is an improvement over the past decade but still somewhat low.40

Long PIDs (12” or 16”) are used by 50.5 percent of all faculty dentists, either exclusively or in combination with short 8” PIDs. This compares favorably with a 1992 report in which 35 percent of dentists used long PIDs.21 Extension of the PID length from 8” to 16” can reduce radiation exposure to various tissues by 30 percent to 38 percent.2,13,14 A recent survey revealed that 88 percent of North American schools of dentistry use 12” and/or 16” PIDs, whereas 12 percent use 8” PIDs exclusively.40 We speculate that the less common usage of longer PIDs among faculty dentists in their practices may be related to the fact that 8” PIDs are provided by default with new intraoral x-ray units. Operators must specifically request or purchase longer PIDs, and this might be a negative incentive, similar to the reason that rectangular beam limiters are not widely used.

Faculty dentists in practice more than fifteen years are significantly more likely to use longer PIDs than younger faculty members (59.6 percent vs. 39.0 percent, p = 0.049). The reasons for this are obscure. In every category, a majority of faculty dentists surveyed use rare-earth intensifying screens for extraoral radiographic procedures. In total, 71.9 percent of respondents use them. The advantages of rare-earth screens and compatible films are well known; exposure reductions of up to 55 percent have been reported when these screen-film combinations are used as compared to the older calcium tungstate screens.15,16,19,20 Whereas differences in perceptibility, contrast, and spatial resolution have been documented between the calcium tungstate and rare-earth systems,16,17,19 investigators have found no significant differences in qualitative evaluation of these images.15,16,18

Most manufacturers of panoramic and skull radiographic units now provide rare-earth intensifying screens, which might explain why such a large percentage (80.0 percent) of faculty dentists in practice fifteen years or less use them. We speculate that dentists who have been practicing more than fifteen years may tend to have older units and still use the original calcium tungstate screens. The reduction in exposure between tungstate and rare-earth screen systems is so large that it may be necessary to add additional filtration to older x-ray units to permit use of rare-earth screen-film combinations.20

The importance of these findings to dental education lies in the fact that students, as the next generation of dental professionals, must receive accurate information on advances in radiation dose reduction. This is the responsibility not only of radiology faculty, but also of all clinical instructors, many of whom serve as role models for their students. Clinical faculty can influence students by their actions, and if they utilize dose-reducing techniques in their practices, they can reinforce important concepts of radiation hygiene. If clinical faculty do not believe in these methods, they can negate the concepts presented by radiology educators. The fact that dental faculty utilize dose-reduction methods to a greater extent than other dentists is encouraging, but dental schools must persevere in educating their faculty on these beneficial changes in radiology practice in the interest of the public welfare.

REFERENCES