DOSE DISTRIBUTION IN ORAL RADIOGRAPHY

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SUMMARY

Although the patient dose due to oral radiography is not very high per examination (at least in comparison to other radiographic procedures in medicine), the frequency of these examinations is high enough to warrant further investigations of dose distributions in standardized experiments.

Dose measurements were performed by means of LiF-100 thermoluminescence dosimeters in an Alderson Rando phantom, that was specially adapted to enable comprehensive measurements in the head and neck region. The measurements refer to several dental X-ray devices, projection techniques, kV-settings, film types and measures for dose reduction. In addition, some other X-ray techniques used to show a larger area of the skull were involved in this study. The effective dose equivalent was calculated for each of the techniques and the related parameters.

The H_{eff} ranged form .002 to .660 mSv. This corresponds to a fatal risk in the order of 10^{-6} or 10^{-7} per examination. The results of this study will be used to estimate the population dose due to oral radiodiagnosis in the Netherlands in a current investigation.

INTRODUCTION

Many publications have appeared concerning dose measurements and risk estimations in oral radiography, based on in vitro and in vivo studies. These studies show a large variance due to the small beam diameter as applied in oral radiography and the complicated anatomical structures in the facial region. These factors make that a small deviation of the projection geometry results in a considerably different dose distribution in the patient.

Although the patient dose due to oral radiography is not very high per examination (at least in comparison to other radiographic procedures in medicine), the frequency of these examinations is high enough to warrant further investigations of dose distributions in standardized experiments.[2] The aim of this study is to determine the dose distribution in the body, especially in the head and neck region during radiodiagnostic procedures as usually applied in dentistry. Factors that influence the dose should be considered as well. These factors include technical parameters like kV settings and aiming devices, differences between various projection techniques and the effects of radiation protection measures.[3]

MATERIAL AND METHODS

Dose measurements were performed by means of LiF-100 thermoluminescence dosimeters in an Alderson Rando phantom. Special provision were made in this

Table I, Effective dose equivalent for several intra-oral dental radiographic techniques. The kV and mAs values were adjusted to produce radiographs of constant density.

technique	kVp	mAs	H_{eff} (mSv)
complete mouth survey, bissecting angle technique, 20 radiographs, Ultraspeed film			
- GE-1000	50	356.5	0.284
- Philips Oralix	65	123.0	0.067
- Philips Oralix	65	127.0	0.067
- Philips Oralix	65	131.0	0.067
- Ritter Expl.	75	231.8	0.122
- GE-1000	90	46.1	0.050
- GE-1000	75	92.1	0.089
diaphragm x .5	75	92.1	0.082
with lead apron	75	92.1	0.084
with lead collar	75	92.1	0.064
complete mouth survey, paralleling technique, 20 radiographs, Ultraspeed film			
- GE-1000	50	477.4	0.173
- GE-1000	90	61.2	0.027
- GE-1000	75	122.4	0.051
with lead apron	75	122.4	0.047
with lead collar	75	122.4	0.046
complete mouth survey, bissecting angle technique, 20 radiographs, Ektaspeed film			
- GE-1000	50	200.1	0.160
- Philips Oralix	65	50.0	0.027
- Philips Oralix	65	57.0	0.027
- Philips Oralix	65	59.0	0.027
- Ritter Expl.	75	117.75	0.062
- GE-1000	90	25.7	0.028
- GE-1000	75	51.3	0.049
diaphragm x .5	75	51.3	0.046
with lead apron	75	51.3	0.047
with lead collar	75	51.3	0.036
complete mouth survey, paralleling technique, 20 radiographs, Ektaspeed film			
- GE-1000	50	283.1	0.103
GE-1000	90	36.3	0.016
- GE-1000	75	72.6	0.030
with lead apron	75	72.6	0.028
with lead collar	75	72.6	0.027
occlusal technique, Ultraspeed film			
- GE-1000	75	3.3	0.002

Table II, Effective dose equivalent for several extra-oral dental radiographic techniques.

technique	kVp	mAs	H_{eff} (mSv)
panoramic technique			
- extra-oral			
Siemens OP2	65	800.0	0.130
Panelete	73	240.0	0.030
- intra-oral	50	0.2	0.013
temporo-mandibular joint			
- Schüller	85	15.0	0.005
- Parma	65	23.0	0.660
- Parma	75	15.0	0.561
lateral skull			
- Siemens	96	175.0	0.015

phantom to enable comprehensive measurements in the head and neck region. The measurements refer to four different dental X-ray devices, five different projection techniques, four different kV-settings, two film types and four measures for dose reduction (table I). In addition to these, two panoramic X-ray techniques and four techniques to X-ray a larger area of the skull were involved in this study (table II).

The TLD measurements were converted into organ doses (mGy).[1] From these the H_{eff} and related fatal risk can be calculated for each of the projection techniques and parameters.

RESULTS

The H_{eff} ranged from .002 to .660 mSv (tabel I and II). This corresponds to a fatal risk in the order of 10^{-6} or 10^{-7} per examination. The kV-settings showed to influence the total dose considerably. A decrease of the kV from 75 to 50 kV almost doubles the H_{eff}. All measures for dose reduction proved to be effective.

CONCLUSION EN DISCUSSION

It can be concluded from the results, that dose reduction can be achieved by several measures:

- Dental X-ray apparatus should have a rectangular open ended tube instead of a closed pointed cone.
- Rotational panoramic radiographs are not a "cheap" substitute for full mouth surveys as far as dose is concerned. The dose in the rotation axis of the X-ray beam in rotational panoramic radiography is rather high and brings the total dose of this technique to the same level as that of a conventional full mouth radiographic survey.

- Radiographs of the temporo-mandibular joint made by the technique according to Parma should be rejected. The Schüller technique is to be prefered in these situation.

- Use of a lead apron or a cervical collar must be made obligatory.

- Tube voltages of less than 65 kV result in a much higher dose than higher kV settings and should be avoided therefore.

The results of this study will be used to estimate the population dose due to oral radiodiagnosis in the Netherlands in a current investigation (Velders and Selling, elsewhere in these proceedings).

REFERENCES

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