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Assessment of panoramic radiography as a national oral examination tool: review of the literature

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ABSTRACT

Purpose : The purpose of this review is to evaluate the possibility of panoramic radiography as a national oral examination tool.
Materials and Methods : This report was carried out by review of the literatures.
Results : Panoramic radiography has sufficient diagnostic accuracy in dental caries, periodontal diseases, and other lesions. Also, the effective dose of panoramic radiography is lower than traditional full-mouth periapical radiography.
Conclusion : Panoramic radiography will improve the efficacy of dental examination in national oral examination. However, more studies are required to evaluate the benefit, financial cost, and operation time and also to make selection criteria and quality management program. (***Imaging Sci Dent 2011; 41 : 1-6***)

KEY WORDS : Radiography, Panoramic; Mass Screening; Outcome and Process Assessment; Radiation Dosage

Introduction

In South Korea, a national health care system provides periodic health examination to the subscribers and their dependants of national health insurance. Ministry of Health and Welfare declares health examination contents and expenses according to national health insurance law and it's implementing ordinances. The intention of health examination is to identify diseases in a community early, thus enabling earlier intervention and management in the hope to reduce mortality and suffering from diseases. Also, the data from examination can be used for public health promotion.

The annual dental examination is a content of health examination and consists of visual inspection and a questionnaire. However, unlike improvements in medical examination, dental examination method has not changed from the past. Some says dental examination is just a pretense, because of poor environment such as lack of equipment, limited time to thorough examination and consultation. The rate of dental examination had fallen to about 21%. 57.8% of subjects answered current dental examination was not satisfactory.[1] In another report, 55.8% of subjects answered that they wanted more accurate dental examination.[2] Therefore, one of the recent suggestion for this problem is the introduction of panoramic radiography to improve the efficacy of national oral examination.

Panoramic radiography is a simplified extraoral procedure which visualizes the entire maxillomandibular region on a single film.[3] Since its introduction into the general practice of dentistry, panoramic radiography has become a popular and valuable diagnostic tool.[3,4] Panoramic radiography has been used for routine screening of patients at various institutions and private clinic because it allows examination of the entire dentition, alveolar bone, temporomandibular joints, and adjacent structures easily.[5,6]

The purpose of this review is to assess the diagnostic ability of panoramic radiography in dental diseases compared with clinical examination and to evaluate the possibility of panoramic radiography as a national oral examination tool.

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Material and Methods

This report was carried out by review of the English and Korean literatures. A few studies have been carried out comparing the diagnostic ability of panoramic radiograph and clinical examination for dental diseases in oral examination. Therefore, the results of other surveys which compared the diagnostic ability of panoramic and intraoral radiographs including clinical examinations were reviewed also.

Results

Dental caries

Radiographs provide critical information to dental caries detection. Kidd and Pitts reviewed the literatures and concluded the use of bitewing radiography was essential if much approximal caries was not to be missed.[7] For this reason, most of previous studies have compared the caries detection between panoramic and intraoral radiographs,[7-13] and there were few studies comparing the panoramic radiography and clinical examination.[2,14,15]

A number of studies concluded that the diagnostic accuracy of dental caries of panoramic radiograph was lower than intraoral radiographs.[7-10] Although it was obvious that the intraoral radiographs showed higher accuracy to the panoramic radiographs for the detection of anterior carious lesions due to the low image quality of panoramic radiograph in the anterior region,[9,11-13] the detectability of dental caries in molar area of panoramic radiographs was comparable with that of intraoral radiographs.[9,10,12,13] Galal et al reported that bitewing radiographs detected the most proximal caries in molar area and there was no significant differences between periapical and panoramic radiographs.[9] Douglass et al reported that the mean positive and negative predictive values of periapical, bitewing and panoramic radiographs for the detection of dental caries in molar area were nearly identical.[11] These results were in agreement with Oba and Katayama[12] and Stewart and Bieser[13]

Choi reported carious detectability of clinical examination in occlusal and buccolingual surface was higher than that of panoramic examination, however it was statistically insignificant.[14] In proximal surface, carious detectability of panoramic examination was higher than that of clinical examination, and it was statistically significant. When the two examination methods were combined, additional detection of caries was possible (26.7% in occlusal, 48.2% in proximal, 33.3% in buccolingual surface, and 38.3% totally). An et al compared the detectability of clinical examination with panoramic radiograph.[15] Panoramic examination revealed 24.2% of dental caries which had not been discovered in clinical examination, however the rate of carious lesion which had been detected only in clinical examination was 5.2%. These results are in agreement with the finding of Shin et al, that panoramic radiography showed a higher detection rate of 23.1% for dental caries than clinical examination.[2]

The results of these studies cannot be compared directly, because there are differences in populations examined, methods for gold standard, diagnostic thresholds and observers. For example, a report of Hurlburt and Wuehrmann demonstrated that the changes in disease thresholds could affect the relative efficacy of caries detection between panoramic and intraoral radiographs.[10] However, these results showed that panoramic examination can improve the effectiveness of caries detection on dental examination.

Periodontal diseases

In diagnosing periodontal disease, radiograph plays an important role since critical information such as alveolar bone level, widening of periodontal ligament, crestal bone height and irregularity, and crown-root ratio cannot be found in clinical examination.[16]

A number of studies demonstrated the advantage of panoramic radiography for the diagnosis of periodontal disease and evaluated that the diagnostic accuracy of panoramic radiograph was comparable to intraoral radiograph.[2,8,9,11,15] Shin et al reported panoramic examination showed a higher detection rate of 31.9% for periodontal diseases than clinical examination.[2] An et al reported 62.6% of calculi deposition in screening panoramic radiographs, which was higher than that of clinical examinations by 7.4%.[15] Galal et al reported panoramic radiographs detected more periodontal bone loss than periapical radiographs.[9] This result is in agreement with the findings of Muhammed et al.[8] Douglass et al reported the sensitivities to periodontal disease between panoramic, bitewing and periapical radiographs showed no differences.[11] Meister et al reported panoramic radiographs with intraoral Polaroid photographs were extremely useful for dental health screening in detection of periodontal disease.[17] These studies identified that when clinical examination was supplemented by radiographic examinations, the overall number of periodontal disease detected improved substantially.[2,9,15]

Panoramic radiography is a useful method in the diagno-

sis of periodontal disease and will improve the detection of periodontal diseases in national oral examination.

Periapical diseases and other findings

Comparing with clinical examination, radiographs are very helpful for detecting dental diseases such as periapical lesion, impacted or missing tooth, maxillary sinus anomalies, and condylar changes, which cannot be seen in clinical examination. Especially panoramic radiograph was the most effective in detecting impacted teeth and other miscellaneous findings due to the greater area of coverage.[2,9,14,15,17-20]

In a study of Shin et al, there were 33.6% of impacted teeth, 11.6% of maxillary sinus abnormalities, 2.1% of condylar abnormalities, 24.5% of dental anomalies, and 14.1% of miscellaneous abnormalities in panoramic examinations.[2] Lee and Kang found 11.9% of periapical radiolucencies, 10.8% of retained roots, and 2.0% of impacted teeth in screening panoramic radiographs.[18] Rushton et al reported 40.2% of periapical lesions, 17.3% of retained roots, 35.6% of unerupted teeth, 14.0% of maxillary antra, and 20.1% of other abnormalities in screening panoramic radiographs.[20] Except dental caries and periodontal disease, other lesions were found in 82.8% of the total panoramic radiographs.[20] These results were in agreement with other studies.[9,14,17,19]

In panoramic examination, it was possible to detect the periapical lesions and other abnormalities which could not be detected in clinical examination.

Tumors and cysts of the head and neck

There are geographic variations in prevalence of tumors and cysts in head and neck area.[21] Despite of the importance of the incidence and frequency of odontogenic tumors and cysts, no information was available on the screening of Korean people. Therefore, the results with those from other parts of the world were reviewed.

Zeichner et al evaluated the efficacy of dental radiography for the detection of occult intraosseous lesions of the face and jaws.[22] An analysis of 30 million health insurance records indicated that the period prevalence of malignant lesions was less than 5 cases/million/year, and for benign lesions approximately 100 cases/million/year. Stephens et al reported the prevalence of primary bone malignancy in head and neck region is 2/million/year.[23] These studies concluded the screening of tumors of head and neck with panoramic radiography could not be justified due to risk of radiation exposure. Daley et al reported relative incidence of odontogenic tumors and jaw cysts in a Canadian population.[24] They identified 445 (1.11%) cases of odontogenic tumors, 6,879 (17%) cases of odontogenic cysts, and 403 (1.00%) cases of non-odontogenic cysts in 40,000 consecutively accessioned oral biopsies. Buchner et al reported 1,088 (1.2%) cases of central odontogenic tumors out of the 91,178 accessed.[25] Regezi et al published a similar study from Michigan, that 706 (1.3%) cases was diagnosed as odontogenic tumors from 54,534 biopsy specimens.[26]

Based on foreign reports, it is doubtful how many tumors and cysts will be detected in panoramic radiography, however further research in Korean population is needed.

Screening with panoramic radiography

Panoramic radiography has been widely used in screening and epidemiological studies because of the convenience of their use.[2,14,15,17,19,27-30] The panoramic screening examination revealed additional 34.2% of the pathosis, which were not discovered by clinical examination with posterior bitewing radiographs.[19] This report concluded that the screening panoramic examination provided a simple and rapid method of recording the general dental health of a large population. Chaffin et al reported panoramic radiograph was sensitive enough to identify soldiers with severe dental disease and panoramic radiograph identified additional 33% of soldiers with severe dental disease than clinical examination.[30] They stated “a policy change may be prudent to allow this type of initial classification, and thus maximize limited dental resources”. Ahlqwist et al were of the opinion that, except for carious lesion, the panoramic radiographs could be useful in epidemiological studies of oral health.[27] A report of An et al showed that abnormal conditions revealed by panoramic examination which had not been discovered on clinical examination were; 24.2% of dental caries, 17.4% of periapical lesions, 7.4% of calculi deposition, 5.3% of retained root, and 15.3% of third molar impaction.[15] They concluded the use of panoramic radiography as a supplement to the clinical examination and might be a valuable screening technique. A number of studies were in agreement with these results.[2,14,19,28,29]

Some researchers expressed concern about patients exposure in screening panoramic radiography and studied selection criteria for panoramic radiography.[4,31-36] Douglass et al found that presence of several caries and tooth mobility were significant indicators of diagnostic yield for radiographic examinations.[36] White et al reported that when

the panoramic examination was taken for any specific indication and particularly no other radiographs are obtained, the yield of positive findings was high.[31] Rushton et al proposed clinical indicators for panoramic radiography as evident caries lesions, unerupted tooth, swelling, and periapical pathology.[33]

It is reasonable to concern about the exposure and unnecessary radiation exposures must be reduced. These studies concluded that routine screening of panoramic radiography was unproductive. However, they have shown exclusion of dental caries, periapical lesions, and periodontal diseases from the findings compared with panoramic radiograph.[4,33,37] They assumed that such diseases could be identified on intraoral radiographs. Therefore, the diagnostic ability of panoramic radiograph was underestimated and the development of panoramic equipment had improved the quality of panoramic radiograph compared to the past. Moreover, these studies alerted routine screening of panoramic radiography in personal dental clinics, not in national oral examination.

Unfortunately, oral hygiene of the people in South Korea was not in relatively good conditions. According to the 2006 National Oral Health Survey, a report to Ministry of Health and Welfare, the percentage of population with dental caries on permanent teeth (decayed, missing and filled rate: DMF rate) was 80% at 16-year-old group.[38] The percentage of population with active dental caries on permanent teeth (decayed rate: D rate) was 30% at 16-year-old group. The percentage of population showing no signs of periodontal disease was only 62% at 16-year-old group and dropped to below 20% at the age of after mid 40's. This high prevalence of oral diseases increases the chance to satisfy the pervious selection criteria for panoramic radiography and there would not be much unnecessary radiation exposure to subjects, however further investigations would be required.

Radiation dose

The traditional method of choice for imaging dental diseases was the full mouth periapical survey, taken by the paralleling technique.[39] In 2007, the International Commission on Radiological Protection (ICRP) revised estimates of the radiosensitivity of tissues including those in the maxillofacial region. Ludlow et al reassessed patients' risk related to common dental radiographic exposures using the 2007 ICRP recommendations.[40] The effective dose of 18 full-mouth radiographs with F-speed film and round collimation was 170.7 μSv, same as 21 days additional background radiation. In case of using rectangular collimation, the dose of 18 full-mouth radiographs with F-speed film was 34.9 μSv, same as 4.3 days additional background radiation. The dose of 4 bitewing radiographs with F-speed film and rectangular collimation was 5.0 μSv, same as 0.6 days additional background radiation. Meanwhile, the doses of panoramic radiography with CCD was 14.2 and 24.3 μSv. These doses were same as 1.7 and 3.0 days additional background radiation. The effective dose of chest radiography which is routinely taken in national health examination, is 0.06 to 0.25 mSv.[41] It is several times higher than that of panoramic radiography. Panoramic radiography can offer a dose advantage over large numbers of intraoral radiographs.

Discussion

Panoramic radiography shows both jaws and their respective dentition continuously on a single film by quick and simple procedure. And it does not require any inconveniences to the patients such as poking by film or pocket probing.[3] Because of the convenience, panoramic radiography has been widely used in screening and in epidemiological studies.[2,14,15,17,19,27-30] Introduction of panoramic radiography will improve the efficacy of national oral examination and will lead to detection of oral diseases more earlier. Early detection of oral diseases will results in better prognosis.

If dental caries was not treated timely, it would progress severely, cause sensitivity or pain, and eventually lead to loss of tooth. Actually dental caries was the leading cause of tooth loss in most countries.[42-44] Also, children with more decay at the time of restoration placement were at higher risk for replacement of restorations.[45] Thus management of dental caries demands detection of carious lesions at an early stage.

As periodontal inflammation progresses, it causes several symptoms, bleeding on probing, formation of periodontal pocket, sensitivity, alveolar bone loss, tooth mobility, and loss of tooth.[46] Many studies reported that periodontal diseases was the second reason for the extraction.[43,47] Even in the maintenance period followed by active treatment, the severity of periodontitis at the time of active treatment, were significantly associated with loss of tooth.[43,48,49] Significant and rapid periodontal care reduces periodontal tissue inflammation, and periodontal tissue destruction can be stabilized over a long term.[50] Muzzi et al reported that the lower amount of the residual supporting bone, the higher the probability of tooth loss, the greater the infra-

bony component, the lower the probability of tooth loss.[51] Thus the early detection and management of periodontal diseases are essential.

In case of odontogenic tumors and cysts, early detection is important also. Pippi stated "odontogenic tumors are more frequently diagnosed in the first three decades of life and therefore they can interfere with the physiological growth of the dento-skeletal apparatus. An early radiographic screening is therefore important to reveal these tumors at an initial stage of their development, when clinical signs or symptoms are not yet present".[52] Nuñez-Urrutia et al reported that large odontogenic cyst results poorer prognosis.[53]

The use of panoramic radiography as a supplement to the clinical examination in national oral examination might enhance the public oral health. However, diagnostic accuracy of anterior region on panoramic radiograph is lower than that of intraoral radiographs.[9,11-13] However, using panoramic radiography with selective intraoral radiographs in national oral examination for better diagnostic accuracy requires much more time and resources. Further researches are required to make balance between benefit, financial cost, and examination time.

Panoramic radiography is valuable as a teaching method for patients also. The main reason of dissatisfaction to national oral examination was short time of examination and consultation.[1] In a study of Shin et al 83.2% of people who received the result of panoramic findings by mail, responded that it was actually helpful.[2] And 70.6% of people responded panoramic examination was necessary.

Although panoramic radiography is effective and people desire panoramic radiography for oral examination, taking panoramic radiography in annual dental examination has a high risk of radiation exposure. All radiation exposures must be kept as low as reasonably achievable (ALARA). This could be achieved in three ways, using physical methods of minimizing dose, applying selection criteria, and consistently producing high quality radiograph to avoid repeat exposure. However, no lead protection was required during panoramic radiography.[32] Thus, further investigations for selection criteria and quality management program of panoramic radiography in national oral examination are required.

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