Diagnostic ability of differential diagnosis in ameloblastoma and odontogenic keratocyst by imaging modalities and observers

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ABSTRACT

Purpose : To evaluate the diagnostic ability in differentiating between ameloblastoma and odontogenic keratocyst according to the imaging modalities and observers.

Materials and Methods : We evaluated thirty-six cases of ameloblastomas and forty-seven cases of odontogenic keratocysts all histologically confirmed. Six oral and maxillofacial radiologists diagnosed the lesions by 3 methods: using panoramic radiograph, using computed tomograph (CT), and using panoramic radiograph and CT. The observers were classified by 3 groups: group 1 had experienced over 10 years in oral and maxillofacial radiologic field, group 2 had experienced for 3-4 years, and group 3 was in the process of residentship. After over 2 weeks, the observers diagnosed them by the same methods.

Results : The ROC curve areas except for group 3 were the highest with interpretation using panoramic radiograph and CT, followed by interpretation using CT only, and the lowest with interpretation using panoramic radiograph only. The overall difference was not found in diagnostic ability among groups in using panoramic radiograph only, but there was difference in diagnostic ability of group 1 and 2 vs 3 in using CT only, and combination panoramic radiograph and CT.

Conclusions : To differentiate between ameloblastoma and odontogenic keratocyst more accurately, the experienced oral and maxillofacial radiologist should diagnose with combination of panoramic radiograph and CT.
(Korean J Oral Maxillofac Radiol 2006; 36 : 177-82)

KEY WORDS : Diagnostic Ability; Ameloblastoma; Odontogenic Keratocyst

Introduction

Ameloblastomas are tumors of odontogenic epithelial origin. Theoretically, they may arise from cell rests of the enamel organ, from a developing enamel organ, from the epithelial lining of an odontogenic cyst, or from the basal cells of the oral mucosa.[1] They make up 1% of all tumors of the jaws,[2] and 11% of odontogenic tumors.[3] Although ameloblastomas are histopathologically benign, they have been characterized as a tumor with marked tendency to recur.[2,4] Radiographically ameloblastomas show an expansile unilocular or multilocular lesion with a "honeycomb or soap bubble" appearance and a sharp scalloping border.[5,6] Buccal and lingual cortical expansion is frequently present. Root resorption of adjacent teeth to the tumor is common.[1]

Odontogenic keratocysts arise from cell rests of the dental lamina and make up 10 to 12 percent of all developmental odontogenic cysts.[1] Histopathologically, they typically show a thin, friable wall, which is often difficult to enucleate from the bone in one piece, and have small satellite cysts within fibrous wall. Therefore odontogenic keratocysts often tend to recur after treatment.[7] Radiographically odontogenic keratocysts demonstrate a well-defined unilocular or multilocular radiolucency with smooth and often corticated margins.[1] Odontogenic keratocysts tend to grow in and anteroposterior direction within the medullary cavity of the bone without causing obvious bone expansion.[1] Displacement of teeth adjacent to the cyst occurs more frequently than resorption.[6]

The surgical treatment of ameloblastomas is marginal or block resection, but most odontogenic keratocysts are treated

Received October 4, 2006; accepted November 6, 2006
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by enucleation and curretage.[8,9] The preoperative differential diagnosis between ameloblastoma and odontogenic keratocyst is important to establish appropriate treatment planning, but ameloblastoma and odontogenic keratocyst are not much different in development age or site, and sometimes they are radiologically similiar, which makes it not easy to differentiate between them.

The studies of the preoperative differential diagnosis between ameloblastoma and odontogenic keratocyst have been reported over years. Tanimoto et al.[10] reported that buccolingual expansion of the ramus caused by odontogenic keratocysts was smaller than that caused by ameloblastomas. Choi[11] reported that lesional outline, the root resorption of adjacent teeth, tooth displacement, and the loss of lamina dura could be the parameters to differentiate odontogenic keratocyst and unilocular ameloblastoma. Minami et al.[12] reviewed the magnetic resonance findings in patients with odontogenic keratocysts or ameloblastomas, and proposed that from the magnetic resonance (MR) findings of the walls, solid components, and the fluid contents, odontogenic keratocysts could be differentiated from ameloblastomas. Jeong[13] et al. described that maxillary lesions were more common in odontogenic keratocyst, multilocular lesions were seen more frequently in ameloblastoma, and the external root resorption of adjacent teeth showed more frequently in ameloblastoma. Tozaki et al.[14] reported that a rapidly enhancing area was detected in cases of ameloblastoma, while no apparent rapid enhancement was seen in the other cystic lesions, including odontogenic keratocyst on dynamic multislice helical computed tomograph (CT). Soh et al.[15] described that the root resorption of the adjacent teeth, mandibular canal displacement, and the impaction of teeth were seen more frequently in ameloblastoma than in odontogenic keratocyst, and cortical expansion showed more severely in ameloblastoma.

The reliable interpretation of dental radiographs may be affected by a variety of biases, including the education, training, and experience of the observer,[16] which makes the observer difference in radiologic diagnosis. Choi et al.[17] examined the accuracy and inter- and intraobserver agreement in the radiologic diagnosis of ameloblastoma and odontogenic keratocyst on panoramic radiograph. They reported that experienced observer could differentiate more accurately than inexperienced observer, and that the diagnostic accuracy highly correlated to the intraobserver agreement.

But we didn't find the studies about the difference of effectiveness by imaging modalities and observers in the differential diagnosis between ameloblastoma and odontogenic keratocyst. The purpose of the present study is to assess the diagnostic ability, intra- and interobserver agreement on radiologic differential diagnosis in ameloblastoma and odontogenic keratocyst by imaging modalities and observers.

Materials and Methods

1. Materials

We examined histopathologically confirmed cases, taken preoperative panoramic radiograph and CT (IQ scanner, Picker International, USA), from January 1997 to July 2003 in Seoul National University Dental Hospital. Thirty-six cases of ameloblastomas and forty-seven cases of odontogenic keratocysts were selected. The cases showing the typical multilocular characteristics of the ameloblastoma and recurrent cases were not included.

2. Methods

1) Observers

The six observers who participated in the study were divided three groups. Group 1 was composed of the two observers (observer A, B), having experience over 10 years in oral and maxillofacial radiologic field. Group 2 was composed of the two observers (observer C, D), having experience 4-5 years in oral and maxillofacial radiologic field. Group 3 was composed of the two observers (observer E, F), in the process of residentship.

2) Diagnostic method

Each one of the six observers diagnosed the 83 randomly selected cases by 3 methods: 1. panoramic radiograph only, 2. CT only, 3. panoramic radiograph and CT simultaneously. The diagnoses were classified on 5-grade semiquantitative scales: 1=must be odontogenic keratocyst; 2=may be odontogenic keratocyst; 3=odontogenic keratocyst or ameloblastoma; 4=may be ameloblastoma; 5=must be ameloblastoma. All observers were blinded to their own results and those of the other observers. After over 2 weeks, the observers diagnosed them by same methods.

3) Statistical analysis

Receiver operating characteristic (ROC) curves for each observers and groups were analysized and areas under the curve were calculated. Intra- and interobserver agreement was determined by using the kappa statistics with 95% confidence intervals for each pairs of observers and groups. All statistical analysis were performed by the statistical software package

SPSS, release 10.0. (SPSS Inc., Chicago, USA).

Results

1. ROC analysis

The overall areas under the curve were the highest with panoramic radiograph and CT (0.825), followed with CT only (0.758), and was the lowest with panoramic radiograph only (0.757) (Fig. 1). The ROC curve areas of group 1 and 2 were the highest with panoramic radiograph and CT (0.870, both), followed with CT only (0.812 and 0.801, respectively), and was the lowest with panoramic radiograph only (0.765 and 0.763, respectively) (Figs. 2, 3). The ROC curve areas of group 3 were the highest with panoramic radiograph and CT (0.751), followed with panoramic radiograph only (0.748), and was the lowest with CT only (0.672) (Fig. 4). When observers diagnosed using panoramic radiograph only, the areas under the curve were 0.765 for group 1, 0.763 for group 2, and 0.748 for group 3. When observers interpreted using CT only, the areas under the curve were 0.812 for group 1, 0.801 for group 2, and 0.672 for group 3. When observers examined using panoramic radiograph and CT simultaneously, the areas under the curve were 0.870 for group 1 and 2, and 0.751 for group 3 (Fig. 5).

2. Intraobserver agreement

We found the various kappa values of 0.27 to 0.76 for the intraobserver agreement. The kappa values varied between

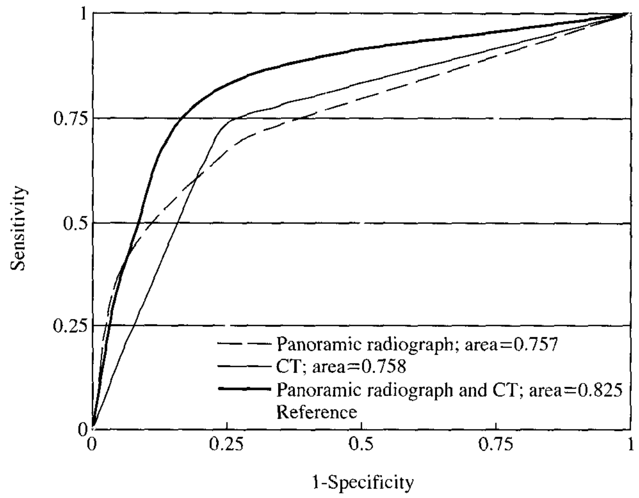

Fig. 1. ROC curve of all observers.

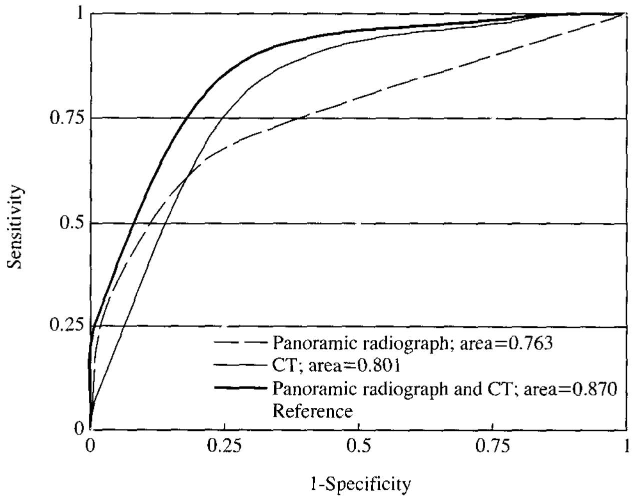

Fig. 3. ROC curve of group 2.

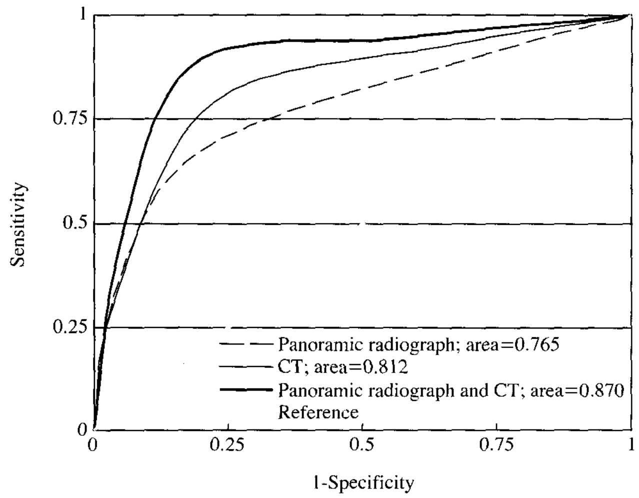

Fig. 2. ROC curve of group 1.

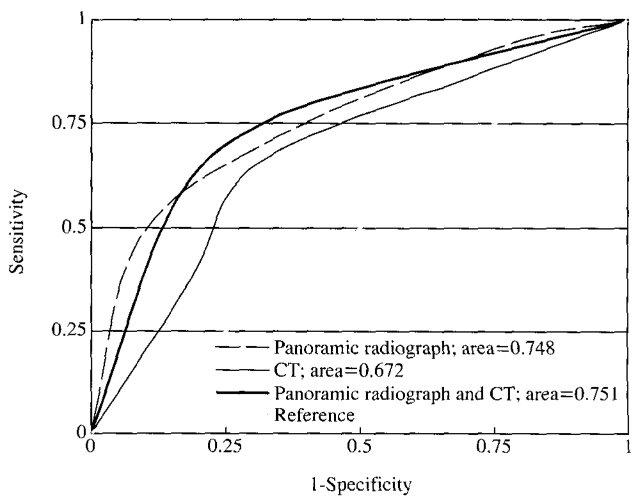

Fig. 4. ROC curve of group 3.

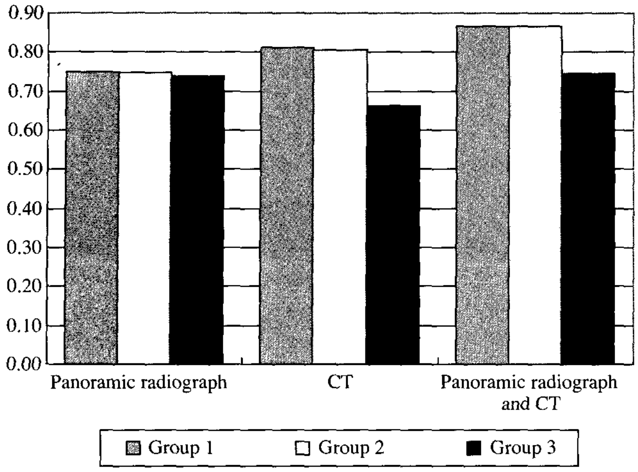

Fig. 5. Areas under curve of individual groups.

Table 1. Intraobserver agreement (kappa values)

Group	Observer	Panoramic radiograph	CT	Panoramic radiograph and CT
1	A	0.61	0.49	0.76
	B	0.59	0.56	0.72
2	C	0.47	0.62	0.57
	D	0.50	0.44	0.67
3	E	0.39	0.27	0.48
	F	0.32	0.52	0.47

Table 2. Interobserver agreement (kappa values)

Group	Panoramic radiograph	CT	Panoramic radiograph and CT
Group 1 and 2	0.42	0.49	0.64
Group 2 and 3	0.38	0.43	0.42
Group 1 and 3	0.34	0.37	0.50

0.49 and 0.76 for group 1, between 0.44 and 0.67 for group 2, and between 0.27 and 0.52 for group 3. The kappa values varied between 0.32 and 0.61 for interpreting panoramic radiograph only, between 0.27 and 0.62 for interpreting CT only, and between 0.47 and 0.76 for interpreting panoramic radiograph and CT (Table 1).

3. Interobserver agreement

Interobserver kappa values ranged from 0.34 to 0.64. The kappa values varied between 0.34 and 0.42 for using panoramic radiograph only, between 0.37 and 0.49 for using CT only, and between 0.42 and 0.64 for using panoramic radiograph and CT (Table 2).

Discussion

Frame and Wake[18] reviewed the value of CT as an aid to diagnosis and treatment planning in selected conditions affecting the jaws and related structures, and many features of CT which are helpful in diagnosis were demonstrated: 1. It is the technique that provides an axial view of the tissue. In addition, coronal scans of the jaw can also be obtained to give greater clarity; 2. A good display of the soft tissue is obtained, both the normal anatomy such as muscles, and pathologic lesions where extension into the adjacent tissues can be seen; 3. An assessment of tissue density is possible by determining the absorption values of the lesions. This indicates the possible make-up or contents of a structure or tumor as to whether it is predominantly fluid, cellular, or vascular; 4. A clearer picture is produced than with conventional radiographs, where there is often blurring because of superimposition of structures outside the plane of interest. Mackenzie et al.[19] reported limitations of CT, which were possibility of failure of coronal CT and streak artifacts on the scans by high density objects. Cohen et al.[20] reported that the soft tissue mass, destruction of cortical bone, and extension of tumor into adjacent structures of mandibular ameloblastoma were clearly visualized using CT. Abrahams and Oliverio[21] reported that dental CT could provide a better means of assessing odontogenic cysts than conventional techniques (orthopantomographic, intraoral, and mandibular films), which are of limited usefulness because of the curved configuration of the mandible. Kawai et al.[22] made a comparative evaluation of the conventional radiography, CT, magnetic resonance (MR) imaging of maxillary ameloblastoma, and reported that CT and MR imaging were superior to conventional radiography, that CT may be superior to MR imaging in the lesions bound by outlining bony tissues, but that MR imaging was the best way of imaging in the recurrent lesions, which might not always be outlined by bony tissues. Iko et al.[23] proposed that CT was the most sensitive imaging technique for detecting ameloblastomas, and Kurabayashi[24] emphasized that CT was useful in demonstrating the extent of maxillofacial mass lesions in children and for surgical treatment planning. So the many studies about the utility of CT in diagnosis and treatment planning of ameloblastoma and odontogenic keratocyst have been reported. But the difference of effectiveness by imaging modalities and observers in the differential diagnosis between ameloblastoma and odontogenic keratocyst does not appear to have been discussed sufficiently. We examined the diagnostic ability of each observers and groups by image modalities. Diagnostic ability is measured by the area under the ROC curve. The closer the curve follows the left-hand border and then the top border of the ROC space, the more accurate the test. The closer the curve comes to the 45-degree diagonal of the ROC space, the less accurate the test.[25] In this study, the ROC curve areas except for group 3 were the highest with interpretation using panoramic radiograph and CT, followed by interpretation using CT only, and was the lowest with interpretation using panoramic radiograph only. As a result, in differential diagnosis between ameloblastoma and odontogenic keratocyst the diagnostic ability of CT was superior to that of panoramic radiograph, and combination of panoramic radiograph and CT could increase the diagnostic ability more.

The overall difference was not found in diagnostic ability among groups in using panoramic radiograph only, but there was difference in diagnostic ability of group 1 and 2 vs 3 in using CT only, and combination panoramic radiograph and CT. The group 1 and 2 were composed of the experienced observers of CT, but group 3 was composed of the observers who had not experienced with interpretation of CT. Although the observers of group 3 had studied the characteristics of CT of ameloblastoma and odontogenic keratocyst by textbook before this study, most cases of this study were not shown the typical characteristics of them. In addition, they did not analyse them accurately even in some cases showing typical characteristics. We could analogize that the experience of radiologic diagnosis was an important factor for differential diagnosis between ameloblastoma and odontogenic keratocyst, and the result of this study corresponded to that of previous study, which the observers, having the experience of interpretation over 3 years could differentiate more accurately than those of below 3 years.[17]

Kappa is defined as the difference between observed and expected agreement expressed as a fraction of the maximum difference. The kappa value is 1 when agreement is perfect, but a kappa value of 0 indicates agreement is only due to chance, and negative values show worse than chance agreement. The following qualitative terms are used to interpret kappa statistics: poor, 0.00-0.20; fair, 0.21-0.40; moderate, 0.41-0.60; good, 0.61-0.80; and perfect, 0.81-1.00.[26] In this study the overall kappa values were fair-to-good intraobserver agreement within a group. The kappa values of group 1 and 2 were moderate-to-good intraobserver agreement, but those of group 3 were fair-to-moderate intraobserver agreement. The kappa values of using panoramic radiograph only and using CT only were fair-to-good intraobserver agreement, but those of using panoramic radiograph and CT were moderate-to-good intraobserver agreement. The overall kappa values were fair-to-good interobserver agreement. The kappa values between group 1 and 2 were moderate-to-good interobserver agreement, but the other kappa values were fair-to-moderate interobserver agreement. The kappa values of using panoramic radiograph only and using CT only were fair-to-moderate interobserver agreement, and those of using panoramic radiograph and CT were moderate-to-good interobserver agreement. As a general, when the observers who had experienced interpretation of CT over years diagnosed by using panoramic radiograph and CT simultaneously, it was a tendency to show higher intra- and interobserver agreement.

Conclusionally, when making a differential diagnosis between ameloblastoma and odontogenic keratocyst, combination of panoramic radiograph and CT increases the diagnostic ability and the intra- and interobserver agreement, especially in the experienced oral and maxillofacial radiologists.

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