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Abstract

The radiographical differentiation of adenomatoid odontogenic tumor (AOT) from dentigerous cysts, calcifying odontogenic cysts, calcifying epithelial odontogenic tumors, odontogenic keratocysts, and amelobastomas is sometimes difficult. We attempted to differentiate AOT from other lesions similar to AOT in radiographic findings using MRI. The MRI features of AOT in our 3 cases included homogeneous low SI in the cystic portion and homogeneous intermediate SI in the solid portion on T1WI, homogeneous high SI in the cystic portion and intermediate to slightly high SI in the solid portion on T2WI, and enhancement of only the solid portion on CE-T1WI although non of the sequences included SI of calcifications. The contrast index curves in the 3 cases of AOT showed a gradual increase to 300 s, which signified a benign tumor. These MRI features were characteristic features of AOT and might be a basis for differentiating AOT from the above possible lesions in radiographic examinations.

Keywords: AOT, odontogenic tumor, odontogenic cyst, MRI, DCE-MRI

1. Introduction

Adenomatoid odontogenic tumor (AOT) is a relatively rare benign tumor. The characteristics of the radiographic findings show a well-defined, unilocular radiolucency associated with numerous tiny calcifications and the crown and often part of the root of an unerupted tooth [1-5]. However, we have often experienced that the radiographic findings of AOT include no calcifications. Therefore, the radiographic findings of AOT frequently resemble other odontogenic lesions such as dentigerous cysts, calcifying odontogenic cysts (COC), calcifying epithelial odontogenic tumors (CEOT), odontogenic keratocysts, and ameloblastomas [1-3]. Philipsen et al. have reported that AOT might appear in three clinicotopographic variants: follicular, extrafollicular and peripheral, all of which have an identical histology [4]. The radiographic features of the follicular type, which is considered to be the predominant form of AOT, show a well-defined, unilocular radiolucency associated with the crown of an unerupted tooth, thus mimicking a dentigerous cyst. In fact, 77% of follicular-type AOTs are initially diagnosed as dentigerous cysts [3].

In the present study, we attempted to differentiate AOT from other lesions, in particular dentigerous cyst, using magnetic resonance imaging (MRI). We described here the features of MRI and dynamic contrast-enhanced MRI (DCE-MRI) of 3 cases of AOT compared with those of the lesions for which the radiographic findings are similar to AOT.

2. Materials and Methods

2.1 . MR sequence

The MR images were acquired using a 1.5-Tesla clinical MR unit (Siemens). Routine T1- and T2-weighted images were acquired with spin-echo and turbo spin-echo sequences with frequency-selective fat-suppression in the transverse and coronal planes, respectively. For DCE-MRI, 21 consecutive data sets were acquired over 315 sec (14 sec/1 scan) with three-dimensional fast imaging with steady-state precession (repetition time/echo time/flip angle=5/2/25 degrees, 16 slices in 48 mm of slub thickness, resulting in an effective slice thickness of 3 mm). Immediately, frequency-selective fat-suppressed T1-weighted images were acquired as contrast-enhanced T1-weighted images. Intravenous injection of Gd-DTPA (Magnevist; Nihon Schering, Osaka, Japan) was archived manually at a rate of approximately 2 ml / sec through a 21-gauge

butterfly needle inserted into a vein in the cubital fossa. The injection of a contrast medium started 6 sec before the initiation of a second scan of 21 DCE-MRI data sets. The DCE-MR images were acquired repeatedly at 600, 615, 900 and 915 sec after the start of the contrast injection.

2.2. Data analysis

A region of interest (ROI) was drawn to include the whole mass area selected from post-contrast images. Then, the mean signal intensity (SI) of the ROIs was measured on the monitor using the electric cursor. Contrast index (CI) versus time curves (CI-Curve) were drawn. CI was calculated using the formula: CI=(SIt-SI0)/SI0, where SIt is the mean signal intensity at the time t after the injection of contrast medium, and SI0 is the mean signal intensity before the injection of the contrast medium.

2.3. Materials

Case 1: 15-year-old female

Panoramic radiograph showed a unilocular radiolucency of 15 mm in diameter, including the crown of the right mandibular canine. The occlusal film did not show expansion and calcification. CT also showed findings similar to those of the panoramic and occlusal radiographs.

Case 2: 24-year-old male

Panoramic radiograph showed a unilocular radiolucency including the crown of the left mandibular canine extending from the left mandibular central incisor to the third molar. Occlusal film showed expansion to the buccal site. CT showed slight calcification inside of the crown of the canine.

Case 3: 28-year-old male

Occlusal film showed showed a unilocular radiolucency with a diameter of 40 mm including the crown of the left mandibular canine and numerous scattered calcifications.

It was difficult to diagnose these 3 cases as AOTs on the basis of these conventional radiographs. Therefore, we performed the MRI and DCE-MRI of 3 cases of AOT to obtain further information.

3. Results

3.1. MR imaging

Case 1

MRI showed low SI on T1WI, slightly high SI on T2WI (Figure 1a) and whole enhancement on CE-T1WI (Figure 1b). These MRI findings showed that the whole lesion included a solid portion but not a liquid portion, and therefore it was suspected to be a tumorous lesion but not a cystic lesion. This lesion was suspected to be AOT on the basis of MRI findings and was histopathologically proved to be AOT.

Case 2

MRI showed low SI on T1WI, high SI extending through the whole lesion corresponding to the cystic portion and high SI corresponding to the small solid portion on T2WI (Figure 2a), and enhancement only in the peripheral portion corresponding to the solid portion and no enhancement corresponding to the cystic portion on CE-T1WI (Figure 2b). In this case, fenestration of the lesion was performed, and histopathological examination of the portion corresponding to the substance on the basis of MRI findings was performed, and this case was proved to be AOT.

Case 3

MRI showed low SI on T1WI, high SI corresponding to the cystic portion of the central portion and intermediate to high SI corresponding to the solid portion of the peripheral portion on T2WI, and enhancement in the peripheral portion corresponding to the solid portion but no enhancement in the cystic portion on CE-T1WI [5]. This lesion was difficult to differentiate from COC even if CE-MRI was performed, and was proved to be AOT by histopathological examination.

3.2. MR features of AOT

Our 3 cases of AOT showed homogeneous low SI in the cystic portion and intermediate SI in the solid portion on T1WI, homogeneous high SI in the cystic portion and intermediate to slightly high SI in the solid portion on T2WI, and enhancement only of the solid portion on CE-T1WI.

3.3. DCE-MRI

The CI curve of one case of AOT showed a gradual increase to 900 s and those of two other cases showed gradual increases to 300 s and gradually decreased thereafter

to 900s (Figure 3).

Discussion

The radiographical differentiation of AOT from dentigerous cysts, COC, CEOT, odontogenic keratocysts, and amelobastoma is sometimes difficult. We attempted to use MRI to differentiate AOT from these lesions for which the radiographic findings are similar. We show the MR features of other possible lesions that display radiographic findings that are similar to AOT, according to literature and our own experience (Table 1).

In our 3 cases, case 1 was suspected to be a dentigerous cyst on the basis of conventional radiographs and CT, but was suspected to be AOT on the basis of MRI, and it proved to be AOT histopathologically. Case 2 was suspected to be COC on the basis of both radiographical and MRI findings, but was proved to be AOT histopathologically. Case 3 could not be distinguished from COC by means of an imaging diagnosis including MRI. Thus, we were found it difficult to distinguish AOT from COC even if CE-MRI was performed because we had not experienced the MRI features of COC.

The MRI features of AOT in our 3 cases showed homogeneous low SI in the cystic portion and homogeneous intermediate SI in the solid portion on T1WI, homogeneous high SI in the cystic portion and intermediate to slightly high SI in the solid portion on T2WI and enhancement of only the solid portion on CE-T1WI, although none of the sequences showed SI for calcifications. Ameloblastoma shows similar features to AOT on the cystic portion, but the heterogeneous SI on the solid portion differed from that of AOT [6]. Therefore, we may distinguish AOT from ameloblastoma by comparing their respective solid portions. However, it would be difficult to distinguish between these two types of lesions on the basis of MRI when the ameloblastoma was a unicystic lesion. CEOT consisted of a solid but cystic component and showed heterogeneous SI on all sequences [7 and 8]. Therefore, AOT could be distinguished from CEOT on the basis of its MRI features. Although the MRI features of COC resemble those of AOT, it shows a slightly high SI on T1WI, which differs from AOT, which shows low to intermediate SI [9]. The slightly high SI on T1WI has been reported to be due to the brownish appearance of the cystic liquid, which is related to the existence of minimal bleeding [9]. Furthermore, it has been reported that COC shows no enhancement because it has no solid nodule [9], while AOT has a relatively thick wall or a solid nodule. Thus, AOT could be distinguished from COC on the basis of MRI. Demtigerous cyst showed an SI on T1WI and T2WI that was similar to that of AOT, but showed rim enhancement on CE-T1WI because its cyst wall was thin compared with that of AOT [10]. Thus, AOT

could be distinguished from the dentigerous cyst by means of its thick enhancement compared with that of the dentigerous cyst. Odontogenic keratocyst, in addition to dentigerous cyst, showed heterogeneous SI on T1WI and rim enhancement on CE-T1WI because its cyst wall is also thin compared with that of AOT [10]. Therefore, AOT could be distinguished from odontogenic kerartocyst on the basis of MRI.

Moreover, we performed DCE-MRI reflecting their intratumor angiogenesis [11 and 12]. The CI curves of 3 cases of AOT showed a gradual increase to 300 s, which signified a benign tumor. In our experience, ameloblastoma shows a similar pattern to the CI curves of AOT, but dentigerous cyst tended to have a low peak at maximum CI. DCE-MRI might be useful as a means of determing whether a tumor is benign.

In the present paper, we attempted to use MRI to differentiate AOT from other lesions for which the radiographic findings are similar to those of AOT. The MRI features of AOT were characteristic, and in a radiographic examination involving MRI they can differentiate AOT from the other lesions discussed above.

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Figure legends

Figure 1

Case 1

MRI showed low SI on T1WI, slightly high SI on T2WI (a) and whole enhancement on CE-T1WI (b). These MRI findings showed that the whole lesion included a solid portion but not a liquid portion, and therefore it was suspected to be a tumorous lesion, but not a cystic lesion.

Figure 2

Case 2

MRI showed low SI on T1WI, high SI extending through the lesion corresponding to the cystic portion and high SI corresponding to the solid portion on T2WI (a), and enhancement only in the peripheral portion corresponding to the solid portion and no enhancement corresponding to the cystic portion on CE-T1WI (b). Thus, this lesion included relatively thick solid portion, and therefore it was suspected to be a tumorous lesion, but not a cystic lesion.

Figure 3

DCE-MRI

The CI curve of one case of AOT showed a gradual increase to 900 s and those of two other cases showed gradual increases to 300 s and gradually decreased thereafter to 900s, and therefore they showed that these three lesions were benign tumors.

Figure 1a

Figure 1b

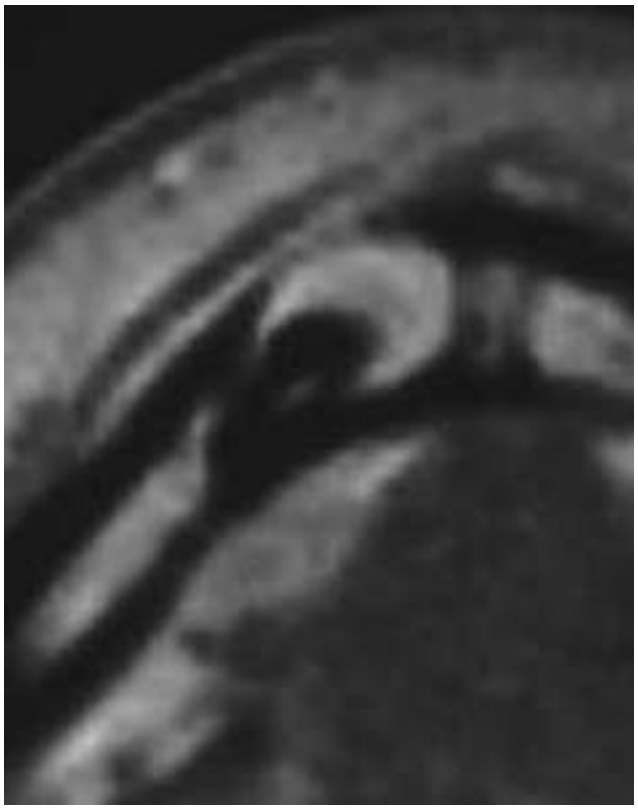

Figure 2a

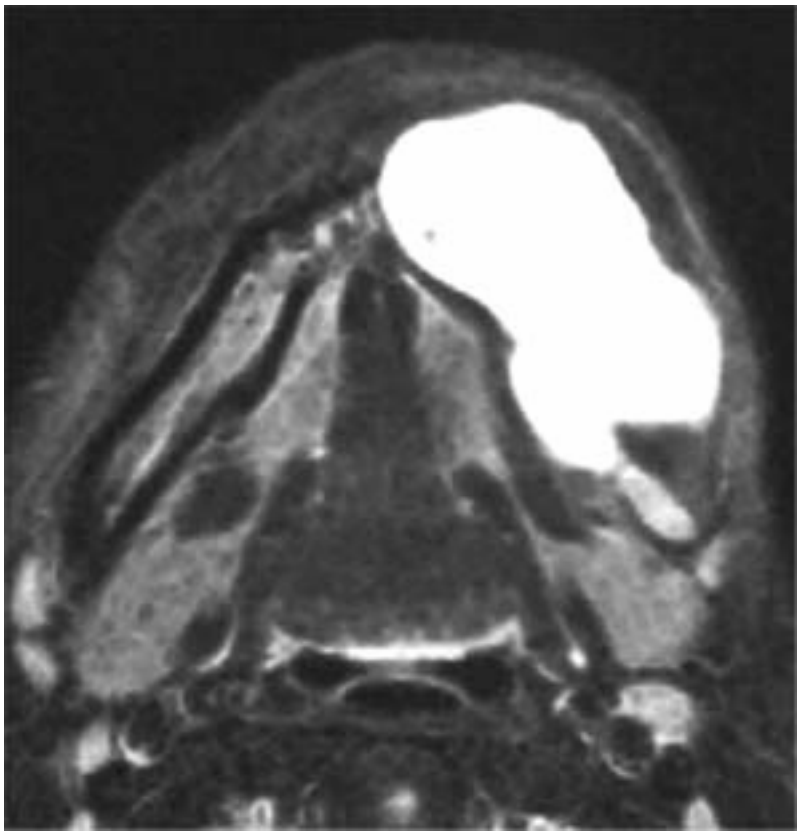

Figure 2b

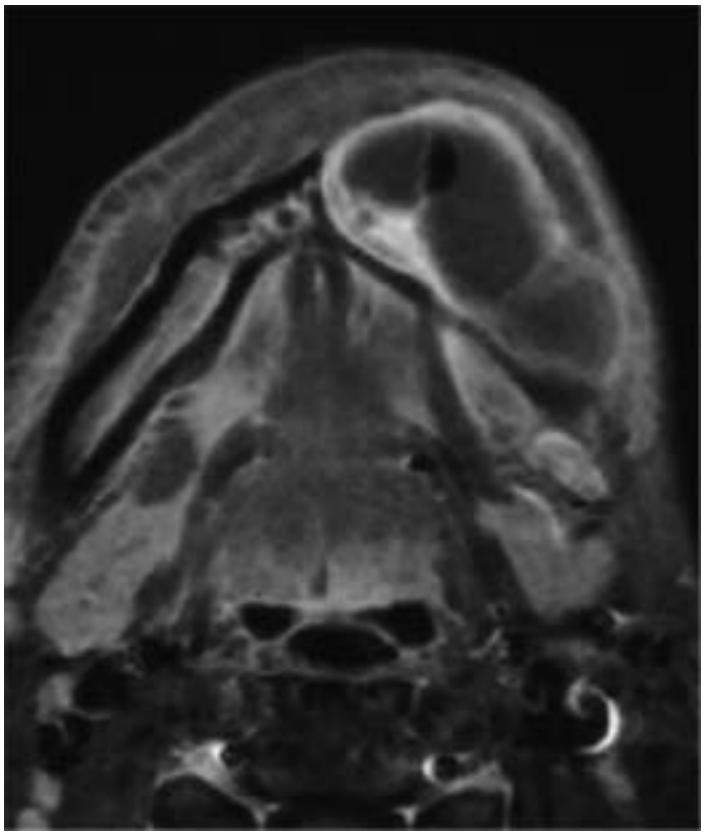

Figure 3

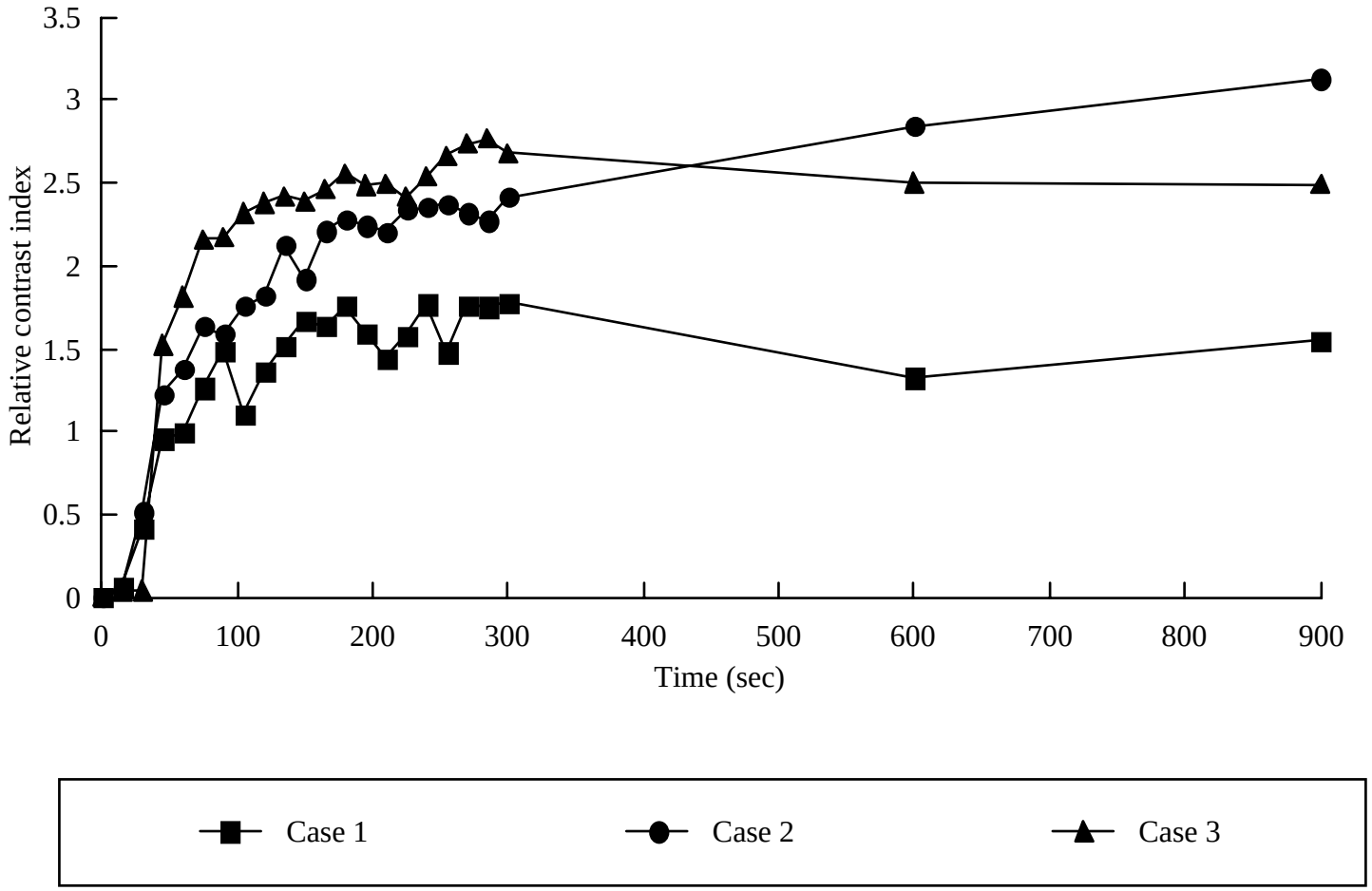
3.5
3
2.5
2
1.5
1
0.5
0
Relative contrast index
0
100
200
300
400
500
600
700
800
900
Time (sec)
Case 1
Case 2
Case 3

Table 1 MR features of possible lesions, which show the similar radiographic findigns to adenomatoid odontogenic tumor

	T1WI	T2WI	CE-T1WI
Adenomatoid odontogenic tumor			
Cystic portion	low to intermediate, homogeneous	high, homogeneous	no enhancement
Solid portion	low to intermediate, heterogeneos	high, homogeneou	enhancement, homogeneous
Ameloblastoma			
Cystic portion	low to intermediate, homogeneous	high, homogeneous	no enhancement
Solid portion	low to intermediate, heterogeneos	high, heterogeneous	enhancement, heterogeneous
Calcifying epithelial odontogenic tumor	low to intermediate, heterogeneos	intermediate to high, heterogeneous	enhancement, heterogeneous
Calcifying odontogenic cyst	slightly high, homogeneous	high, homogeneous	no enhancement
Dentigerous cyst	low to intermediate, homogeneous	high, homogeneous	rim enhancement
Odontogenic keratocyst	low to high, heterogeneos	high, homogeneous	rim enhancement