Magnetic resonance images of ameloblastoma

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ABSTRACT

Purpose : To classify and describe the characteristic features of MRI of some ameloblastoma variants.

Materials and Methods : The MR images, CT images, and panoramic radiographs in 5 cases were retrospectively examined as follows. First, the contents of ameloblastomas were devided into two portions of either solid or cystic components on the basis of MR signal intensities. The signal intensity within the solid or cystic portions was classified as homogeneous or heterogeneous. Next, the characteristic internal feature of the lesion on T1W1 or T2WI was described. The signal intensities were classified into low, intermediate, slightly high, high, and strong high signal intensity.

Results : Unicystic lesion showed homogeneous high signal intensity (SI) on T2W2 and the rim enhancement of the surrounding area including the mural nodule and the thick wall except the central portion on Gd-T1W1. Solid type revealed heterogeneous and high SI area with strong high SI area on T2W2. On Gd-T1W1, the area corresponding to the low signal spot on T1W1 and the strong high signal spot on T2W1 showed low SI. Hybrid type showed slightly enhanced capsular structures and low SI for the round bony septa and the areas connecting the mixed and cystic lesions on T2W1 and Gd-T1W1.

Conclusion : MRI could easily assess the relationship between the mixed and cystic findings in ameloblastoma. (***Korean J Oral Maxillofac Radiol 2005; 35 : 207-13***)

KEY WORDS : Ameloblastoma; Magnetic Resonance Imaging

Introduction

Ameloblastoma is a relatively common epithelial odontogenic neoplasm that frequently affects the molar and ramus regions of the mandible, accounting for about 10% of all odontogenic tumors.[1] Although no sex differences exist in the onset of this disease, people between the ages of 30 and 40 are most commonly affected.[2] Several histopathologic types of ameloblastoma are known: follicular, plexiform, acanthomatous, keratinizing, granular cell, basal cell, and clear cell types have all been reported.[3-6]

Multilocular cystic radiolucent lesions are typical radiographic findings associated with ameloblastoma. Park et al.[7] reported that in 56 cases, 21 cases (37.5%) were unicystic ameloblastoma, 35 cases (62.5%) were solid or multicystic ameloblastoma. Only 1 case (4.8%) of unicystic ameloblastoma and 4 cases (11.4%) of solid or multicystic ameloblastoma were occurred in maxilla, but the desmoplastic variant of ameloblastoma usually appears in the anterior and premolar regions as a mixed radiolucent and radiopaque lesion that sometimes resembles a benign fibro-osseous lesion.[8] The number of ameloblastoma variants in imaging can be expected to increase from this time onwards. Furthermore, in conventional radiography, differential diagnosis may include odontogenic keratocyst, odontogenic myxoma, dentigerous cyst, aneurysmal bone cyst and other lesions.[9]

Regarding the use of computed tomography (CT), the cystic component of ameloblastomas can be clearly demonstrated using this modality, providing important information for a differential diagnosis.[7,10]

Past studies[2,11-19] have suggested that magnetic resonance imaging (MRI) is useful for diagnosing ameloblastomas and that odontogenic keratocysts can be differentiated from ameloblastomas based on the findings of the wall, solid components, and fluid contents.[2,11,12] Unfortunately, in spite of several case reports of ameloblastoma variants, systemic assessment of MR images of ameloblastoma variants was rare. This study was attempted to classify and describe the characteristic features of MRI of some ameloblastoma variants for their

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diagnosis and the differential diagnosis from other lesions.

Materials and Methods

1. Materials

1) Case 1 : 40-year-old male

Panoramic radiograph showed a unilocular radiolucency of 50 mm in diameter, extending from the right mandibular 2nd molar with root resorption to the sigmoid notch. The lesion showed medial expansion toward the maxilla. CT showed an extensive unilocular and cystic radiolucency and expansion to the buccal side.

2) Case 2 : 16-year-old female

Panoramic radiograph showed an extensive multilocular radiolucency including the displaced the right mandibular 3rd molar and displacing the right 2nd molar downwardly, extending from the right mandibular 1st premolar to the middle of the ramus. CT showed an extensive unilocular radiolucency similar to dentigerous cyst.

3) Case 3 : 16-year-old male

Panoramic radiograph showed a multilocular radiolucency of a diameter of 30 mm having the downward expansion with thinning of mandibular cortex, the discontinuity of medial border, and expansion to the buccal side.

4) Case 4 : 27-year-old male

Panoramic radiograph showed a multilocular radiolucency of a diameter of 30 mm with the root resorption of the left mandibular 2nd molar and the downward expansion with thinning of mandibular cortex. CT showed an extensive unilocular radiolucency including numerous scattered calcifications, the discontinuity of medial border, and expansion to the buccal side.

5) Case 5 : 20-year-old male

Panoramic radiograph showed a round radiopacity in the left maxillary sinus, displacing the upper left 3rd molar. Axial computed tomogram with soft algorithm revealed a lesion showing isodensity to the muscles with internal round trabeculations in the left maxillary sinus.

2. MR sequence

The MR images were acquired using a 1.5-Tesla clinical MR unit (Siemens AG, Germany). 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. Immediately, T1-weighted images were acquired as contrast-enhanced T1-weighted images.

3. Image analysis

1) The CT images

Hounsfield units (HU) were calculated for the several regions of interest showing various radiopacities in the computed tomograms with soft algorithm that retrospectively examined in 3 cases and analyzed. The internal pattern of the lesion was examined respectively.

2) The MR images

The MR images in 5 cases were retrospectively examined as follows. First, the contents of ameloblastomas were devided into two portions of either solid or cystic components on the basis of MR signal intensities. The signal intensity within the solid or cystic portions was classified as homogeneous or heterogeneous. Next, the characteristic internal feature of the lesion on T1W1 or T2W1 was described. Regarding the signal intensity, a signal from the musculature was interpreted as intermediate on T1W1, and a signal from the cerebrospinal fluid as high on T2W1. The signal intensities were classified into low, intermediate, slightly high, high, and strong high signal intensity.

Results

1. Case 1

CT revealed 0 to 11 HU at the ROIs and no internal structure (Fig. 1A).

MRI showed a lesion of homogeneous low signal intensity on T1W1 and homogeneous extremely high signal intensity on T2W1. On Gd-T1W1, only the surrounding area including the mural nodule and the thick wall showed well enhancement in the lesion, while the area corresponding to the central portion showed no enhancement. The overall feature was unicystic and similar to dentigerous cyst on T1W1 and T2W1 (Fig. 1B).

2. Case 2

CT showed dentigerous cyst like lesion including the tooth without internal structure.

MRI showed a lesion of homogeneous and intermediate signal intensity on T1W1. T2W1 image showed heterogeneous and slightly high to high signal intensity. The overall feature was solid type on T2W1 (Fig. 2).

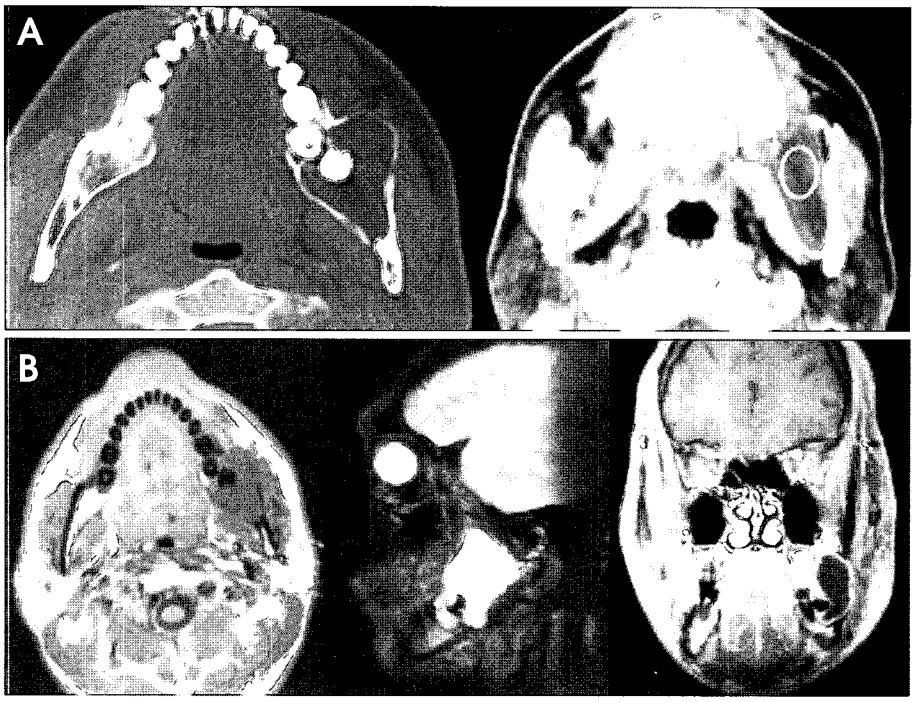

Fig. 1. A: CT revealed 11 HU at the ROI and no internal structure. B: MRI shows a lesion of homogeneous low signal intensity on T1W1 and homogeneous extremely high signal intensity on T2W1. On Gd-T1W1, only the surrounding area of the lesion including the mural nodule and the thick wall shows rim enhancement except the central portion.

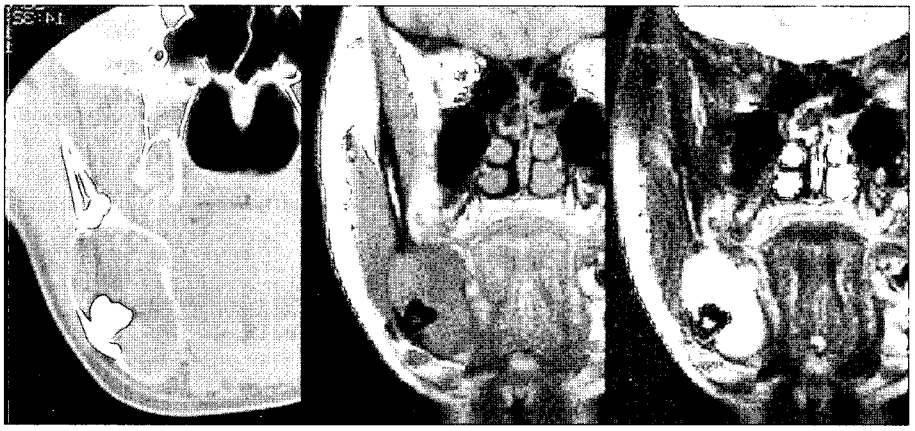

Fig. 2. CT shows dentigerous cyst like lesion. MRI shows a lesion of homogeneous and intermediate signal intensity on T1W1 and heterogeneous high signal intensities on T2W1.

3. Case 3

MRI showed heterogeneous and intermediate signal intensity with small spots of low signal intensity on T1W1. The solid portions of the ameloblastomas showed intermediate signal intensities on T1W1 and high signal intensities on T2W1, and the small cystic portions showed as small spots of homogeneous low signal intensities on T1W1 and homogeneous strong high signal intensities on T2W1, which were suspected to be water-like signal intensities. On Gd-T1W1, the areas corresponding to the low signal spots on T1W1 and the strong high signal spots on T2W1 showed low signal intensity. Overall feature of the tumor corresponded to solid type with small cystic areas (Fig. 3).

4. Case 4

CT showed 29-43 HU at various ROIs and some scattered calcifications in the lesion (Fig. 4A).

Axial T1-weighted MR image showed a well-defined focal mass of heterogeneous intermediate signal intensity with low signal areas at the left mandible. Axial T2-weighted MR image showed a well-defined focal mass of heterogeneous high signal intensity with an extremely high signal spots. On Gd-T1W1, the area corresponding to the low signal spot on T1W1 and the extremely high signal spot on T2W1 showed no enhancement and low signal intensity on Gd-T1W1. The lesion showed clear boundaries between the solid and cystic areas on T1W1, T2W1, and Gd-enhanced T1-weighted scans.

Fig. 3. MRI of lesion shows the area of intermediate signal intensities with the small spots of homogeneous low signal intensities on T1W1 and high signal intensities with homogeneous strong high signal intensities on T2W1. The areas corresponding to the strong high signal spots on T2W1 shows no enhancement and low signal intensities on Gd-T1W1.

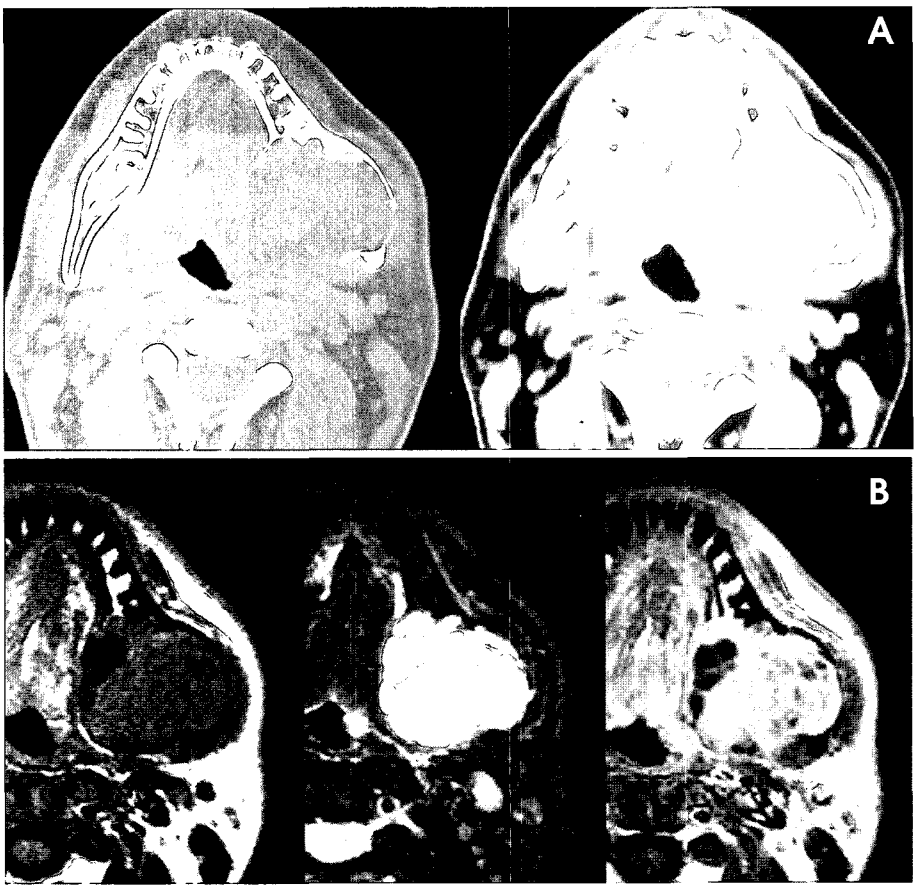

Fig. 4. A: CT shows some scattered calcifications in the lesion. B: Axial T2-weighted MR image shows a well-defined focal mass of heterogeneous high signal intensity with an extremely high signal spots. On Gd-T1W1, the area corresponding to the low signal spot on T1W1 and the extremely high signal spot on T2W1 shows no enhancement on Gd-T1W1.

Gross feature of the tumor showed a mixed type of desmoplastic and cystic areas (Fig. 4B).

5. Case 5

CT revealed a lesion in the left maxillary sinus, distribution of 22-43 HU and the internal round trabeculations in the lesion.

Axial T2 weighted MR image showed a lesion of heterogeneous high signal intensity with round and no signal intensity areas corresponding to the internal round trabeculations and the ossified areas on CT.

The lesion showed overall intermediate signal intensity on T1W1 and heterogeneous and high and strong high signal intensities on T2W1, implied that at the cystic posterior regions, the T2-weighted scan showed strong high-intensities signal which were suspected to be a water-like signal intensity. The Gd-enhanced T1-weighted scan showed slightly enhanced capsular structures and low signal intensity for the area

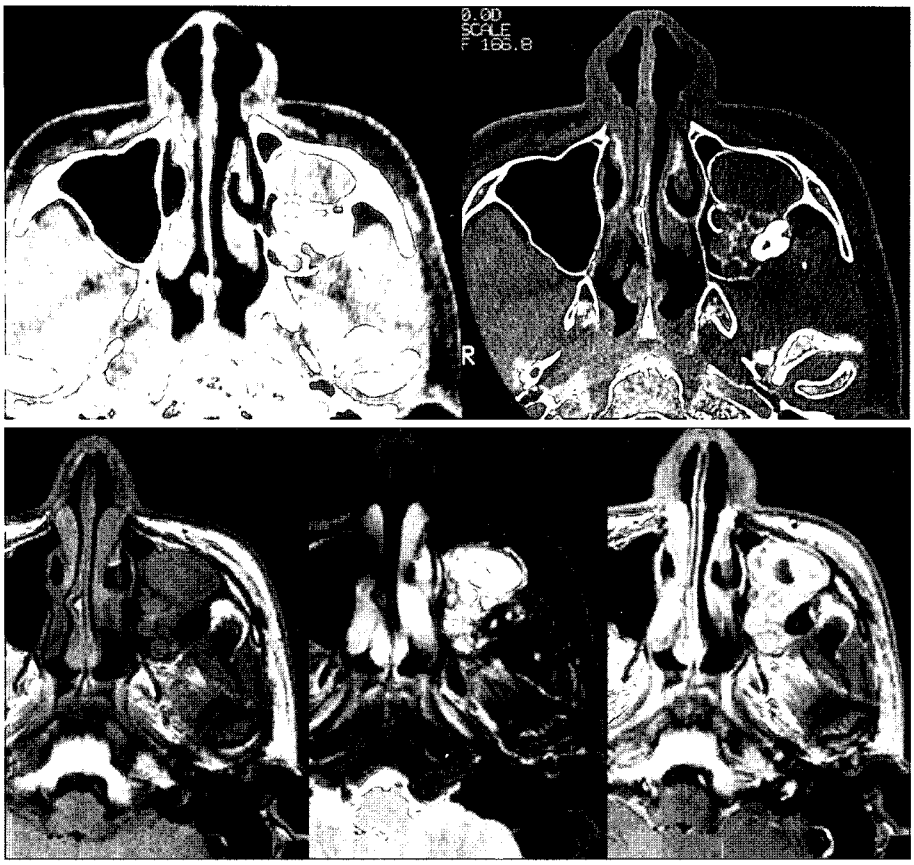

Fig. 5. CT reveals a lesion with the internal round trabeculations in the left maxillary sinus. Axial T2 weighted MRI shows a lesion of heterogeneous high signal intensity with round and no signal intensity areas corresponding to the internal round trabeculations and the ossified areas on CT. The enhanced T1-weighted scan shows slightly enhanced capsular structures.

connecting the mixed and cystic lesions. MRI showed a characteristic honey comb appearance of cystic/desmoplastic hybrid type (Fig. 5).

Discussion

In plain radiographs, Kim et al.[20] reported that 42 (59.2%) of the 71 cases were unilocular with a well-demarcated border, whereas 14 (19.7%) were multilocular in appearance. Many authors have ascribed to this lesion a mixed radiolucent and radiopaque appearance[17,21-23] that closely resembles the radiologic findings associated with desmoplastic ameloblastoma, sometimes with indistinct border.[23]

Park et al.[7] reported that Hounsfield units in the lesion were 24.9 ± 8.8 HU in unicystic ameloblastoma, 31.2 ± 11.5 HU in solid or multicystic ameloblastoma. There is no statistically significant difference ($p > 0.05$). They concluded that to measure the Hounsfield units in the lesion is helpful, but it is not a differential diagnostic point between unicystic ameloblastoma and solid or multicystic ameloblastoma. Odontogenic keratocysts were shown to have higher CT numbers than ameloblastomas.[24] Wakoh et al.[2] reported that CT values for 2 regions were approximately 150 Hounsfield units (HU) each, whereas one region exhibited a value of 20 HU, suggesting a cyst in a mixed radiolucent and radiopaque lesion. High Hounsfield unit was supposed to attributed to the area including the calcified mass.

In present study, case 2 was supposed to be a cystic ameloblastoma showing a value of 11 HU. Case 3 and 4 were supposed to be a mixed lesion ranging from a value of 43 suggesting soft tissue to a value of 20 suggesting a cyst.

The calculated Hounsfield unit from a lesion can be various according to the selection of slice level and ROI on the computed tomogram. CT showed well the internal bony structure of the lesion and the border. However the relationship between the mixed and cystic findings of ameloblastoma could not be easily assessed with CT.

Regarding the image findings of MRI, Minami et al. (1992)[12] have first described the features of ameloblastomas. Thompson and colleagues (1996)[16] reported that T1-weighted MRI confirmed isointensity to muscle, T2-weighted MRI confirmed hypointensity to muscle, and Gd-enhanced T1-weighted MRI demonstrated mild enhancement. Fukushima and colleagues (1997)[23] also performed MRI, but presented only T2-weighted images with heterogeneous signal intensity.

1. Unicystic ameloblastoma

In this study, unicystic lesion (case 1) showed homogeneous high signal intensity on T2W2 and the rim enhancement of the surrounding area including the mural nodule and the thick wall except the central portion on Gd-T1W1. Han et al.[14] reported an odontogenic cyst in the right maxilla. The wall of the cyst was seen as a thin, enhancing rim on the postcontrast T1-weighted MR image and as a slightly hypointense rim on the T2-weighted axial image. Dentigerous cyst have a predilection regarding signal intensity, showing homogeneous intermediate signal intensity on T1W1 and homogeneous high signal intensity on T2W1, which reflects with their water-like content.[26] Ameloblastoma can be therefore differentiated from dentigerous cyst, except for unicystic ameloblastoma. Occasionally an ameloblastoma may occur from the epithelial lining of a dentigerous cyst; this has been termed mural ameloblastoma.[25] Asaumi and his colleagues[19] reported also that MRI, especially Gd-enhanced T1W1, could easily detect the mural nodule and thick wall in 4 cases.

MR images of odontogenic keratocysts show various signal intensities, with a predilection for immediate-to-high signal intensity on T1W1 and heterogeneous low-to-high mixed signal intensity on T2W1.[15,26] It may therefore be difficult to differentiate ameloblastoma from odontogenic keratocyst on the basis of only signal intensities. By confirming the presense of the mural nodule and thick wall on MRI, especially on contrast-enhanced images, ameloblastoma could be differentiated from these odontogenic cysts.

2. Solid type and mixed type

MR features of ameloblastomas in the present study showed various signal intensities reflecting their polymorphic features. Solid type (case 2, 3) and mixed type (case 4) revealed a lesion of heterogeneous and low or intermediate signal intensity on T1W1 and heterogeneous and high signal intensity and partly strong high intensity on T2W2. On Gd-T1W1, the area corresponding to the low signal spot on T1W1 and the extremely high signal spot on T2W1 showed no enhancement and low signal intensity on Gd-T1W1. Characteristically, solid and mixed types showed clear boundaries between the solid and cystic areas without rim enhancement on T1W1, T2W1, and Gd-T1W1.

3. Cystic/desmoplastic hybrid type

In 1984, Eversole and colleagues[27] introduced 3 desmoplastic ameloblastomas as examples of a new type of ameloblastoma displaying a unique histopathologic pattern that was once classified as a variant of follicular ameloblastoma. Nonetheless, few studies have reported the radiographic features of desmoplastic ameloblastoma. Minami et al.[12] have described the features of ameloblastomas in 11 cases as mixed solid and cystic patterns with irregular thick walls, with low signal on T1W1 and high signal on T2W1, and strong contrast enhancement in 7 of the 11 cases. Thompson and colleagues (1996)[16] reported simply Gd-enhanced T1-weighted MRI demonstrated mild enhancement of desmoplastic ameloblastoma. Wakoh et al. (2002)[2] also reported follicular/desmoplastic hybrid ameloblastoma and mentioned as follows; the mixed and cystic lesions were not separate lesions. Gd-enhanced T1-weighted MRI revealed a moderate signal intensity for the area connecting the mixed and cystic lesions.

However, in this study, hybrid type (case 5) showed slightly enhanced capsular structures and low signal intensity for the round bony septa and the areas connecting the mixed and cystic lesions on T2W1 and Gd-T1W1. Gd enhanced MR image showed enhanced border with center areas not enhanced in the cystic lesion. Most ameloblastomas have multiple cystic portions of various sizes that show a water-like signal intensity on T1W1 and T2W1, and no enhancement on Gd-T1W1.

MRI supply therefore significant findings associated with desmoplastic ameloblastoma, particularly given the fact that MRI with Gd-enhanced T1-weighted scan proved to be the most useful modality for confirming the diagnosis.

MR images of odontogenic myxoma show intermediate signal intensity on T1W1, homogeneous high signal intensity on T2W1, and the peripheral area of the lesion shows enhancement with the appearance of rim enhancement on Gd-T1W1.[28] We have observed that in ameloblastomas, the cystic portion showed no intensity, but the tumor substance intermediate intensity, while in odontogenic myxoma, the central portion shows high signal intensity, which appears to be a cyst-like area, as well as the peripheral portion, which is strongly enhanced on Gd-enhanced MRI.[28]

Particularly, in this study, axial T2W1 and Gd-T1W1 image of cystic/desmoplastic hybrid type of ameloblastoma showed a lesion of heterogeneous high signal intensity with round and no signal intensity areas corresponding to the internal round trabeculations and the ossified areas on CT. Thus, MR images provide useful additional information to help clinicians differentiate between odontogenic myxomas and ameloblastomas.

In conclusion, MRI could easily assess the relationship between the mixed and cystic findings in ameloblastoma.

MRI revealed unicystic, solid type, mixed type of desmoplastic and small cystic areas, and cystic/desmoplastic hybrid type of ameloblastoma on T2W1 and Gd-T1W1.

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