Luminal, Intramural Unicystic Ameloblastoma with Marked Fluid-Fluid Level: Validity of CT and MRI Findings

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Received 30 November, 2018/Accepted for publication 2 April, 2019
Published Online in J-STAGE 20 February, 2020

Abstract

We report herein a case of a luminal and intramural unicystic ameloblastoma (UA) with a marked fluid-fluid level. The validity of imaging findings in diagnosing UA in the present case is discussed in reference to the literature. The patient was a 50-year-old woman who presented with swelling of the gingiva in the region of the left mandibular third molar and numbness in the lower lip. Computed tomography (CT) and magnetic resonance imaging (MRI) revealed a large mass lesion with a unilocular appearance and a biphasic aspect, suggesting liquid content. Contrast-enhanced MRI (CE-MRI) and dynamic contrast-enhanced MRI (DCE-MRI) demonstrated that the biphasic aspect indicated a fluid-fluid level with no blood pooling/flow; it also revealed a thick rim-enhanced margin with mural protrusion. Postoperatively, the lesion was histopathologically diagnosed as a luminal and intramural UA. In conclusion, extensive imaging including both standard CT and MRI together with CE-MRI and DCE-MRI allowed mural protrusions or nodules on a thick cystic wall and liquid content to be correctly identified. This suggests that such imaging can play an important role in diagnosing a UA, even though the results were at first misleading due to the marked fluid-fluid level.

Key words: Unicystic ameloblastoma — CT — MRI — Fluid-fluid level — Time-intensity curve
**Introduction**

Ameloblastoma is an epithelial odontogenic neoplasm frequently arising in the maxillo-mandibular region. A relatively common type of tumor, it accounts for approximately 28% of all odontogenic tumors in Japanese research\(^2\) and represents the second most common type of odontogenic tumor after what was previously termed keratocystic odontogenic tumor\(^2,9\). In a previous histopathologic classification published by the World Health Organization (WHO) in 2005, ameloblastoma was divided into 4 types: solid/multicystic; extraosseous/peripheral; desmoplastic; and unicystic\(^1\). In a later classification (2017), however, the WHO reclassified unicystic ameloblastoma (UA) as a benign epithelial odontogenic tumor separate from these other types, and also from metastasizing ameloblastoma and squamous odontogenic tumor, too\(^3\).

Radiographically, UAs are commonly unilocular, radiolucent, and show internal uniformity on plain films. On computed tomography (CT) and magnetic resonance imaging (MRI), also, most UAs show a homogeneous internal density and signal intensity, with well-defined margins. Such findings can mislead imaging specialists attempting to differentiate this type of lesion from other types of cystic lesion such as dentigerous cyst (DC) and orthokeratinized odontogenic cyst (OKOC)/odontogenic keratocyst (OKC). Computed tomography is effective, however, in the quantitative estimation of the internal properties of lesions, and can thus be helpful in diagnosing UA\(^4\). Magnetic resonance imaging has further potential to demonstrate the internal structure of a unilocular ameloblastoma due to the imaging characteristics of superior soft-tissue contrast and multiplanar facilities\(^5,12,13\).

In particular, the utility of contrast-enhanced MRI (CE-MRI) and dynamic contrast-enhanced MRI (DCE-MRI) has been reported in distinguishing various types of unilocular lesion of the jaw, such as DC, OKOC/OKC, UA, simple bone cyst and aneurysmal bone cyst (ABC)\(^5,13,14,32\).

The number of histologically differentiated types of UA is likely to increase, and each will have its own imaging characteristics. Herein, we report a case of a luminal and intramural UA which displayed a marked fluid-fluid level. The validity of CT and MRI in identifying UA is discussed based on a review of the literature.

**Case Report**

The patient was a 50-year-old woman who presented at our hospital with swelling of the gingiva around the left mandibular third molar and numbness in the lower lip. She had been aware of the swelling in the region of the left mandibular third molar for approximately one month. Her family dentist had prescribed antibiotics, which she had taken for approximately one month. She was then referred to our hospital because the swelling continued to gradually increase in size. Past and family medical histories were unremarkable. Initial examination revealed no notable findings outside the oral cavity. Within the oral cavity, a bone-like, hard, painless, fluctuant mass, and bone parchment were observed in the gingiva in the region of an unerupted third molar. Bony expansion of the left mandible was observed toward the ramus from the third molar region. This region was covered by healthy mucous membrane and demonstrated a clear boundary. Neither percussion pain nor mobility was observed in the adjacent left second molar. Slight sensory paralysis was also detected.

As clinical findings suggested a benign tumorous lesion, various types of diagnostic imaging were performed. Initial panoramic radiography revealed a unilocular, radiolucent lesion with a well-defined margin extending from the left third molar region to the ramus in the mandible. No resorption of the second molar root was revealed, and the third molar was completely impacted on the mesial side of the lesion (Fig. 1). The mandibular canal was slightly displaced by the lesion inferiorly along the margin. A week after the ini-
tial examination, CT and MRI were performed the same day in accordance with an imaging request from the Department of Oral Surgery. The CT-soft tissue algorithm revealed a mass lesion which was less dense than muscle. It was large and unilocular in appearance, with well-defined margins and a marked biphasic aspect, suggesting liquid content. A CT-bone tissue algorithm revealed thinned, slightly swollen cortical bone around impacted tooth on the mesial side of the lesion (Fig. 2a). The results of MRI also revealed a marked biphasic aspect of the lesion on T1-weighted images (T1WI), T2-weighted images (T2WI) and fat-suppressed T2-weighted images (FS-T2WI) (Fig. 2b). A cystic mass mainly composed of liquid content was suspected based on these findings, with candidates including DC, OKOC/OKC, and UA. An ABC could not be ruled out either due to the marked biphasic aspect of the lesion. Contrast-enhanced MRI was therefore scheduled for 3 weeks later to aid in the differential diagnosis. When the patient visited our hospital again, however, the swelling had further progressed in the bucco-lingual direction. This new finding together with the previously noted biphasic aspect of the lesion led us to carefully consider the possibility of a bone-related lesion with blood pooling or flow. Consequently, it was decided to perform DCE-MRI in conjunction with ordinary MRI prior to CE-MRI to obtain more detailed information regarding the margins and inner parts of the lesion, focusing on the site of expansion. The results of DCE-MRI and CE-MRI showed homogeneously low signal intensity without contrast enhancement, while the margins were clearly defined with thick rim enhancement (Fig. 3).

An incisional biopsy later revealed a UA. The cystic cavity was lined with ameloblastomatous epithelium, with infiltration of the cyst wall, mainly in a follicular pattern, but with some other areas showing a plexiform pattern. The histological type was compatible with luminal and intramural (Fig. 4).

Surgical excision was scheduled taking an extraoral approach, to be followed by intraoral surgery. First, skin incisions were performed, taking mastoid protrusions as the upper limits. After exposing the facial anterio-venous system and submandibular gland, the facial vein was ligated and amputated. The submandibular gland was exfoliated from the surrounding tissue, leaving the inferior border of the mandible clearly visible. An incision was then made, extending from the anterior margin of the mandibular ramus to the molar teeth along the external oblique ridge. The tumor, which originated in the mandibular inferior margin, was enucleated with extraction of the unerupted tooth taking an intraoral approach. The cortical bone at the mandibular inferior margin was preserved. After enucleation, mandibular reconstruction and reinforcement was achieved using a titanium plate only, with no bone grafting.

The postoperative course has been favorable, and no marked changes have been observed during 18 months of follow-up panoramic radiography at 6-month intervals (Fig. 5).

**Discussion**

Ameloblastoma has received considerable attention due to its frequency, clinical subtypes, and high tendency to infiltrate and recur\(^9\). Under the current histopathologic classification, intraosseous ameloblastoma can be of 2 types: 1) solid/conventional/mul-
Fig. 2  Initial CT (a) and MR images (b)
CT-soft tissue algorithm demonstrated large mass lesion with lower density than muscle; it was unilocular in appearance and had well-defined boundaries and biphasic aspect, suggesting fluid content (white arrow). MRI also displayed biphasic aspect. On T1WI, ventral side showed higher signal intensity than dorsal side. On FS-T2WI and T2WI, signal intensity inside lesion was clearly elevated, with brighter signal intensity on ventral side in same manner.

Fig. 3  T1WI, FS-T2WI, and CE-MRI, DCE-MRI at 1 month after initial examination
Note expansion in buccolingual direction compared to on initial CT and MRI, with biphasic aspect evident on T1WI and FS-T2WI (white arrow).
ticystic; or 2) unicystic. Unicystic ameloblastoma accounts for 5–22% of all ameloblastomas, and is most often seen in young patients, with 50% of such tumors diagnosed during the second decade of life. The mean age for UA is lower than that for solid/multicystic-type ameloblastoma\(^1\),\(^2\), a finding which is in contrast with the age of the patient reported here.

The term UA was first proposed by Robinson and Martinez in 1977\(^2\). This entity represents a distinctive type based on the histopathologic features of the mural epithelium, which are described as follows: 1) luminal, with ameloblastic epithelium limited to the cyst wall; 2) mural, with tumor growth invading the fibrous wall of the cyst; 3) intramural, as downgrowth without invasion of the ameloblastic epithelium into the connective tissue portion of the cyst wall; or 4) intraluminal, with protrusion into the cyst cavity. Ackermann et al.\(^1\), on the other hand, classified UA into 3 histological types: 1) luminal; 2) intraluminal/plexiform; or 3) mural. Another subgroup modification of UA was proposed by Philipsen and Reichart\(^3\), which was as follows: 1) luminal; 2) luminal and intraluminal; 3) luminal, intraluminal, and intramural; or 4) luminal and intramural. Even though it constitutes a benign tumor, a preoperative diagnosis of UA is very important, as Subgroups 3 and 4 according to the Philipsen and Reichart

Fig. 4  Histological findings from HE staining
a) Low-magnification microscopic finding revealed lining of ameloblastomatous epithelium.
b) Middle-magnification microscopic finding showed downgrowth of ameloblastomatous epithelium into connective tissue portion of cyst wall (arrow).

Fig. 5  Panoramic radiographs in postoperative course
a) Immediately postoperatively, b) 18 months postoperatively
No recurrence observed at 18 months later.
system of classification, are thought to be associated with a high risk of recurrence, and therefore require more aggressive surgical procedures.

From a radiological viewpoint, the macroscopic configuration of a UA is also usually “unicystic”; that is to say, ameloblasts stimulate infiltrative growth within the cystic wall of a large cyst. Radiographically, ameloblastomas show considerable variation on plain films, and are commonly classified as uni- or multilocular radioluencies with well-defined margins, except for desmoplastic ameloblastoma, which has mixed radiolucent/radiopaque areas and ill-defined margins, similar to the situation seen with fibro-osseous lesions. Unicystic ameloblastomas are usually unilocular, although rare cases show the characteristic soap bubble appearance of a multilocular lesion.

Furthermore, there can be varying degrees of bony expansion with a UA, and they sometimes have the so-called scalloped appearance. They are often associated with an unerupted tooth, particularly the mandibular third molar (up to 80% of cases occur in conjunction with an unerupted tooth). Consequently, radiologically, UAs need to be differentiated from DC and OKOC/OKC, other types of benign odontogenic lesion.

In the present case, panoramic radiographs revealed unilocular and radiolucent findings with internal uniformity in the mandibular body and ramus, with attenuation and bone loss superiorly. An unerupted mandibular third molar was also identified along the mesial portion of this lesion. These findings were compatible with the conventional radiographic characteristics of UA. The CT-bone tissue algorithm revealed marked bony expansion and perforation with thin cortical bone, and an impacted tooth, which are also general characteristics of ameloblastoma. Commonly, a UA shows homogeneous intermediate (low to slightly high) signal intensity on T1WI and homogeneous, very bright signal intensity on T2WI, as do odontogenic cysts.

However, the inner part of the present lesion showed a marked biphasic aspect on both CT and MRI. This imaging finding prioritized differentiation from a bone-related lesion, such as an ABC, before DC or OKOC/OKC, due to the risk of heavy bleeding during surgical treatment with bone-type lesions. An ABC commonly displays multiple fluid-fluid levels due to vascular spaces separated by stroma lacking endothelial lining. This is in contrast to the present case. They are also characterized by an expansile, ballooning appearance, with a thin outline of reactive bone, as in the present case, which gives them an appearance which ranges from unicystic/moth-eaten to extensive multilocular.

On the other hand, the first thing to be taken into consideration in determining whether a mass constitutes a UA is to ascertain whether the cystic component with a thick cystic wall forms the main body of the lesion. In the present case, the inner part of the lesion showed no enhancement other than thick rim enhancement of the cystic wall on CE-MRI and DCE-MRI (Fig. 6b). No change in enhancement over the time-course was also seen in regions of interest on biphasic regions on DCE-MRI (① and ② in Fig. 6c). These findings demonstrated that both regions comprised different liquid content, and that there was no blood pooling or flow. Consequently, an ABC was ruled out. Rather, they suggested a cyst-like lesion with cystic epithelium, such as a DC, OKOC/OKC, or UA. A UA generally shows thicker rim enhancement than an odontogenic cyst, such as an OKOC/OKC, and this is an important point in differentiating a UA from an OKOC/OKC.

Furthermore, in contrast to with an ameloblastoma, an OKOC/OKC tends to grow along the longitudinal axis of the mandible, and there is no root resorption. Taking these factors into account further reduced the possibility of OKOC/OKC as a morphological diagnosis.

Based on these histopathological differences in the definitions of various tumors and cysts, the differences between a UA and other true cysts, such as a DC, should also be reflected in imaging findings. In 2005, Asaumi et al. investigated whether MRI reflected the histopathological findings of ameloblastoma. They concluded that image extraction of
solid and cystic components using MRI can lead to differentiation of so-called cystic ameloblastomas other than UA from DC. They also noted that CE-MRI and DCE-MRI may contribute to differentiating ameloblastomas (including UA) from other cystic lesions, due to easy detection of mural nodules with gradually increasing contrast enhancement and a contrast-enhanced thick wall of the lesion. In 2011, Hisatomi et al. also mentioned the usefulness of DCE-MRI and CE-MRI in diagnosing UA. Their study demonstrated that a contrast-enhanced mural nodule of UA on CE-MRI appeared to protrude into the cyst cavity, and gradually increasing contrast enhancement on it was seen over the time-intensity course on DCE-MRI, reflecting intraluminal UA. Their proposal was very consis-

Fig. 6 Verification of imaging findings on initial CT, MRI and CE-MRI, DCE-MRI
a) Initial CT and MRI: Regions (1), (2) and (3) showed attenuation values of approximately 10–30 HU, 20–40 HU, and 60–70 HU, respectively (black arrow). Note presence of solid-like component in mesio-lingual and mesio-buccal region (white arrow).

b) CE-MRI and DCE-MRI: Note presence of contrast-enhanced mural protrusion outside cavity along rim-enhanced thick wall in mesio-lingual and mesio-buccal regions (white arrow).

c) Time-intensity courses on DCE-MRI: Time-intensity courses in mesio-lingual (③) and mesio-buccal regions (④) showed gradual increment in signal intensity, while those in inner part with biphasic aspect (①, ②) in Fig. 3 showed no change.
tent with the histopathological definition of intraluminal UA. In 2015, Apajalahti et al. also investigated whether CT and MRI features reflected the histopathologic patterns of different types of ameloblastoma, and stated that CE-CT provided a clue to UA with a unilocular appearance and a tiny, contrast-enhanced solid component (mural nodule). In the present case, all the imaging findings were retrospectively confirmed. A mural protrusion was also later found in the mesio-lingual and mesio-buccal regions on DCE-MRI and CE-MRI (Fig. 6b). A solid-like component was also observed in the mesio-lingual region on initial CT and MRI, and in the mesio-buccal region on MRI (Fig. 6a). This was consistent with the gradually increasing contrast-enhanced regions on DCE-MRI (3, 4 in Fig. 6c). Furthermore, both the contrast-enhanced regions were seen to migrate along the rim-enhanced thick cystic wall and protrude outside the cyst cavity on DCE-MRI (Fig. 6b).

Considering the histopathological definition of UA, these findings may reflect mural variants, representing a histopathologic type other than intraluminal UA.

In conclusion, we encountered a case of a luminal and intramural UA with a marked fluid-fluid level. Extensive imaging comprising CT, MRI, CE-MRI, and DCE-MRI, permitted mural protrusions or nodules along the thick cystic wall and liquid content to be accurately identified. Based on these results, we believe that such imaging can play an important role in diagnosing a UA, even though the results were at first misleading due to the marked fluid-fluid level involved.

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