The use of high resolution magnetic resonance on 3.0-T system in solid/multicystic ameloblastoma surgical planning

Case report

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OBJECTIVES: The solid/multicystic ameloblastoma is a slowly growing, locally invasive epithelial odontogenic tumour. In 80% of cases this lesion occurs in the mandible, mainly in the posterior region, and it is characterized by the involvement of the inferior alveolar nerve. A panoramic radiograph of a 43-year-old man with chronic deep pain in the posterior area of the mandible showed a multilocular radiolucent lesion with scalloped borders in the left mandibular ramus. After the execution of a computed tomography of the jaws, to accurately determine the limits of the lesion and the relationship with the the inferior alveolar nerve, the magnetic resonance imaging was used.

METHODS: The spatial relationship between the lesion and the inferior alveolar nerve was defined comparing different imaging methods: panoramic radiography, computed tomography and magnetic resonance imaging. T1-weighted fast spoiled gradient-recalled echo, T1-weighted fast imaging employing steady-state acquisition, T2-weighted interactive decomposition of water and fat with echo asymmetry least-squares estimation and Diffusion weighted imaging acquisition sequences were used on a 3.0 T unit.

RESULTS: Regarding the inferior alveolar nerve course and its spatial relationship with the mandibular lesion, magnetic resonance imaging provided more detailed spatial and structural information than other imaging methods.

CONCLUSION: The described acquisition sequences allowed us to highlight the diagnostic efficacy of the magnetic resonance in the morpho-structural characterization of a maxillofacial lesion and showed the importance of this imaging method as an additional technique to the computerized tomography in the maxillofacial surgical planning, resulting in a risk reduction of the inferior alveolar nerve surgical injury.

KEY WORDS: Ameloblastoma, Mandibular Nerve, Magnetic Resonance Imaging, Tomography X-Ray Computed.

Introduction

The solid/multicystic ameloblastoma is the second most common odontogenic tumour; it is mostly diagnosed between 30 and 60 years of age, rarely below the age of 20 years. This tumour is characterized by a low speed expansion and it is frequently associated to a local invasion of the contiguous epithelial areas[1]. The pre-operative evaluation in oral maxillofacial surgery is currently performed by several imaging methods. One of the principal difficulties in the surgical planning is to define the anatomic relation among the lesion and peripheral nerves. The evaluation of the spatial relationship between the inferior alveolar nerve (IAN) course and a mandibular lesion is important to avoid injuries of this anatomic structure[2-13].
Both panoramic radiography (OPT) and computerized tomography (CT) can be used to detect the bone structures. However, the efficacy of these imaging methods in the IAN course detection is lower than magnetic resonance imaging (MRI). In fact, while CT and OPT can clearly depict the bone structure of the mandibular canal, MRI allows a significant appreciation of its contents 14-17. In the present case report, the use of the MRI was used to evaluate the limits and structural characterization of a severe case of solid/multicystic ameloblastoma and to determine the relationship with the inferior alveolar nerve 18. Moreover, a comparative analysis among OPT, CT and MRI approaches was performed.

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A 48-year-old man with deep pain on the left side of the mandible that began two months before. The clinical examination did not show oral inflammation of the mucosa, nor bone-like swelling in the corresponding area of the mandible; the only clinical feature observed was a suppurating fluid leakage from the gingival margin of the second molar, determining foetor ex-ore.

OPT revealed a multiple-locus radiolucency presenting scalloped and well defined margins, interesting the whole left mandibular ramus. The lesion determined the resorption of the anterior margin of the mandible (Fig. 1). CT showed a lesion with a characteristic “soap bubble” shape (41 mm x 14 mm) (Fig. 2: a-c). Axial CT imaging highlighted a wide lesion from the upper part of the mandibular ramus (under the mandibular notch) to the alveolar bone distally to the second mandibular molar; no basal bone involvement was detected (Fig. 2a). Sagittal CT imaging revealed involvement of the anterior margin of the ramus; the mandibular angle was not interested (Fig. 2b). Moreover, the lesion induced the resorption of the mandibular canal roof (Fig. 2b). Coronal CT imaging showed erosion of both medial and lateral cortical bone of the left mandibular ramus (Fig. 2c).

MRI was performed on a 3.0-T system (Discovery MR750, GE Healthcare, Milwaukee-WIS, USA). Unenhanced T1-weighted (Figs 2: d-f) and T2-weighted sequences were initially acquired with and without fat suppression; this allowed to detect the morphologic features of the lesion and its anatomic relation with the IAN. Contrast-enhanced MRI (CE-MRI) with gadoteric acid (DOTAREM, 12 ml) was performed to evaluate possible soft tissue invasion and to investigate the benign nature of the lesion.

Since extensive resections provide discomfort (i.e. masticatory dysfunction, facial deformity or abnormal mandibular movements) and seriously compromise the patient’s quality of life, according to the current trend of the scientific community a less invasive surgery treatment was initially performed 2. A conservative approach and evaluation of clinical results was used.

The lesion was treated conservatively with cystectomy and curettage of peripheral bone.

The surgery was performed under general anesthesia. The surgical incision allowed to expose the whole left mandibular ramus. Medial and lateral soft tissues were elevated and immobilized using a suture. The point of communication of the lesion with the oral cavity has been used as a starting point to broaden the access to the bone lesion. The size of bone access were extended to the 2/3 of the lesion to allow its entire excision. The lesion was detached from the bone structures using a periosteals upholstered with gauze in order to limit the risk of tearing the neoformation. After detaching the 2/3 of neoplasia, the remnant 1/3 was excised using a tissue forcep. The pulling action of tissue forcep was added to the action of detachment of the periostal. The mass was excised completely and entirely and this was very important to reduce the risk of recurrence. The revision of the residual cavity was performed and the inferior alveolar nerve was preserved. Since the cavity had containment capacity it was not necessary to perform any kind of restorative treatment. The surgery was completed with suture.

The integrity of the inferior alveolar nerve was preserved, and there were no post-operative neurological disorders.

The X-ray follow-up at 12 months showed signs of healing with re-mineralization of the residual bone cavity. Histological findings showed a tumour mass characterized by follicular growth pattern with fibrous stroma; isolated ghost cells and infiltrating inflammatory cells were found; the follicular nests were composed by palisaded columnar cells surrounding arranged stellate reticulum-like cells. Plexiform pattern was detected exclusively in isolated regions of the tumor mass.

The lesion was finally diagnosed as solid/multicystic type ameloblastoma composed by dominant follicular growth pattern, according to the 2005 WHO Histological classification of odontogenic tumours.

Fig. 1: Panoramic radiography (OPT) of a multilocular radiolucent lesion that involves the left mandibular ramus. The white arrows highlight the posterior margins of the lesion.

Discussion

Since CT imaging can provide precise information about the bone resorption, in case of mandibular lesions this imaging technique is currently used in oral and maxillofacial surgery to perform a detailed evaluation of the bone structures.

However, in previous studies CT imaging has often provided unclear depiction of the mandibular canal contents and low definition of thin peripheral nerves, particularly for the incisal nerve, one of the terminal branches of the IAN. In contrast, the present MRI protocol provided high resolution images of these anatomic structures and together with the CT imaging was decisive for the surgical planning and for the risk reduction of IAN damage. Since the maxillofacial area is composed by a high percentage of fat and fluid, the study of this region could not be performed by means of routine conventional techniques of MRI. Consequently, our protocol was carried out using the following sequences:

1) T2-weighted axial images acquired with a fast spin echo interactive decomposition of water and fat with echo asymmetry and leastsquares estimation (FSE IDEAL). Water A) and Fat B) (T2 FSE-IDEAL) show an heterogeneous pattern within the tumour mass.

2-13 In contrast, the present MRI protocol provided high resolution images of these anatomic structures and together with the CT imaging was decisive for the surgical planning and for the risk reduction of IAN damage.
Echo asymmetry and least-squares estimation (FSE IDEAL) using a repetition time (TR) of 3038 ms, echo time (TE) of 124 ms, field of view (FOV) of 24 x 24 cm, slice-thickness (SL) of 4 mm, and number of excitations (NEX) of 3 (Fig. 3). The IDEAL sequence allowed to acquire 3 images with different phase shifts between water (Fig. 3a) and fat (Fig. 3b) saturation thus leading to the possibility to distinguish water and fat images and the field map. In order to obtain this separation, iterative fat-water decomposition algorithm and a 3-echo data acquisition, with the center echo shifted relative to the SE point, were combined. This sequence allows to depict the component (solid or liquid) of the lesion. In the Water: (T2 FSE-IDEAL) the lesion appeared as a high signal intensity region (Fig. 3a), while it was characterized by intermedial-low intensity in the Fat: (T2 FSE-IDEAL) (Fig. 3b). Both the sequences unveiled an heterogeneous pattern within the tumour mass, commonly observed in ameloblastoma (Fig. 3).

2) T1-weighted axial images fat-saturated fast spin echo pre-contrast administration (Ax T1 Fs FSE pre-CE) (Fig. 4a) and post-contrast administration (Ax T1 Fs FSE post-CE) (Figure 4b) using a repetition time (TR) of 418 ms, echo time (TE) of 8 ms, field of view (FOV) of 25 x 25 cm, slice-thickness (SL) of 4 mm, and number of excitations (NEX) of 2 were acquired to evaluate the potential enhancement of the mass. The contrast index (CI) pre-(figure 4 c) and post-contrast (Figure 4d) administration was calculated using one region of interest (ROI) in the centre of the tumour mass (a ROI in the muscular tissue was used as a control-image). No significant differences were observed in the CI between the two ROIs. Contrast-enhanced MRI revealed an encapsulated lesion and highlighted well defined margins; this finding allowed us to assign the diagnosis of a benign tumour, such as ameloblastoma.

3) Diffusion weighted imaging (DWI b=800) using a repetition time (TR) of 4375 ms, echo time (TE) of 72 ms, field of view (FOV) of 23 x 23 cm, slice-thickness (SL) of 5mm, bandwidth (b) of 800 s/mm² and number of excitations (NEX) of 1 (Fig. 5). DWI evaluates intercellular water motion: every change in the water protons movements induces a variation of signal intensity in this sequence. Diffusion-weighted imaging is currently used to improve the diagnostic accuracy in the differential diagnosis between benign and malignant nodes. Metastatic nodes are characterized by reduction of diffusivity, which is associated with a hypercellularity, to an increased nuclear-to-cytoplasmatic ratio and a perfusion 19-25. This decrement in diffusion is represented as an area of hyperintensity on diffusion images; adversely, inflammatory nodes appear hypointense. The DWI sequence showed a benign latero-cervical lymphadenopathy, ipsilateral to the lesion, in the upper part of the neck. No malignant lymph nodes were observed. (Fig. 5). The presence of intermedial signal intensity on T1WI, bright signal intensity on T2WI and no enhancement on CE-T1WI suggested a prevalent multicystic compo-
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OBIETTIVI: L’ameloblastoma nella variante solida / multicistica è caratterizzato da una lenta crescita, localmente invasiva all’interno del tessuto osseo. Nel 80% dei casi questa lesione insorge nella mandibola, soprattutto nella regione posteriore, con interessamento del nervo alveolare inferiore. Una Rx ortopanoramica di un uomo di 43 anni, con dolore cronico profondo nella zona posteriore della mandibola, ha evidenziato una lesione radiotrasparente multiloculare con bordi festonati nel ramo mandibolare sinistro.

In aggiunta all’esecuzione di una tomografia computerizzata della mandibola sono state utilizzate delle particolari sequenze di risonanza magnetica per determinare con precisione i limiti della lesione ed il rapporto che essa contrae con il nervo alveolare inferiore, al fine di valutare il ruolo che questa tecnica di imaging può avere nella fase della programmazione chirurgica.

METODI: Il rapporto spaziale tra la lesione e il nervo alveolare inferiore è stato analizzato confrontando i diversi metodi di immagine: RX ortopanoramica, tomografia

Fig. 6: In the Coronal CT images A) the relationship between the lesion and the mandibular canal is not detectable; in the coronal T1-weighted fast imaging employing steady-state acquisition (FIESTA) B) and in the coronal T1-weighted fast spoiled gradient-recalled echo (fast SPGR) C) the relationship between the lesion and IAN (white arrows) is clearly detectable.
computerizzata e risonanza magnetica con unità 3.0-T. Le sequenze utilizzate nell’esame di risonanza magnetica sono state: T1-weighted fast spoiled gradient-recalled echo, T1-weighted fast imaging employing steady-state acquisition, T2-weighted interactive decomposition of water and fat with echo asymmetry least-squares estimation e Diffusion weighted imaging acquisition sequences.

**CONCLUSIONE:** Le sequenze di acquisizione descritte hanno spaziali e strutturali più dettagliate rispetto ai metodi di relazione spaziale con una lesione proliferativa della mandibola contenute all’interno del canale mandibolare e della loro relazione spaziale con una lesione proliferativa della mandibola, la risonanza magnetica ha fornito informazioni spaziali e strutturali più dettagliate rispetto ai metodi di imaging tradizionali.

**CONCLUSIONI:** Le sequenze di acquisizione descritte hanno permesso di evidenziare l’efficacia diagnostica della risonanza magnetica nella caratterizzazione morfo-strutturale di una lesione maxillo-facciale e dei rapporti che essa con- trae con il nervo alveolare inferiore, rendendo questa metodica un supplemento fondamentale alla tomografia computerizzata al fine di una corretta pianificazione chirurgica, con conseguente riduzione del rischio di lesione iatrogena del nervo alveolare inferiore.

**References**


