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Computed Tomography / Tomodensitométrie

Postprocessing in Maxillofacial Multidetector Computed Tomography

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Abstract

Multidetector computed tomography (CT) and volumetric rendering techniques have always been a useful support for the anatomical and pathological study of the maxillofacial district. Nowadays accessibility to multidetector CT scanners allows the achievement of images with an extremely thin collimation and with high spatial resolution, not only along the axial plane but also along the patient's longitudinal axis. This feature is the main theoretical assumption for multiplanar imaging and for an optimal 3-dimensional postprocessing. Multiplanar reconstruction (MPR) techniques permit images along any plane in the space to be obtained, including curved planes; this feature allows the representation in a single bidimensional image of different anatomical structures that develop on multiple planes. For this reason MPR techniques represent an unavoidable step for the study of traumatic pathology as well as of malformative, neoplastic, and inflammatory pathologies. Among 3-dimensional techniques, Maximum Intensity Projection and Shaded Surface Display are routinely used in clinical practice. In addition, volumetric rendering techniques allow a better efficacy in representing the different tissues of maxillofacial district. Each of these techniques give the radiologist an undoubted support for the diagnosis and the characterization of traumatic and malformative conditions, have a critical utility in the neoplastic evaluation of primary or secondary bone involvement, and are also used in the planning of the most modern radiosurgical treatments. The aim of this article is to define the main technical aspects of imaging postprocessing in maxillofacial CT and to summarize when each technique is indicated, according to the different pathologies of this complex anatomical district.

Résumé

La tomodensitométrie multibarrettes et les techniques de reconstruction volumétrique ont toujours appuyé efficacement les études anatomiques et pathologiques de la région maxillo-faciale. De nos jours, l'accès à des appareils de tomodensitométrie multibarrettes permet l'acquisition d'images par collimation extrêmement étroite et présentant une résolution spatiale très élevée pas seulement dans le plan axial mais aussi dans l'axe longitudinal du patient. La principale hypothèse qui régit l'imagerie multiplanaire et le post-traitement tridimensionnel optimal repose sur cette caractéristique. Grâce aux techniques de reconstruction multiplanaire, on peut obtenir des images suivant n'importe quel plan de l'espace, y compris les plans courbes, ce qui permet de représenter des structures anatomiques se projetant dans plusieurs plans à l'aide d'une seule image bidimensionnelle. Pour ce motif, on utilise immanquablement des techniques de reconstruction multiplanaire pour l'examen des lésions traumatiques ainsi que des affections malformatives, néoplasiques et inflammatoires. La projection d'intensité maximale et le rendu de surface font partie des techniques de reconstruction tridimensionnelle couramment utilisées dans la pratique clinique. Par ailleurs, les techniques de rendu de volume assurent une représentation efficace des différents tissus de la région maxillo-faciale. Chacune de ces techniques appuie sans contredit le radiologiste dans le diagnostic et la caractérisation des lésions traumatiques et des affections malformatives, joue un rôle essentiel dans l'évaluation des atteintes néoplasiques primitives et secondaires des tissus osseux et sert à la planification de traitements radiochirurgicaux de pointe. Cet article a pour objectif de définir les principaux aspects techniques du post-traitement des images observées par TDM maxillo-faciale et de résumer les situations propices à chaque technique, en tenant compte des diverses lésions et affections que peut présenter cette région anatomique complexe.

Key Words: Multiplanar reconstruction; Maximum intensity projection; Shaded surface display; Volume rendering technique; Maxillofacial district

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Table 1
Parameters of imaging acquisition for maxillofacial examinations with 16- and 64-slice CT scanners

	16-slice CT	64-slice CT
kV	120	120
mAs	200	200
Collimation	0.75	0.6
Section thickness	3 mm	3 mm
Kernel	Bone/soft tissue	Bone/soft tissue

CT = computed tomography.

In the last decade the advent of multidetector technology has given a great boost to the development and use of different postprocessing imaging techniques in computed tomography (CT; 2- and 3-dimensional postprocessing) [1,2].

Among the different anatomical regions, the maxillofacial district has always gained an advantage from 2- and 3-dimensional reconstruction techniques, due to its anatomical complexity. For this reason it must be remembered that even the first clinical applications of 3-dimensional rendering software used in CT were already addressed to the assessment of malformative conditions and traumatic craniofacial diseases [3].

The current availability of multidetector scanners allows the acquisition of images with an extremely thin collimation and high spatial resolution, achievable not only on the axial plane, but also along the longitudinal axis of the patient (z-axis). This feature, in combination with the achievement of a cubic voxel (isotropic voxel), is the prerequisite for multiplanar imaging with optimal postprocessing of 2- and 3-dimensional volumetric data [4–8]. The rendering work on dedicated and interactive processing-consoles is becoming increasingly complex due to the greater volume of data obtained with the last-generation multidetector equipment and to the complex diagnostic questions to which the diagnostician must answer.

This work is aimed at understanding the technical principles underlying the postprocessing in maxillofacial CT, an essential condition for a correct use of the different modalities of imaging processing in the various pathological fields.

Acquisition Techniques

General Features

The volume of acquisition, depending on the diagnostic indications, can be limited to the oral cavity, extended to the maxillofacial bones, or extended to the whole head and neck region.

The acquisition parameters (summarized in Table 1 for 16- or 64-slice scanners), partially variable depending on the different scanners, must be oriented as much as possible to the isotropic resolution, a prerequisite for the maximum exploitation of the diagnostic potential deriving from the volumetric acquisition with multidetector technology, resulting in high-quality 2D and 3D reconstructions [4,5].

Before addressing the issues related to the postprocessing data management, it should be taken into account how the fast multislice CT acquisition time allows the use of some methodological tricks that, together with the 2- and 3-dimensional reconstructions, are often crucial to the diagnosis (eg, puffed cheeks and open mouth acquisitions) [8–11].

In fact, the puffed cheeks scan enables a better displaying of the vestibulum oris (Figure 1A), as well as the open mouth acquisition allows a better visualization of the hard palate, otherwise inseparable from the tongue muscles (Figure 1B).

Postprocessing

The multiplanar reconstructions (MPR) are the most important 2D techniques for obtaining images according to any anatomical plane, even curved planes (Curved-MPR) [12–14]. The reconstructions obtained with the use of

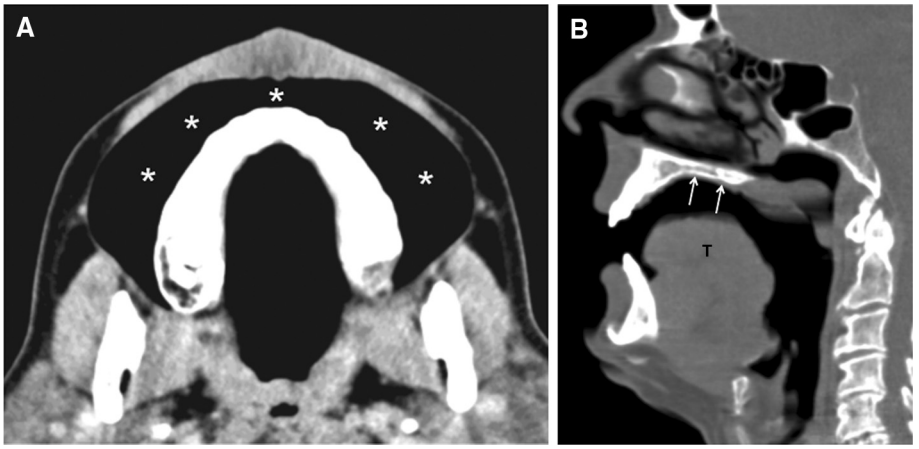

Figure 1. "Puffed-cheek" computed tomography (CT) scan: multiplanar reconstruction (MPR) image obtained at the level of the superior dental arch along the axial plane (A). Superior oral vestibule (asterisks). "Open-mouth" CT scan: MPR image obtained along the sagittal plane (B). Hard palate (arrows). T = tongue.