

G30 Magnetic Resonance Imaging (MRI) of Third Molars in Forensic Age Estimation: Validation of the Gent and Graz Protocols

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After attending this presentation, attendees will be aware of the strengths and weaknesses of two Siemens Magnetic Resonance Imaging (MRI) protocols for third molars that can be applied for age estimation.

This presentation will impact the forensic science community by providing considerations for the interpretation of two main MRI protocols to examine third molars for age estimation. It will be demonstrated that both approaches have their own characteristics and that research using both should continue. These protocols are a next step toward radiation-free dental age assessments.

Background: Panoramic radiographs are used for age estimation in forensic dentistry; however, they imply an exposure to radiation without a medical indication. Moreover, superposition can lead to misinterpretation of the developmental status of the examined structures. To counter these drawbacks, several research groups are studying the use of MRI in forensic age estimation. Per research, dental age estimation by means of third molar MRI has been studied by three research groups.¹⁻⁴ Guo et al. described a protocol for 3 Tesla (3T) MRI with a Philips scanner, while Baumann et al. and De Tobel et al. used a 3T Siemens scanner. MRI sequences of the latter two research groups will respectively be referred to as the Graz protocol and the Gent protocol.

Purpose: To validate the Gent and Graz MRI protocols for third molars by evaluating to which extent staging third molars for age estimation is influenced by: (1) in-plane resolution and slice thickness; and, (2) head fixation using a bite bar.

Materials and Methods: Eleven healthy volunteers (5 females, 6 males, 16-30 years of age) scheduled for surgical removal of third molars were included. *In vivo*, two 3T MRI scan protocols were applied: the Gent protocol with T2 Fast Spin Echo (FSE) and thin slice T2 FSE sequences, and the Graz protocol with T1 3D FSE and 3D Constructive Interference in Steady State (CISS) sequences.¹⁻³ Although bite bar fixation is inherent to the Gent and not to the Graz protocol, for both protocols scans were obtained with and without bite bar. After surgical removal, 39 third molars were scanned *in vitro* with 7 Tesla μ MRI, applying T2 FSE and Zero Echo Time (ZTE) sequences, and scanned with μ CT. Three observers evaluated the randomized MRI and μ CT images in consensus. Assessability was judged and compared in all applied MRI sequences. Third molar staging was conducted according to the technique by De Tobel et al.⁵ Staging outcomes between imaging modalities and between MRI sequences (with and without head fixation) were compared.

Results: The Gent T2 FSE sequence (voxel size $0.33 \times 0.33 \times 2\text{mm}^3$) with and without bite bar was significantly more assessable ($97\%=38/39$ and $81\%=26/32$, respectively) than the Graz T1 3D FSE sequence (voxel size $0.59 \times 0.59 \times 1\text{mm}^3$) with bite bar ($80\%=28/35$; $P=0.02$) and without bite bar ($59\%=19/32$; $P<0.001$). The combination of the voxel size and the inherent high-contrast of μ CT rendered the optimal reproduction of the hard tissue specimens. Hence, imaging with μ CT was considered as comparison standard to visualize and stage third molars. Allocated stages on MRI were most frequently equal to or higher than those on μ CT. The difference between staging based on the Gent and the Graz protocol, using the bite bar, was not statistically significant, and neither was the difference in staging based on MRI with bite bar, compared with the same sequence without bite bar.

Conclusion: Compared with μ CT, third molars appeared more developed on MRI. Using a bite bar increased the proportion of assessable third molars. By contrast, it did not influence allocated stages to assessable third molars. The differences in in-plane resolution between Gent and Graz protocols also resulted in differences in assessability rather than differences in allocated stages. Images of the Gent protocol allowed interpretation of the highest proportion of third molars available for age estimation.

Funding: Provided by the department of Radiology and Nuclear Medicine at Ghent University and the American Society of Forensic Odontology (ASFO) Research Grant 2017.

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Age Estimation, Magnetic Resonance Imaging, Third Molars