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REVIEW ARTICLE

Cone beam CT imaging of the mandibular third molar: a position paper prepared by the European Academy of DentoMaxilloFacial Radiology (EADMFR)

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Objectives: Lack of evidence on the use of CBCT for management of mandibular third molars in Radiation Protection guideline no. 172 of the European Commission made the European Academy of DentoMaxilloFacial Radiology (EADMFR) decide to update the recommendations of the guideline.

Methods and materials: A literature search was performed addressing the following questions: (1) does CBCT change the treatment of the patient?; (2) does CBCT reduce the number of post-operative sensory disturbances of the inferior alveolar nerve?; and (3) can CBCT predict the risk for a post-operative sensory disturbance of the inferior alveolar nerve?

Results: Since the European Commission published the guideline in 2012 several high-evidence studies on the use of CBCT before removal of mandibular third molars have been conducted including five randomized controlled clinical trials and one meta-analysis. Present literature allows to propose recommendations with highest level of evidence.

Conclusion: New and up-to-date evidence-based recommendations advocate that CBCT imaging of the mandibular third molar should not be applied as a routine method before removal of mandibular third molars and therefore, CBCT imaging should only be applied when the surgeon has a very specific clinical question in an individual patient case that cannot be answered by conventional (panoramic and/or intraoral) imaging.

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Keywords: molar, third; CBCT, surgery

Background

In 2012, the European Commission issued Radiation Protection guideline no. 172, an evidence-based guideline on the use of CBCT for dental and maxillofacial radiology.¹ This guideline was a result of the SedentexCT project. This SedentexCT project (2008–2011) was supported by the seventh Framework Programme of Euratom and conducted by six European universities and a company (see also: <http://www.sedentexct.eu/>).

One objective of the SedentexCT project was to review the literature on CBCT and to derive useful guidelines that would clarify those clinical situations in which this imaging technique might be beneficial to both the clinician and the patient. The method chosen was a systematic review of the literature. However, the literature available for a formal review was limited in quantity, as Dr Vivian E Rushton, the chair of the Guideline Development Panel, wrote in the introduction of the Guidelines.

At that time, the Panel only found 13 papers about the use of CBCT for pre-surgical assessment of impacted mandibular third molars. Those studies had mostly

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assessed the diagnostic value of CBCT compared with conventional radiographs with regard to the nerve-tooth relationship.

However, only two papers satisfied the criteria for inclusion in the review of diagnostic accuracy and, moreover, those papers arrived at contradictory results.^{2,3}

So the level of evidence for the recommendation in the Guideline was only Grade C. Based on the literature the following recommendation was made: “*where conventional radiographs suggest a direct inter relationship between a mandibular third molar and the mandibular canal, and when a decision to perform surgical removal has been made, CBCT may be indicated*”.

In 2015, *DMFR* published a special edition on the use of CBCT including a review on the efficacy of the method for impacted mandibular third molars. In this review, it was concluded that more high evidence studies were needed.⁴ At the 15th European Congress of Dentomaxillofacial Radiology in Cardiff, Wales, in 2016 a plenary lecture was given on the use of CBCT in the management of mandibular third molar removal. After the lecture a lively discussion was held by the members of the European Academy of Dentomaxillofacial Radiology (EADMFR) on this topic. The latest papers that were included in the Guideline originated from 2011, and since then this topic had received much attention from several research groups resulting in numerous papers of good quality. The members of EADMFR concluded their discussion that it was necessary to update the recommendations from the Radiation Protection no. 172—CBCT for dental and maxillofacial radiology (evidence-based guidelines).

Unfortunately, it was not possible to obtain financial support from the European Commission for an extensive update of the Guidelines. Therefore, EADMFR decided to issue a position paper on the topic that was studied most extensively in the past years, the use of CBCT in the management of mandibular third molars, specifically the use of CBCT before removal of mandibular third molars with regard to avoiding post-operative sensory disturbances of the inferior alveolar nerve (IAN).

Objective

The objective of this position paper is to present up-to-date recommendations regarding the radiographic imaging of the mandibular third molar, particularly concerning the use of CBCT. The scientific papers that have been published since 2011 allow recommendations to be made related to the following three questions:

- Does CBCT change the treatment of the patient?
- Does CBCT reduce the number of post-operative sensory disturbances of the IAN?
- Can CBCT predict the risk for a post-operative sensory disturbance of the IAN?

Does CBCT change the treatment of the patient?

A pilot study compared the surgical planning and risk assessment based on panoramic images and CBCT, respectively, and concluded that CBCT contributed to optimal risk assessment and a more adequate surgical planning compared with panoramic radiographs.⁵ Significantly more patients were reclassified to a lower risk of IAN injury after the CBCT examination. In this study, the patients were not treated, and the final treatment and outcome is thus unknown. In another prospective clinical study, changes in the treatment of mandibular third molars were measured when CBCT was available to the surgeon compared to a panoramic radiograph alone.⁶ The surgeon had to decide on performing a full removal or a coronectomy of the third molar in question. The treatment was changed in 12% of the cases; in 15 cases the treatment changed from full removal to coronectomy, and in 7 cases the opposite was decided. In two cases (full removals), the patient had a post-operative temporary sensory disturbance of the IAN. In the same study, it was found that no bony separation between the roots of the third molar and the mandibular canal observed in CBCT was the main reason that the surgeon performed a coronectomy. It may therefore be that CBCT to some extent change the treatment decision. On the other hand, for the majority of patients the treatment of mandibular third molars is the same based on panoramic radiographs and CBCT.

Does CBCT reduce the number of post-operative sensory disturbances of the IAN?

To answer this question, randomized controlled clinical trials (RCT) are needed, in which patients are randomly allocated to either the CBCT group or the group receiving conventional radiographic examination, and the number of post-operative sensory disturbances is compared between the groups. Five RCT-studies are available which have assessed this topic.⁷⁻¹¹ Recently, a meta-analysis including the five RCTs has been published.¹² In the meta-analysis, the RCTs were assessed for risk of bias according to the Cochrane Handbook for Systematic Reviews of Interventions, and in general, the RCTs were assessed with low risks of bias although four of the five RCTs were assessed as having high risk of bias in their blinding process which was one out of the seven parameters that were assessed. In total, 1178 third molars had been removed in the studies with a systematic set-up for inclusion and test methods for sensory disturbances. The overall conclusion of the meta-analysis is that CBCT does *not* reduce the number of post-operative sensory disturbances of the IAN after full removal of a mandibular third molar. Besides the RCTs, the meta-analysis also included one high-quality retrospective cohort study with medical CT, adding to the conclusion.¹³ Additionally, another study found that CBCT did not reduce the operation time, number of

pain-relieving analgesics, or complications leading to contact with the surgeon.¹⁴

Other studies with different study designs have also addressed this subject. Results from an epidemiological register study confirmed the above conclusion. Data from national registers in Finland were collected, which showed that the number of CBCT devices had increased from 2002 to 2009. The number of teeth removed was almost the same over the years, but despite the increased use of CBCT the number of permanent injuries to the IAN did not decrease.¹⁵ In a longitudinal observational study, including 1486 mandibular third molars, 23% had a CBCT performed before surgical intervention.¹⁶ In 16 cases, the patient had a sensory disturbance after removal of a mandibular third molar. In four cases, the surgery was based on a panoramic radiograph and, in one of these cases, the roots of the third molar were positioned superior to the white upper border of the mandibular canal indicating a very low risk for IAN injury. In another four cases, the surgical intervention was based on a CBCT; one case was interpreted as bony separation between the roots of the third molar and the mandibular canal, and three cases as no bony separation between these structures. Eight cases were removed based on a stereo-scanogram in which the mandibular third molar was judged to be positioned either buccal or lingual to the mandibular canal and therefore not in close relation to the mandibular canal. In 6 of the 16 cases, the sensory disturbance was permanent. Five of these six third molars had been removed by a dental student, and one tooth had been removed by an oral surgeon. The results from this study therefore indicate that a post-operative sensory disturbance may not be influenced by the choice of radiographic method. Recently, a third epidemiological study also concluded that CBCT does not seem to reduce the number of post-operative sensory disturbances of the IAN after removal of a mandibular third molar.¹⁷ In a randomly selected sample of 18 general dentists' private clinics, 1500 mandibular third molars had been removed. Most third molars were removed based on merely an intraoral image (67%), 29% were removed based on a panoramic image, and 4% based on a CBCT. One fourth of the third molars were removed based on an insufficient radiographic image, meaning that the whole tooth and mandibular canal were not displayed in the image. Three patients had a temporary sensory disturbance of the IAN; in one case the surgery was based on an intraoral radiograph, another was based on a panoramic radiograph, and the third operation was based on a CBCT.

To sum up, studies with different designs, high numbers of patients and high levels of evidence have reached the same conclusion: CBCT does not reduce the number of post-operative sensory disturbances after removal of a mandibular third molar compared with conventional two-dimensional radiography.

Can CBCT predict the risk for a post-operative sensory disturbance of the IAN?

As briefly mentioned in the SedentexCT report, CBCT is redundant to plan a coronectomy if the intervention can be performed based on a panoramic image. The outcome of the coronectomy procedure has been evaluated during the last decade. In an RCT study, it was concluded that the frequency of nerve injury to the IAN was significantly lower when a coronectomy of a mandibular third molar was performed compared to a full removal, a finding which was also confirmed in a recent meta-analysis.^{18,19} On the other hand, post-operative sensory disturbances of the IAN have been reported after coronectomy.²⁰ The long-term condition of the root complex left in the mandible in addition with patients' symptoms, e.g. infections, pain, and need for re-operation, have also been evaluated.^{19,20} The subjective symptoms were not more severe after a coronectomy and, moreover, the root complex re-erupted during the first year after the intervention to a position without over-projection of the mandibular canal seen in a panoramic radiograph. This may be interpreted as a reduced risk of injuring the IAN, if a second operation is needed. Conclusively, coronectomy seems to be a reasonable method for high-risk third molars to avoid injury to the IAN.^{19,20}

If coronectomy is a valid treatment option for mandibular third molars at "high-risk" for IAN injuries, it may be discussed, on which basis the decision to perform a coronectomy should be taken, and how a "high-risk" third molar is defined. It can be concluded from several previous studies that radiographic signs observed in CBCT are not more valid as predictors for a sensory disturbance of the IAN compared to signs seen in panoramic radiographs.^{9,21-23} Particularly, the sign "no bony separation between the roots of the third molar and the mandibular canal" seen in CBCT had a low positive predictive value, which was not higher than some of the seven signs for a close relationship between the tooth and the IAN in panoramic radiographs suggested in 1990.²⁴ We conclude from these findings that the decision to perform a coronectomy may be achieved as well from a panoramic radiograph as from CBCT. An RCT is needed, however, to assess the outcome for the patient when a coronectomy is based on a CBCT examination compared with a panoramic radiograph.

In conclusion, the number of post-operative sensory disturbances of the IAN will not to be reduced by the use of CBCT, and the use of CBCT does not seem to be a good predictor for post-operative sensory disturbances. It is also known that CBCT is associated with significantly higher costs for the patient and for society, and with higher radiation doses to the patient. This should be kept in mind when discussing the rationale of adding CBCT to the radiographic protocol for third molar imaging.^{14,25,26}

Recommendations

Since the SedentexCT workgroup delivered its guideline numerous papers with varying level of evidence have been published on the topic of imaging and management of the mandibular third molar. For this position paper only high quality studies with a good level of evidence were selected, assessing impact and outcome of CBCT on the treatment of mandibular third molars. A review of this literature makes it possible to make more specific recommendations, according to the grading system as used in the SedentexCT report:

- (1) CBCT should not be used routinely when assessing mandibular third molars for extraction (Grade A) or coronectomy (Grade C).
- (2) Great restraint should be shown for the pre-operative use of CBCT imaging for third mandibular molar removal or coronectomy. Panoramic imaging in most cases leads to the same patient outcome, with lower costs and radiation dose.

There is good evidence (several RCTs as mentioned before) suggesting that before full removal of a mandibular third molar, CBCT does not reduce the frequency of post-operative sensory disturbances of the IAN compared to conventional panoramic imaging (Grade A). CBCT does not reduce the operation time, number

of pain-relieving analgesics, or complications leading to contact with the surgeon (Grade A).

For assessment of the risk factors for a post-operative sensory disturbance of the IAN after removal of a mandibular third molar, CBCT does not perform better than conventional panoramic imaging (Grade B).

Overall recommendation

CBCT imaging of the mandibular third molar should only be applied when the surgeon has a very specific clinical question in an individual patient case that cannot be answered by conventional (panoramic and/or intraoral) imaging and goes beyond the recommendations as stated above.

Review of this position statement

This statement shall be reviewed in 5 years, or earlier if the evidence underlying is judged to have changed significantly.

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