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The possibilities and limitations of CBCT in endodontology

- From 'overtreatment' till 'artificial intelligence'.

2

To cBCT or not to cBCT
That is the question ...



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PART I

- Validation and reliability

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When do YOU use CBCT?



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ACTA ACADEMISCH CENTRUM
TANDHEELKUNDE AMSTERDAM



THE USE OF CBCT BY ENDODONTISTS IN THE NETHERLANDS 2022

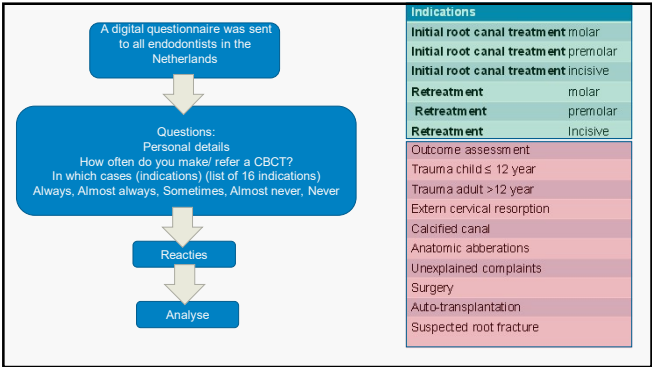
TANDARTS ENDODONTOLOGISCH ERKENNEN DOOR
NWE Nederlandse
Vereniging
voor
Endodontologie

BACHELOR THESIS - 2022

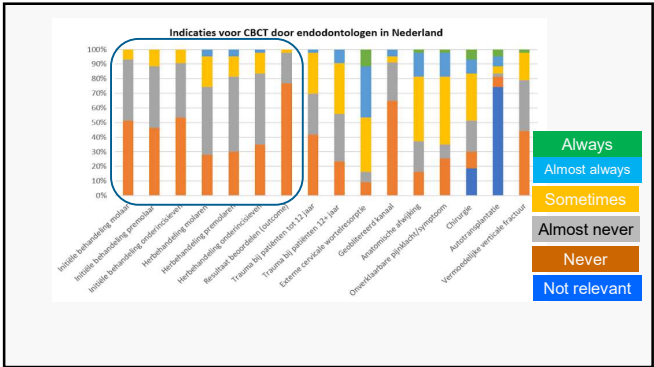
Christian van Mierlo and Rob Vergouwen
(supervisors: F. Dommering & H. Shemesh)



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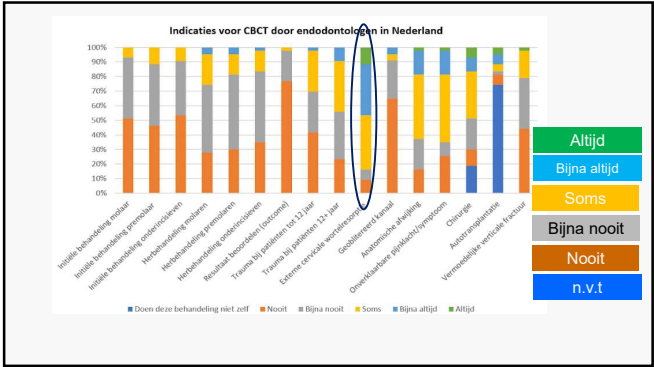
- Assessment of CBCT Referral Reasons and the Impact of CBCT Evaluation on Decision Treatment Planning Procedure in Endodontics

JOE 2020: Kakavetos et al.

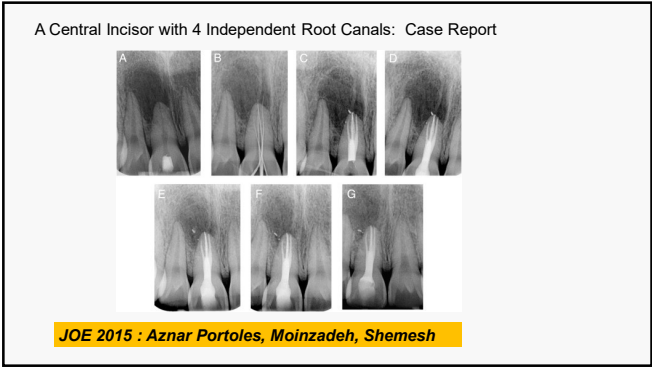
- CBCT-Predictors and characteristics of usage in Australia and New Zealand, a multifactorial analysis

Aust Endod J 2022: Isaac-Mathew et al.

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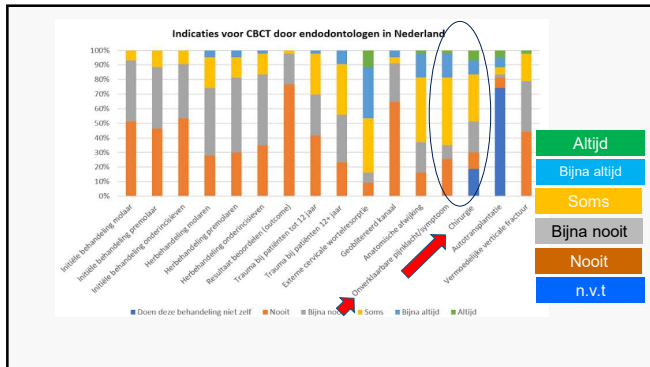


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The present report is the first to describe a maxillary central incisor with 4 canals in a tooth with no developmental abnormalities. It stresses the importance of using a dental operating microscope during endodontic treatment as well as questioning the routine use of CBCT imaging for similar cases.

JOE 2015 : Aznar Portoles, Moizadeh, Shemesh

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- Limitations of previously published systematic reviews evaluating the outcome of endodontic treatment.
- IEJ 2009 : Wu, Shemesh & Wesselink**
- Editorial Int Endod J
 - Radiographs and CBCT--time for a reassessment?
- IEJ 2011 : Patel, Mannocci, Shemesh, Wu, Wesselink, Lambrechts**

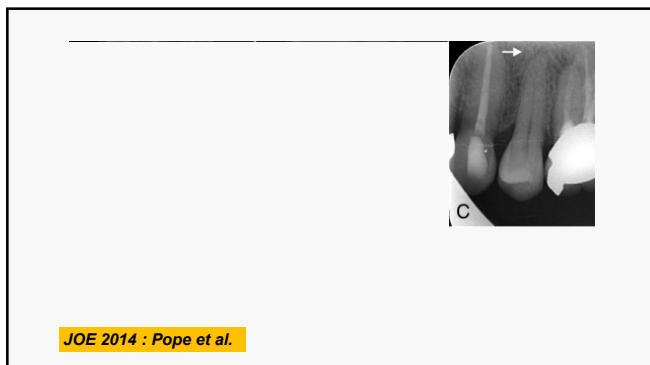
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- A comparative investigation of CBCT and periapical radiography in the diagnosis of a healthy periapex
- CBCT's of 200 patients
 - 200 healthy premolars
 - Clinical investigation
 - verify healthy premolars
- JOE 2014 : Pope et al.**
-

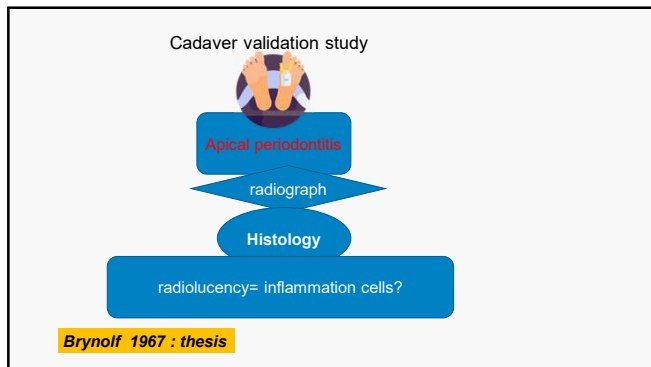
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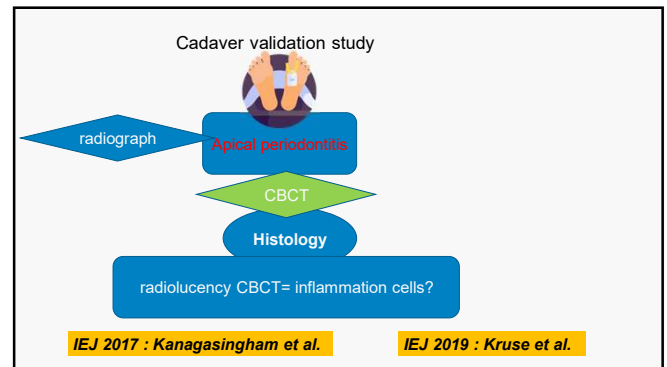
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- Conclusions: the PDL space of a healthy tooth demonstrated significant variation when examined by CBCT. The radiographic interpretation of health and disease on CBCT must be further investigated ...
-
- JOE 2014 : Pope et al.**

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Validation study No. 1

Diagnostic accuracy of periapical radiography and CBCT in detecting apical periodontitis using histopathological findings as a reference standard.

IEJ 2017 : Kanagasingham et al.

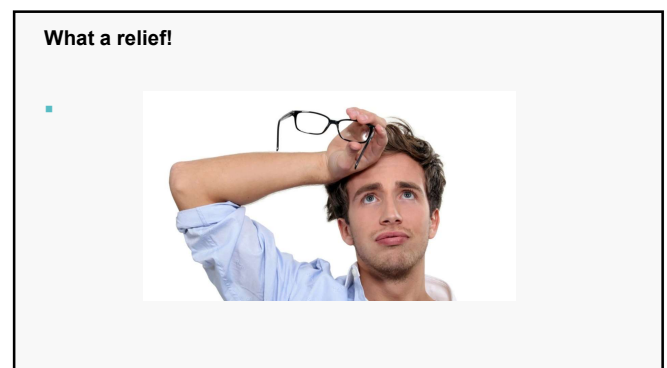
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- 9 unclaimed bodies before cremation (Malesia)
 - Maximal 14 days old
 - 67 teeth
 - Apical periodontitis detection on radiographs and CBCT
 - Histopathological investigation
- IEJ 2017 : Kanagasingham et al.**

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- Positive predictive value (If there is a lesion on CBCT, there is indeed also a visible inflammation process on histology)
 - = 1
- IEJ 2017 : Kanagasingham et al.**

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Validation study No. 2

Diagnostic accuracy of CBCT used for assessment of apical periodontitis: an ex vivo histopathological study on human cadavers.

IEJ 2019 : Kruse et al.

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- Donated bodies for research (Denmark)
- Fixed bodies in Formalin
- Jaw sections with 223 teeth in them
- Apical periodontitis detected by CBCT
- Histopathological investigation

IEJ 2019 : Kruse et al.

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- Positive predictive value (If there is a lesion on CBCT there is also a visible inflammation process on histology)
- = 0,77 (Teeth with a root-canal-treatment: 0,48-0,64)

IEJ 2019 : Kruse et al.

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Diagnostic validity of periapical radiography and CBCT for assessing periapical lesions that persist after endodontic surgery

- 149 patients after Apex-resection (about 7 years ago)
- 108 were called again for evaluation → CBCT
- Those with still a periapical lesion present got offered a re-surgery for free (20 patients accepted)
- Biopsy

Dentomaxillofac Radiology : Kruse et al.

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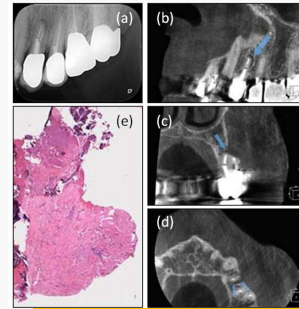
42% without a periapical inflammation process
Correct diagnosis with CBCT: 58%
and 63% with regular radiographs

- Of the 42% showed no inflammation process and no need for re-surgery

Overtreatment

Dentomaxillofac Radiology : Kruse et al.

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Dentomaxillofac Radiology : Kruse et al.

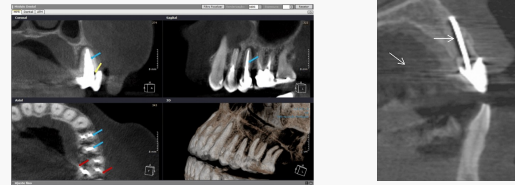
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- Root canal treated teeth can demonstrate a periapical lesion also when there is no inflammation

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- Beam Hardening and streaking artefacts



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Deel I

- Dutch endodontists are reserved in the use of CBCT
- Detection of periapical periodontitis with CBCT is accurate for teeth without a root canal treatment, But significantly less accurate for teeth with a root canal treatment.

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CBCT for the diagnosis of VRF: A systemic review of the literature and meta-analysis

„No superiority of CBCT compared with conventional radiography...“



Oral and Maxillofacial Radiol 2014; Corbella et al.

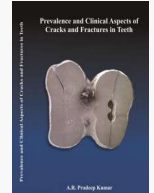
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Diagnosis of VRF by CBCT in Root-filled Teeth with Confirmation by Direct Visualization: A Systematic Review and Meta-Analysis.

“CBCT imaging is still not a good tool for diagnosing VRFs in root-filled teeth compared with direct visualization”.



JOE 2021: Pradeep Kumar et al.



Promotie : 2022

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CBCT kan HELPEN bij de diagnose van wortelfractuur SAMEN met de klinische tekenen en symptomen:

- De combinatie van een diepe pocket, een fistel en een laterale laesie bij een endodontisch behandeld element (vooral maxillary premolaren en de mesiale wortel van mandibulaire molaren)
- Op de CBCT-scan kan het botverliespatroon worden aangetoond

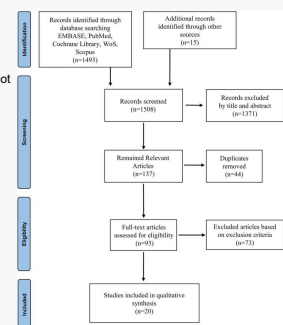
maar verwacht niet dat de breuk zichtbaar is op de CBCT

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BMC Med Imaging 2023

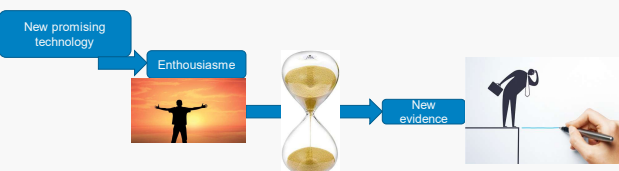
Diagnostic efficacy of CBCT for detection of vertical root fractures in endodontically treated teeth: a systematic review
Habibzadeh et al.

Conclusions:
Further clinical research is needed to validate the optimum efficiency of CBCT as a diagnostic technique for detecting VRFs in teeth that have had endodontic treatment, given the low sensitivity, significant heterogeneity of studies, and lack of in-vivo studies on the subject.



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Is there a pattern here?



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Remember

Technology evolves !



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Voorbeeld : ultrasonic irrigatie

- The most extensively investigated
- Increased interest in the 2000's

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Căpută PE et al. J Endod. **2019**
...no strong clinical recommendations could be formulated.



Silva EJNL et al. Br Dent J. **2019**

...there was no evidence of effective improvement on periapical healing ...that supports the use of ultrasonic irrigation...

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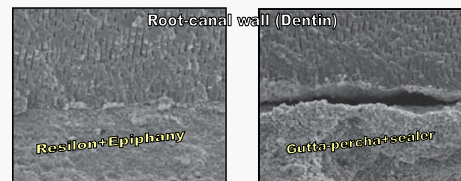
Resilon Epiphany

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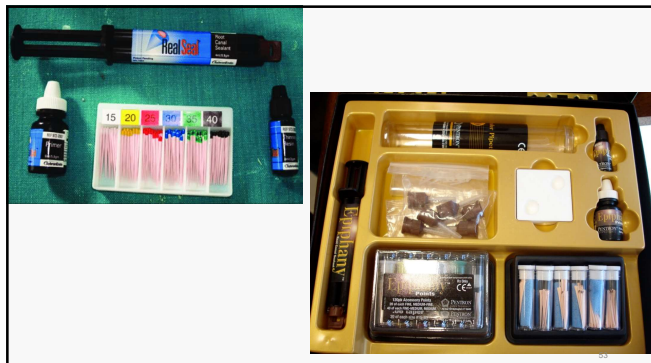
Resilon-Epiphany

- New composite filling material for root canals
- Introduced in 2004 (Shipper et al. JOE)



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"monoblock" concept



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Leakage studies

Resilon is better than GP	GP is better than Resilon	GP=Resilon
Shipper <i>et al.</i> 2004	Shemesh <i>et al.</i> 2006	Shemesh <i>et al.</i> 2007
Budrumglu & Tunga 2006	Paque & Sirtes 2007	De Deus <i>et al.</i> 2007
Different conditions & models	Pasqualini <i>et al.</i> 2007	Baumgartner <i>et al.</i> 2007

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Long-term Outcomes of Endodontic Treatment Performed with Resilon/Epiphany
Strange *et al.* J Endod. 2019

Long-term Clinical Outcome of Teeth Obturated with Resilon.
Barborka *et al.* J Endod. 2017

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Effect of object position in the field of view and application of a metal artifact reduction algorithm on the detection of VRF on CBCT scans: An in vitro study

Imaging Sci Dent 2018: Nikbin *et al.*

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Detection of vertical root fracture with Optical Coherence Tomography



JOE 2009: Shemesh *et al.*

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Artificial Intelligence in health care

Virtual

Physical (robotics)

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Artificial Intelligence in health care

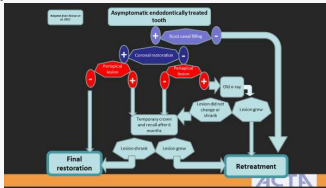
Virtual

Physical (robotics)

- Detection of periapical lesions (CBCT?)
- Detection of root fractures (CBCT?)
- Length determination (CBCT)
- Morphology of the root and root canal system (CBCT)
- Predictions (re-treatments, vital pulp treatments)

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Artificial intelligence (AI) has the potential to replicate human intelligence to make predictions and complex decision making in the health care systems



Artificial Intelligence in Endodontics: Current Applications and Future Directions.

JOE 2021 : Aminoshariae et al.

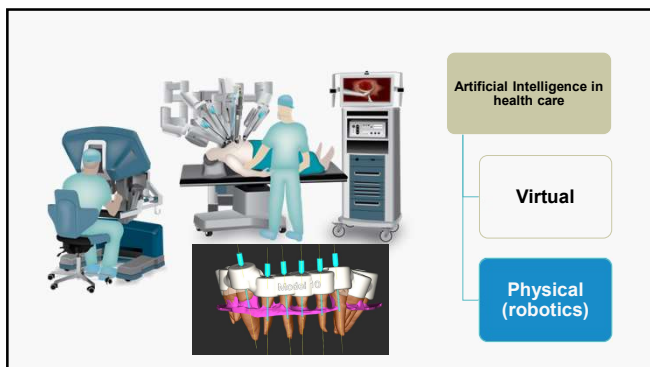
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Association between patient-, tooth- and treatment-level factors and root canal treatment failure: A retrospective longitudinal and machine learning study.

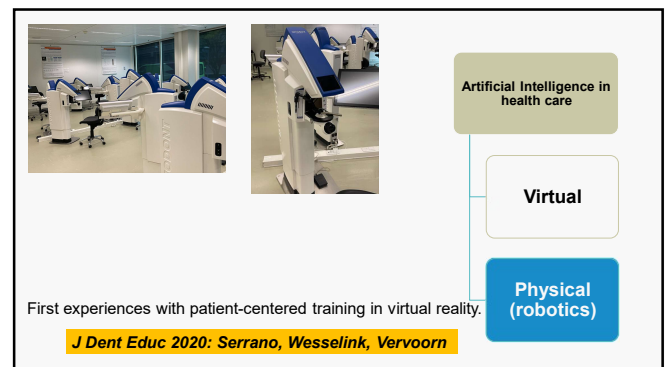
Predicting failure was only limitedly possible, also with more complex Machine Learning.

J Dent 2022 : Herbst et al.

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First experiences with patient-centered training in virtual reality.

J Dent Educ 2020: Serrano, Wesselink, Vervorm

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Conclusions- CBCT limitations & future

- Periapical lesions in endodontically treated teeth can be confused with healing on CBCT-scan. Base your diagnosis and treatment plan NOT ONLY on the CBCT.
- CBCT is (still) not effective in the diagnosis of vertical root fractures
- Excitement on new technology vs. Reality and limitations
- Developments in CBCT-technology
- AI



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www.shemesh.nl

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