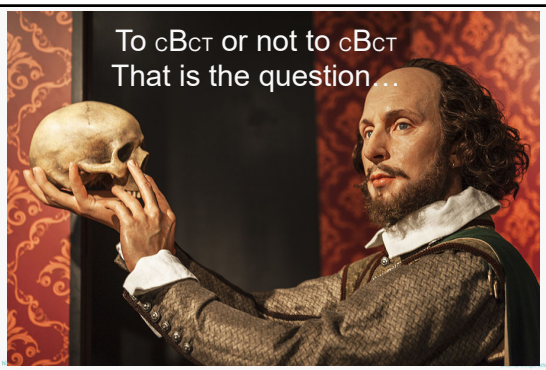
De mogelijkheden en beperkingen van CBCT in endodontologie

- van 'overtreatment' tot 'artificial intelligence'.

Hagay Shemesh
Dep. Of Endodontology, ACTA

1



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DEEL I

- Validatie en betrouwbaarheid

3

ACTA ACADEMISCH CENTRUM TANDHEELKUNDE AMSTERDAM

HET GEBRUIK VAN CBCT DOOR ENDODONTOLOGEN IN NEDERLAND 2022

TANDARTS-ENDODONTOLOOG ERKEND DOOR NVE Nederlandse Vereniging voor Endodontologie

BACHELOR THESIS - 2022

Christian van Mierlo en Rob Vergouwen
(begeleiders: F. Dommering & H. Shemesh)

4

Digital questionnaire was sent to all endodontists in the Netherlands

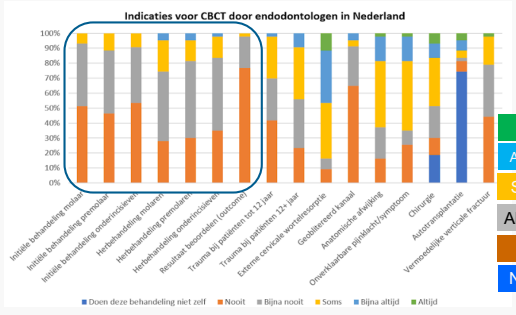
Questions :
- Personal details
- How often do you make a CBCT
- In which indication (list of 16 indications)
- Always, Almost always, sometimes, almost never, never

Response

Analysis

Indications
Initial treatment molar
Initial treatment premolar
Initial treatment incisive
Retreatment molar
Retreatment premolar
Retreatment incisive
Outcome evaluation
Trauma child
Trauma adult
External resorption
Obliterations
Anatomical aberrations
Inexplicable complaints
Surgery
Autotransplantation
Vertical root fracture

5



Always
Almost always
Sometimes
Almost never
NEVER
Not relevant

6

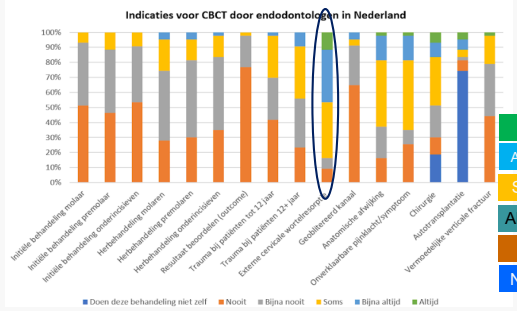
- Assessment of CBCT Referral Reasons and the Impact of CBCT Evaluation on Decision Treatment Planning Procedure in Endodontics

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.

7



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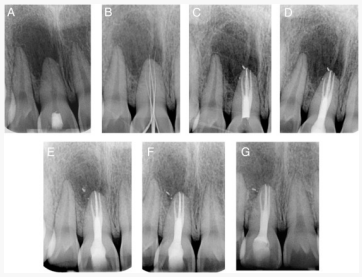
A Central Incisor with 4 Independent Root Canals: Case Report



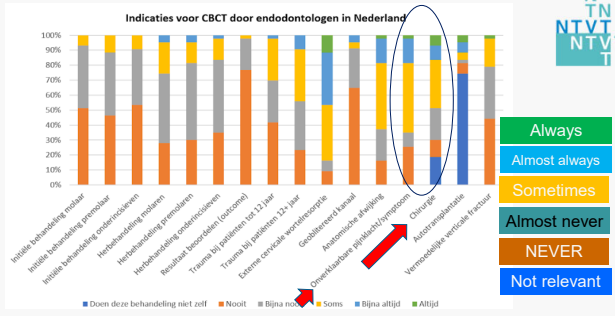
JOE 2015 : Aznar Portoles, Moinzadeh, Shemesh

9

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, Moinzadeh, Shemesh

10



11

- 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

12

13

A comparative investigation of CBCT and periapical radiography in the diagnosis of a healthy periapex

CBCT scans & radiographs of 200 teeth

Clinical tests

JOE 2014 : Pope et al.

14

JOE 2014 : Pope et al.

15

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.

16

Cadaver validation Study Brynolf

Parodontitis apicalis

radiograph

Histology

lesion on radiograph=inflammatory infiltrates?

Brynolf 1967 : thesis

17

Cadaver validation Studies Patel vs. Kruse

radiograph

Parodontitis apicalis

CBCT

Histology

lesion on CBCT=inflammatory infiltrates?

IEJ 2017 : Kanagasingham et al. ***IEJ 2019 : Kruse et al.***

18

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.

19

- 9 unclaimed bodies before cremation (Malaysia)
- Max. 14 days old
- Jaw sections 67 teeth
- AP detection by radiographs and CBCT
- Histopathological examination

IEJ 2017 : Kanagasingham et al.

20

- Positive Predictive Value (if there is a lesion on the CBCT there is indeed an inflammation process histologically) = 1

IEJ 2017 : Kanagasingham et al.

21

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.

22

- bodies donated for science (Denmark)
- Fixated bodies (Formaline)
- Jaw sections 223 teeth
- AP detection by radiographs and CBCT
- Histopathological examination

IEJ 2019 : Kruse et al.

23

- Positive Predictive Value (if there is a lesion on the CBCT there is indeed an inflammation process histologically) = 0.77 (root-filled teeth: 0.48-0.64)

IEJ 2019 : Kruse et al.

24

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 recalled → CBCT
- Those where a periapical lesion still existed were - offered a re-surgery (20 patients accepted)
- Biopsy

Dentomaxillofac Radiology : Kruse et al.

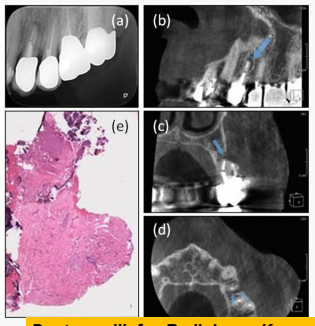
25

42% without periapical inflammation
Correct diagnosis with CBCT : 58% and 63% with PR

- Conclusions: Of the re-operated teeth, 42% had no apical inflammation and hence no benefit from resurgery.

Dentomaxillofac Radiology : Kruse et al.

26



Dentomaxillofac Radiology : Kruse et al.

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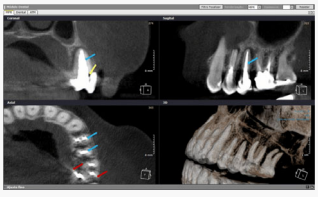
Meaning…

- Endodontically treated teeth could demonstrate a periapical lesion on CBCT while there is ***no*** *inflammatory process* going on

28

- Beam Hardening and streaking artefacts



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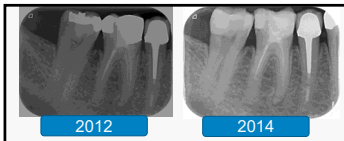

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DEEL II

- Beperkingen en toekomst

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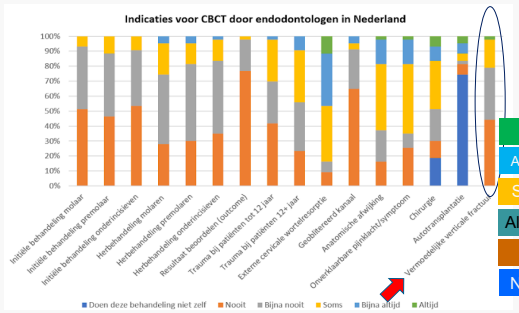

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Recent study from Beijing…

Beijing Da Xue Xue Bao Yi Xue Ban 2023

A prevalence survey of cone-beam computed tomography use among endodontic practitioners

- J X Ye , Y H Liang

- In the diagnosis process, CBCT was mainly used for the diagnosis of chronic periapical periodontitis, root fracture, root resorption and dental trauma.

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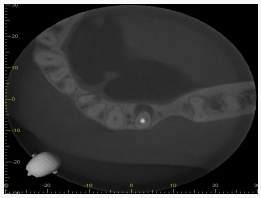
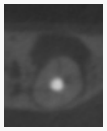
VRF on CBCT





Detection of VRF in endodontically treated teeth by a CBCT

JOE 2009 : Hassan et al.

34

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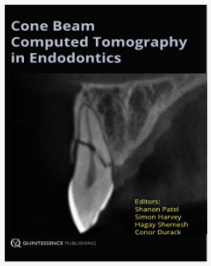
The detection of VRF in root filled teeth with periapical radiographs and CBCT scans.

" …periapical radiographs and CBCT were not accurate in detecting the presence and absence of simulated VRF"



IEJ 2013 : Patel et al.

36

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

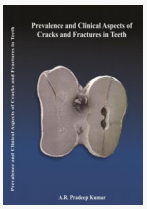
„No superiority of CBCT compared with conventional radiography…“

Oral and Maxillof rad 2014: Corbella et al.

37

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: PradeepKumar et al.

Promotie : 2022

38

CBCT can HELP in diagnosing VRF TOGETHER with the clinical signs and symptoms :

- The combination of a deep pocket, a sinus tract and a lateral lesion on an endodontically treated tooth (especially upper premolars and the mesial root of lower molars)
- On the CBCT the bone loss patern could be demonstrated

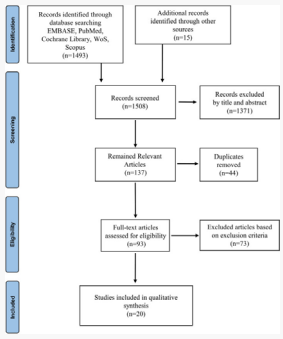
But don’t expect to see the fracture itself

39

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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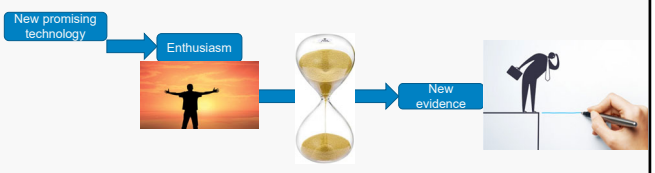
Is there a pattern here ?



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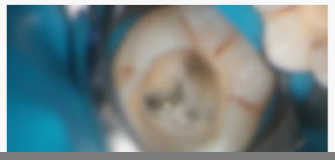
Remember

- Technology evolves !

42



- The most extensively studied
- Surge of enthusiasm in the early ‘2000s

Example : ultrasonic irrigation

43

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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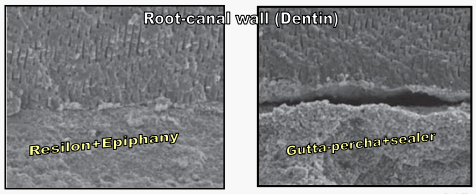
Resilon Epiphany

45

Resilon-Epiphany

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



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“monoblock” concept

48

Leakage studies

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

49

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

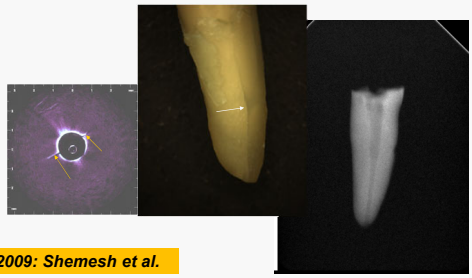
50

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.

51

Detection of vertical root fracture with Optical Coherence Tomography



JOE 2009: Shemesh et al.

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Artificial intelligence (AI) in health care

- **Virtual**
- **Physical (robotics)**

53

Artificial intelligence (AI) in health care

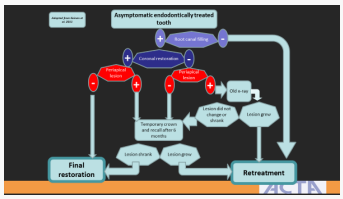
- Detection of periapical lesions (CBCT?)
- Detection of root fractures (CBCT?)
- Working length determination (CBCT)
- Root and root canal system morphology (CBCT)
- Predictions (retreatments, viability of stem cells)

Virtual

Physical (robotics)

54

Artificial intelligence (AI) has the potential to replicate human intelligence to perform prediction and complex decision making in health care



Artificial Intelligence in Endodontics: Current Applications and Future Directions.

JOE 2021 : Aminoshariae et al.

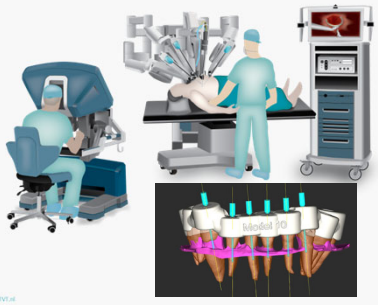
55

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.

56



Artificial intelligence (AI) in health care

- **Virtual**
- **Physical (robotics)**

57

Artificial intelligence (AI) in health care

- **Virtual**
- **Physical (robotics)**

First experiences with patient-centered training in virtual reality.

J Dent Educ 2020: Serrano, Wesselink, Vervoorn

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Conclusions- CBCT limitations & future

- Periapical lesions on endodontically treated teeth can be confusing on a CBCT. Base your diagnosis and treatment plan not on the image alone.
- CBCT is (still) not efficient for diagnosis of VRF
- Enthusiasm new technology vs. reality and limitations
- Developments in CBCT technology
- AI

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