

OUTCOME STUDIES IN ENDODONTICS

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ACADEMIC CENTRE  
FOR DENTISTRY AMSTERDAM



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## Outcome studies in Endodontology

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- Chapter 1: Importance
- Chapter 2: Definitions- outcome measurements
- Chapter 3: Classical studies
- Chapter 4: CBCT
- Chapter 5: The elephant in the room
- Chapter 6: How to assess my root canal treatment ?
- Chapter 7: The scoping reviews of 2022

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- Importance



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Which irrigation protocol?

To re-treat or not to re-treat?

CBCT before every treatment?

Which file should I use?

Ultrasonic irrigation necessary?

Which obturation ?

Use calcium hydroxide?

Which sealer?

Which concentration of hypochloride?

Microscope necessary?

Follow up period ?

Pulpotomy or pulpectomy?

Bleaching with which material ?

MTA or Biodentine?

Perforations- what to do?

Broken instruments- what to do ?

Full crown of composite ?



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

Example : ultrasonic irrigation



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Radiographic healing after a root canal treatment performed in single-rooted teeth with and without ultrasonic activation of the irrigant: a randomized controlled trial

Root canal treatments with and without additional ultrasonic activation of the irrigant contributed equally to periapical healing.

JOE 2013 : Liang et al.



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**JOE 2019 : Căpută et al.**  
 "...no strong clinical recommendations could be formulated"



**BDJ 2019 : Silva et al.**  
 "...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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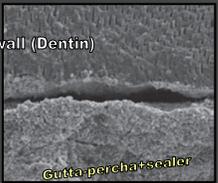
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Resilon-Epiphany

- New composite root canal filling material
- Introduced in 2004



Resilon-Epiphany



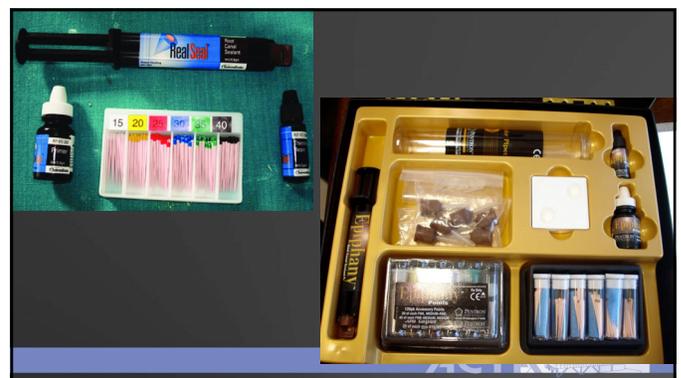
Gutta-percha+sealer

Root-canal wall (Dentin)

**JOE 2004 : Shipper et al.**

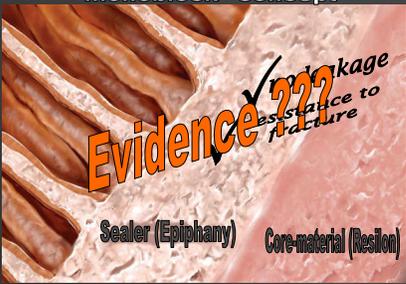
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"monoblock" concept



**Evidence ???**

✓ Leakage resistance to fracture

Sealer (Epiphany) Core-material (Resilon)

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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

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**JOE 2019 : Strange et al.**  
 Long-term Outcomes of Endodontic Treatment Performed with Resilon/Epiphany  
 "Teeth obturated with Resilon were more likely to present with a lesion at follow-up compared with gutta-percha obturated teeth."

**JOE 2017 : Barborka et al.**  
 Long-term Clinical Outcome of Teeth Obturated with Resilon.  
 "Teeth obturated with RS had 5.7 times greater chance of failure compared with teeth obturated with GP."



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**Chapter ONE**

Importance:

- Outcome studies are the only reliable way to check the influence of different treatment modalities/ materials/ instruments on the aims of the treatment



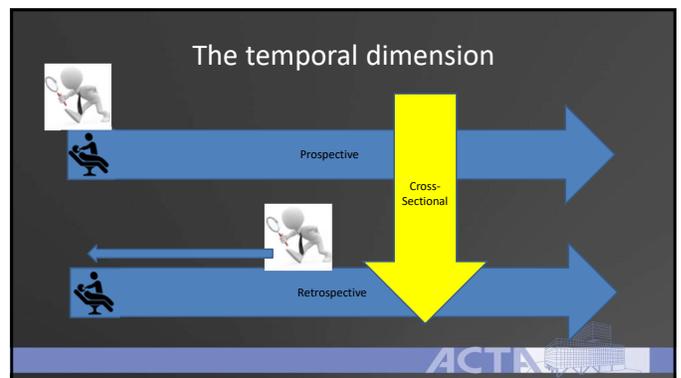

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**Chapter TWO**

- General terms

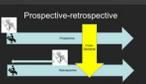



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Prospective-retrospective



- Advantage of prospective : all treatment factors could be controlled and planned- fewer potential sources of bias and confounding
- Advantage of retrospective: easier to perform because you look at charts of previous patients



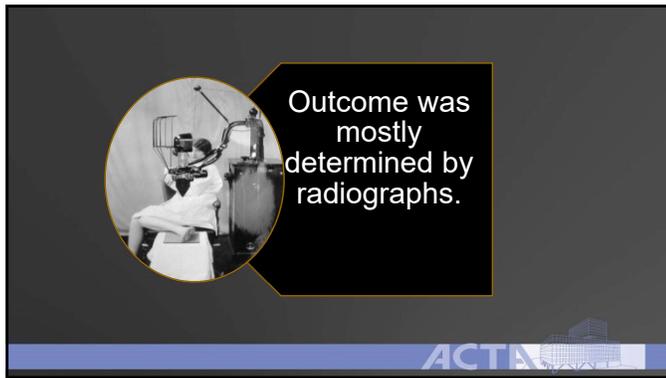
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End point and surrogate end point

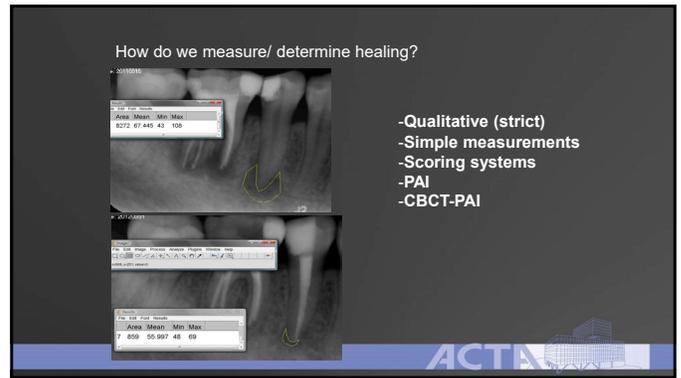
End point	Surrogate	
Healing of the periapical lesion	Time	Efficacy of three different rotary files to remove gutta-percha and Resilon from root canals. Marfisi K et al. Int Endod J. 2010
	Esthetics	Biodentine Pulpotomies on Permanent Traumatized Teeth with Complicated Crown Fractures. Haikal L et al. J Endod. 2020
	Cost effectiveness	Health economic evaluation of endodontic therapies. Schwendicke F, Herbst SR. Int Endod J. 2022
	Pain	Outcome assessment of non-surgical root canal treatment by patients: what factors can influence their evaluation? Atmeh A et al. Br Dent J. 2020



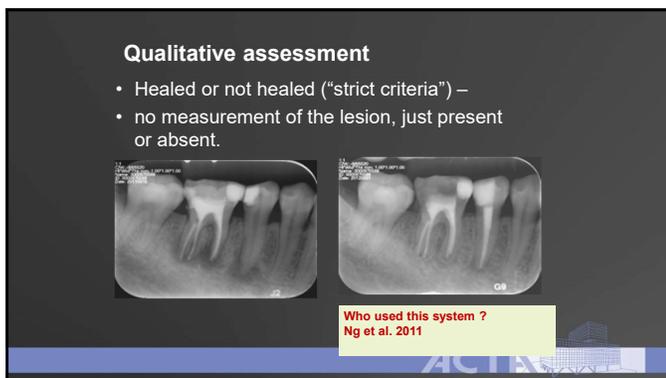
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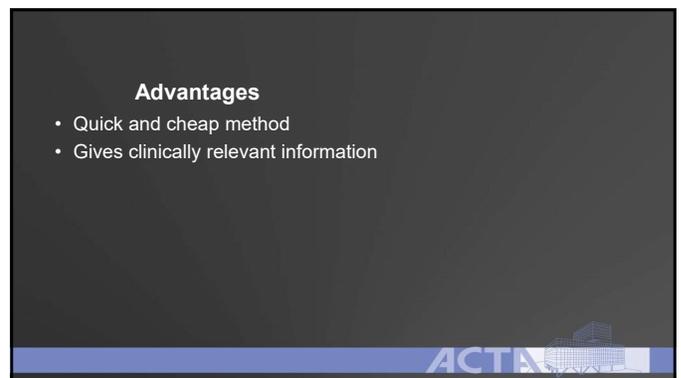
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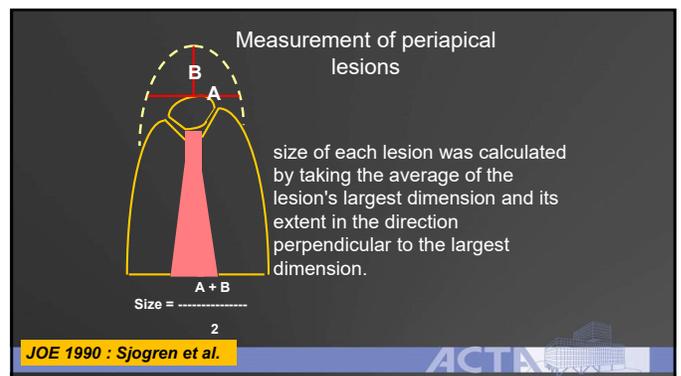
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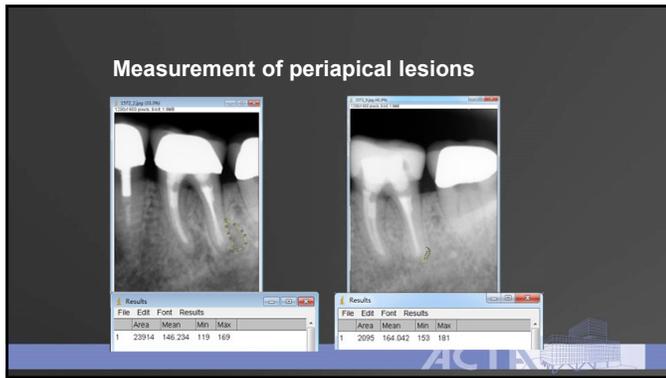
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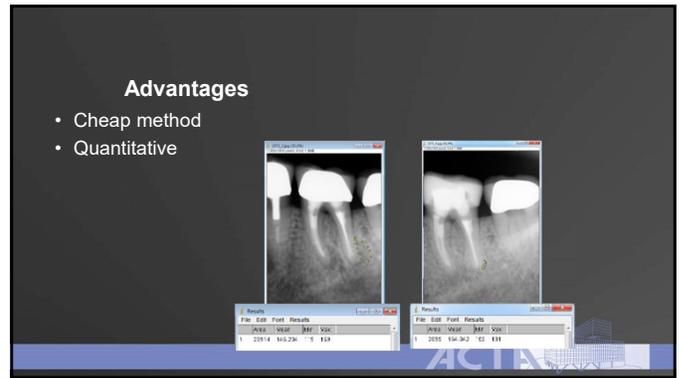
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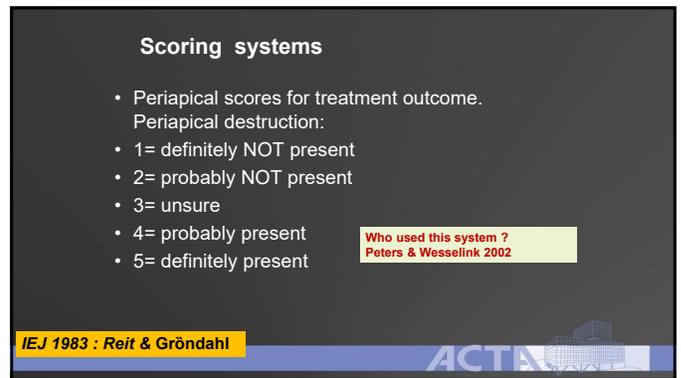
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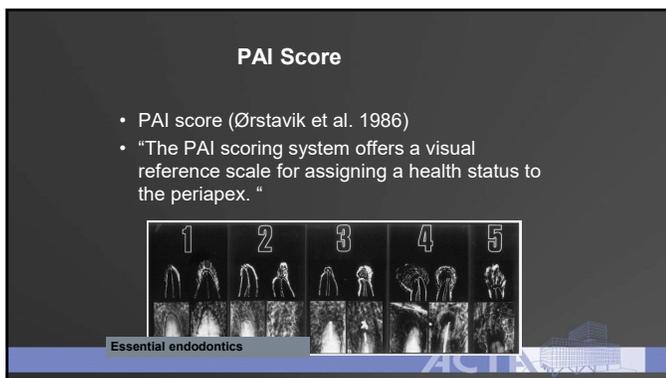
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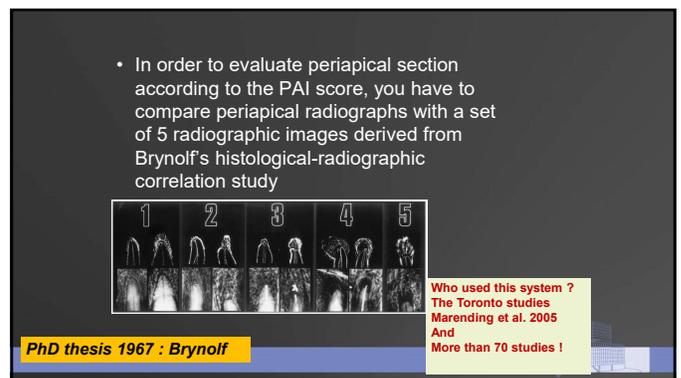
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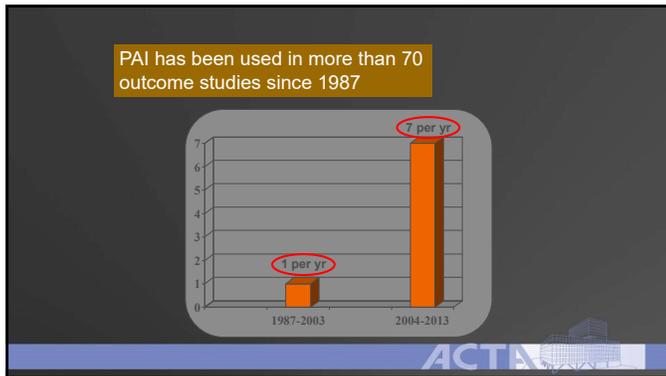
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### Advantages

- Relatively easy to perform
- Many studies and experience with this method
- Uniformity

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### Disadvantages

- Based on findings from maxillary incisors
- Based on 2D information

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“Scores 2 to 5 represent increasing extent and severity of apical periodontitis.”

From studies 2003-2006

Healthy			Disease	
1	2	3	4	5
Normal periapical structures	Small changes in periapical bone structure	Changes in periapical bone structure with some mineral loss	Demineralization of periapical bone with well-defined radiolucent area	Demineralization of periapical bone with exacerbating features

Figure 1 Visual references of the Periapical Index (PAI) (Ørstavik et al. 1986).

Endo Dent Traumat 1986 : Ørstavik et al.

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Prognostic value of the full-scale Periapical Index.

Repeated radiographic assessments of teeth using the full-scale PAI reveal that each of the five scores had distinct prognostic value for the course of periapical disease ...

Figure 4 Visual references of the Periapical Index (PAI) (Ørstavik et al. 1986).

IEJ 2014 : Kirkevang et al.

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Success=	PAI 1+2	PAI 1
ALL	90	58
NO Pre-op PA	94	70
Pre-op PA	79	26

Eur J Oral Sci 2004 : Ørstavik et al.

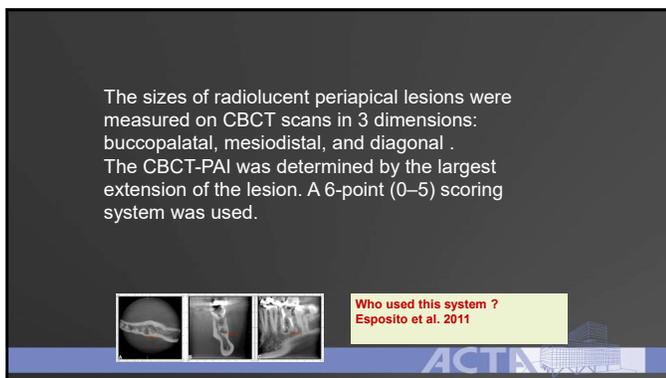
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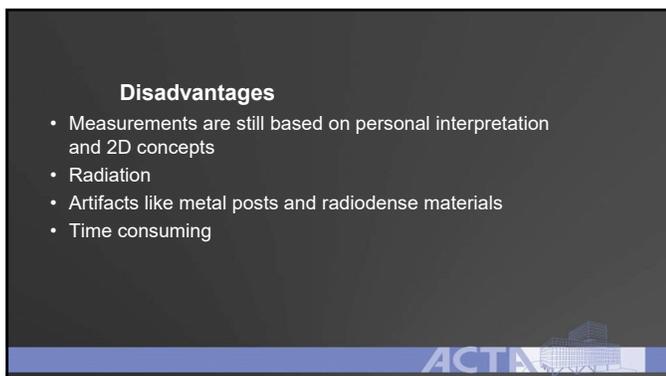
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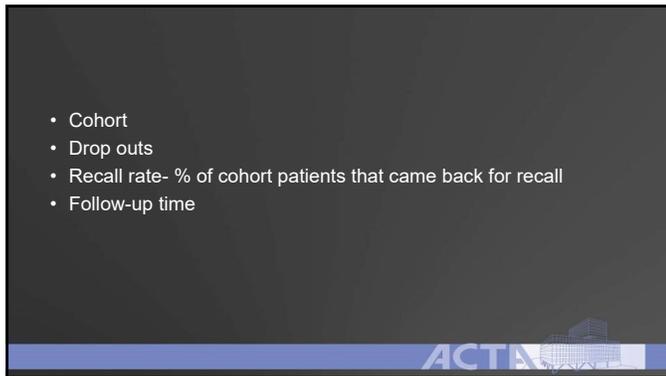
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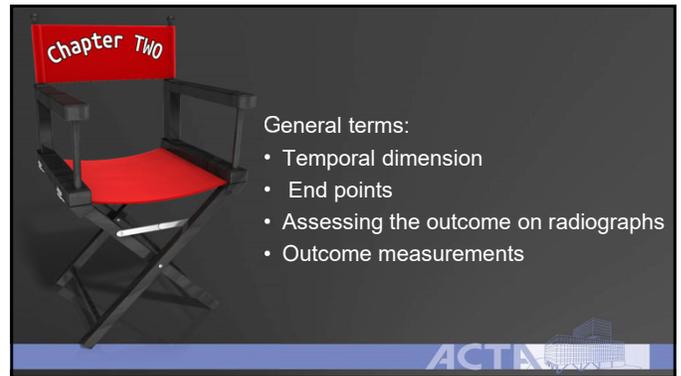
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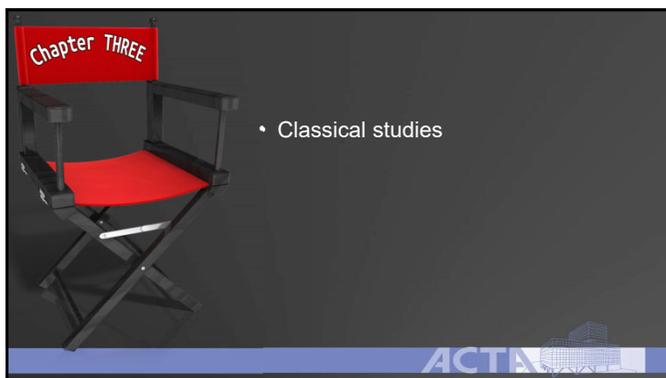
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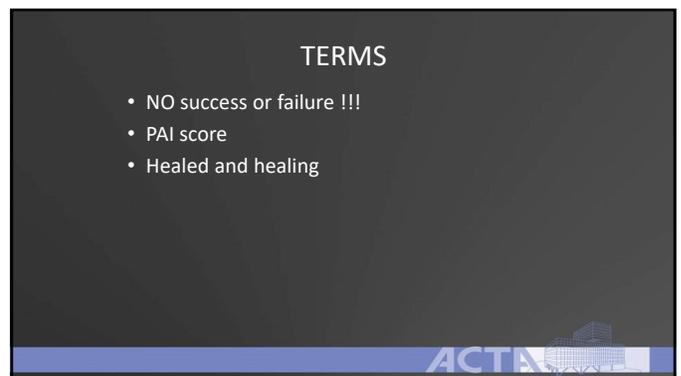
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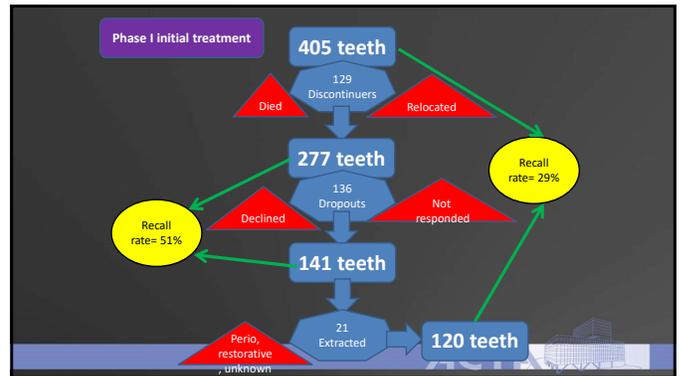


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## Toronto studies – JOE 2003-2010

- Treatment outcome in endodontics: the Toronto Study, Phase I: initial treatment. *Friedman S, Abitbol S, Lawrence HP. 2003*
- Treatment outcome in endodontics: the Toronto Study, Phase II: initial treatment. Farzaneh M, Abitbol S, Lawrence HP. *Friedman S. 2004*
- Treatment outcome in endodontics: the Toronto study, Phases I and II: Orthograde retreatment. Farzaneh M, Abitbol S, *Friedman S. 2004*
- Treatment outcome in endodontics: The Toronto Study, Phases I and II: apical surgery. Wang N, Knight K, Dao T, *Friedman S. 2004*
- Treatment outcome in endodontics: the Toronto Study, Phase III: initial treatment. Marquis VL, Dao T, Farzaneh M, Abitbol S, *Friedman S. 2006*
- Treatment outcome in endodontics: the Toronto study—phases 3 and 4: orthograde retreatment. de Chevigny C, Dao TT, *Bosroni BR, Marquis V, Farzaneh M, Abitbol S, Friedman S. 2008*
- Treatment outcome in endodontics: the Toronto study—phase 4: initial treatment. de Chevigny C, Dao TT, *Bosroni BR, Marquis V, Farzaneh M, Abitbol S, Friedman S. 2008*
- Treatment outcome in endodontics: the Toronto study—phases 3, 4, and 5: apical surgery. Barone C, Dao TT, *Bosroni BR, Wang N, Friedman S. 2010*

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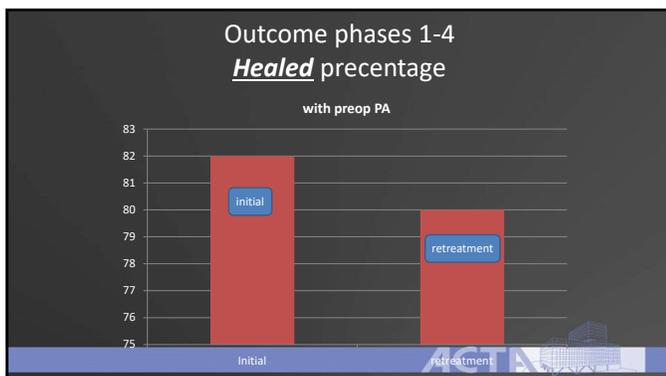
### “Response bias analysis”

- Explores whether the results could be skewed by the loss of follow-up.
- Patients lost to follow-up are checked for different characteristics (gender, pre-op diagnosis, tooth type...)
- If the populations lost to follow up and attending are significantly different in parameters which were identified as an outcome predictor, than the results could be skewed.

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### Results- Toronto studies

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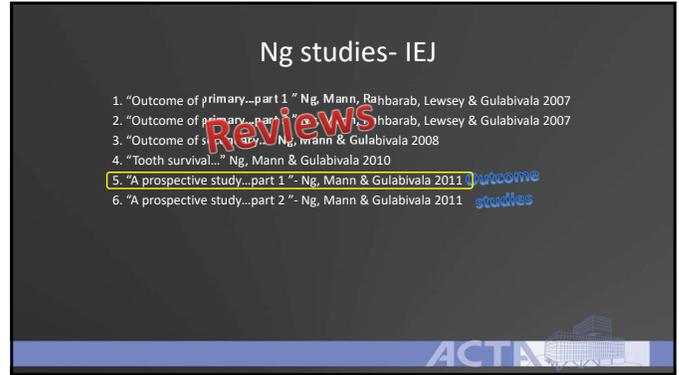
### Conclusions Toronto studies

- Importance
- Methodology
- Relevance
- Future

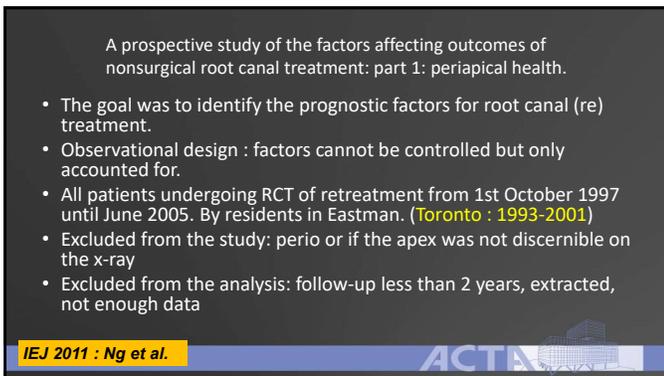
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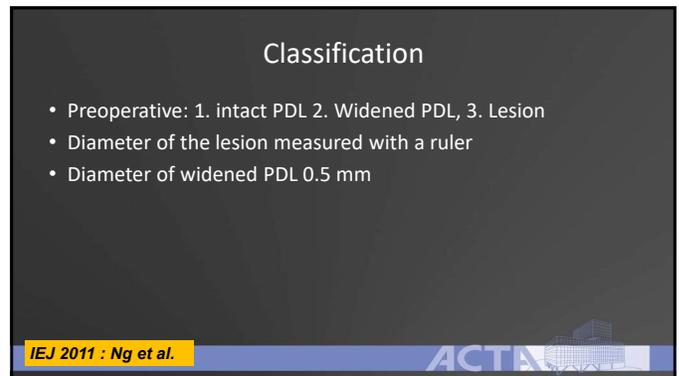
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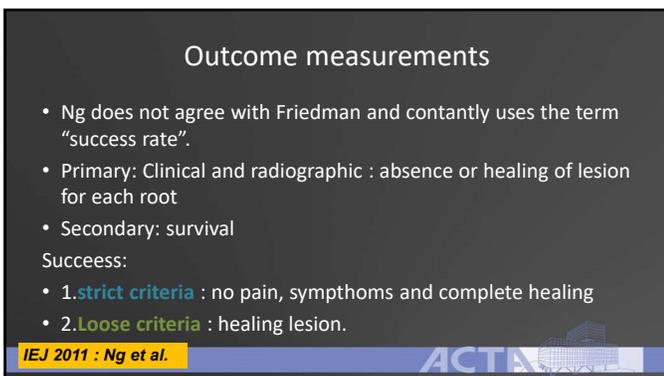
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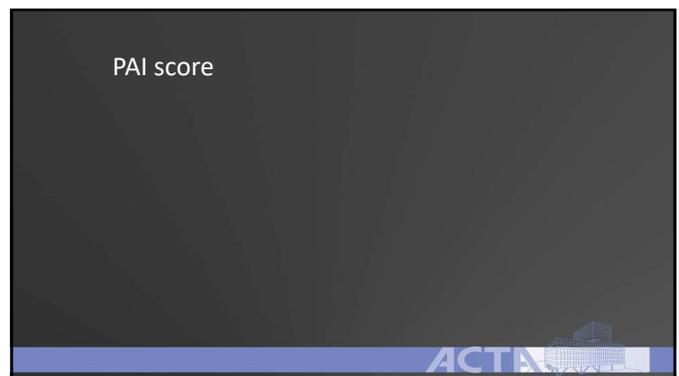
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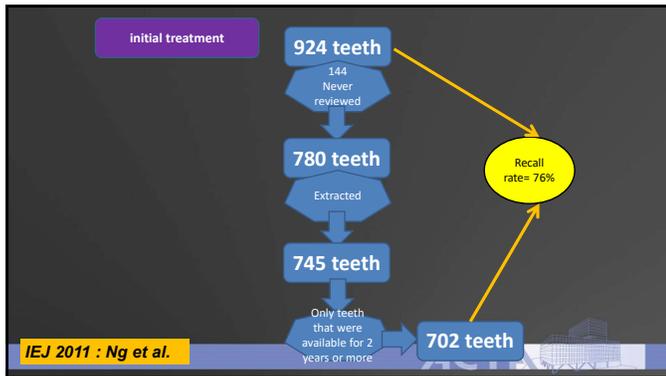
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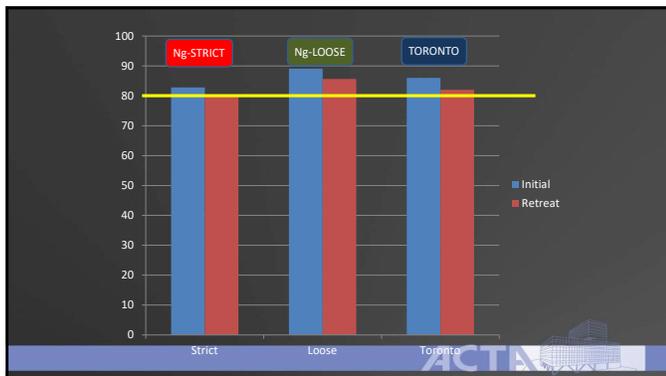
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### Results Ng

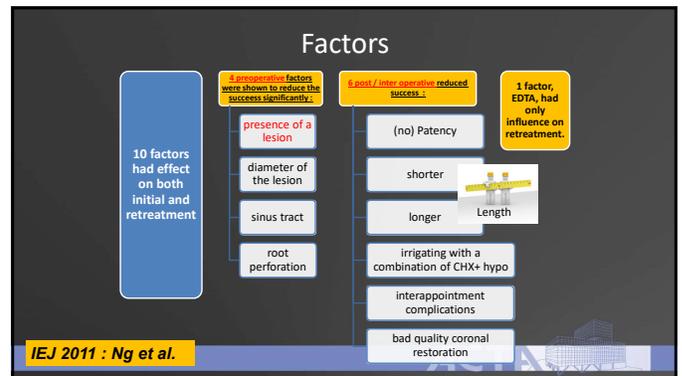
	Initial	retreatment
Strict	82,8	80,1
Loose	89,1	85,6

IEJ 2011 : Ng et al.

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### Significance

- Both the Toronto studies (Friedman et al) and the Ng studies could serve as a reference standard for endodontic outcome references.
- However, they have their limitations
- New technical innovations will challenge these studies

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### Chapter TWO

Classical studies:

- Toronto studies (Friedman S. et al.)
- Ng studies

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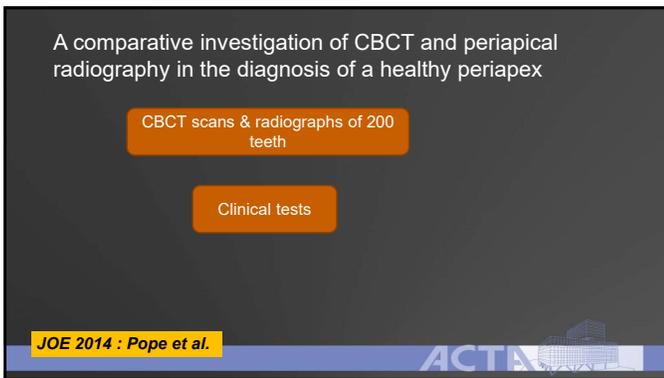
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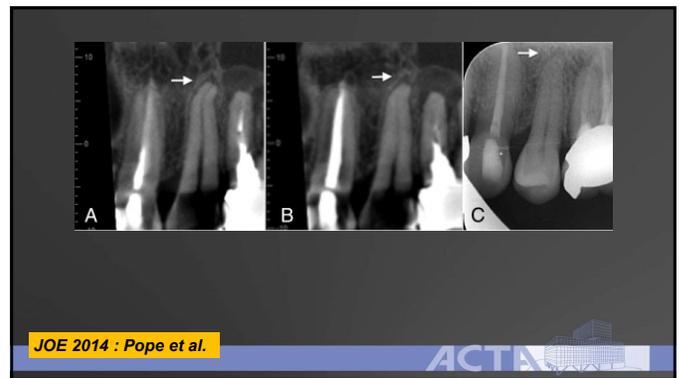
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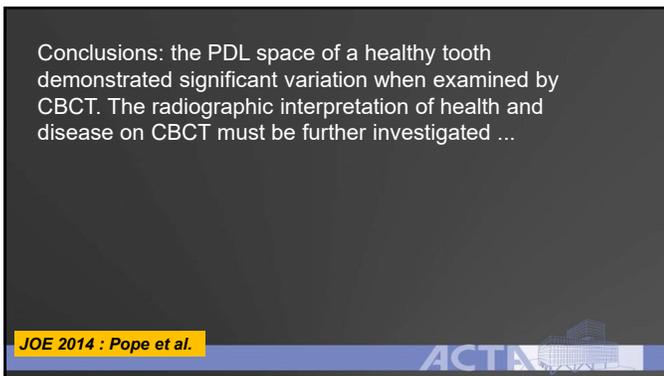
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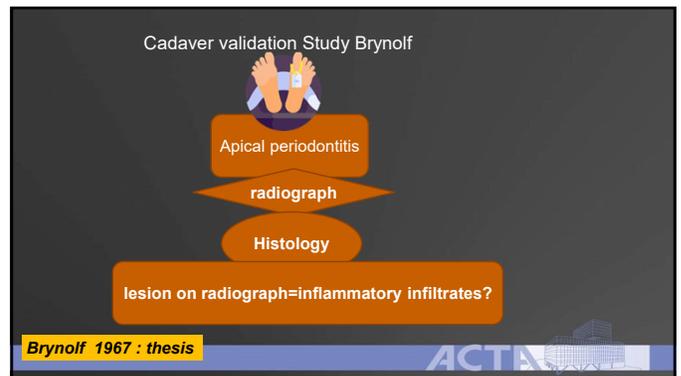
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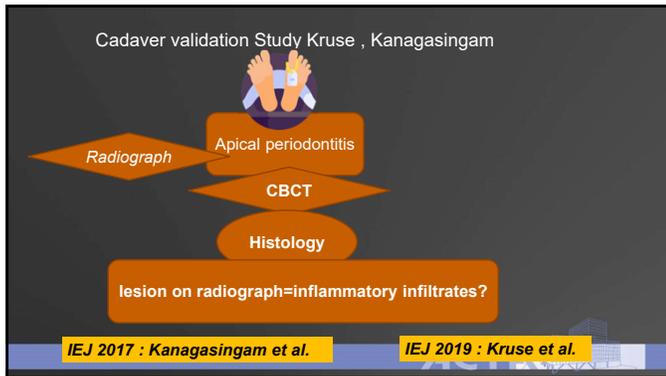
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Validation study No. 1

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

IEJ 2017 : Kanagasingam et al.

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

IEJ 2017 : Kanagasingam et al.

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

IEJ 2017 : Kanagasingam et al.

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What a relief !

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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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- 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.

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- 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.

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

Dentomaxillofac Radiology : Kruse et al.

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

- Conclusions: ... with 42% had no apical inflammation. ... resurgery.

**Overtreatment**

Tomorrow 15:00 Dr. Guillaume Jouanny

Dentomaxillofac Radiology : Kruse et al.

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

Meaning...

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- Beam Hardening and streaking artefacts
- Connective tissue healing

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NEW STUDY

- Selective retreatment



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Outcome of Selective Root Canal Retreatment - a retrospective study

JOÃO FILIPE BROCHADO MARTINS

*J. Brochado Martins, P. Diogo, O. Guerreiro Viegas, R. Cristescu, H. Shemesh*



IEJ 2023 : Brochado-Martins et al.

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Study parameters

- Patient-related parameters
- Tooth related parameters
- Treatment-related parameters
- Clinical and radiographic assessment (CBCT ? Radiographs!)

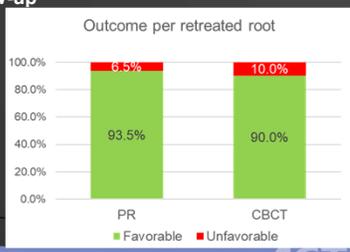


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Clinical and radiographic (PR and CBCT) outcome of selective root canal retreatment after ≥ 12 months follow-up

Outcome per retreated root



Assessment	Favorable	Unfavorable
PR	93.5%	6.5%
CBCT	90.0%	10.0%

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- Selective retreatment could be a reliable option even without a pre-operative CBCT

**CONCLUSION**

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**Remember**  
Technology evolves !

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Ultrasound examination for the detection of simulated periapical bone lesions in bovine mandibles: an ex vivo study.

IEJ 2020 : Musu, Dessalvi, Shemesh, Frenda Mercuri, Cotti

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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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#### Chapter FOUR

CBCT:

- Looking at shrinkage of the lesion rather than full healing
- Reliability in looking at periapical lesions in endodontically treated teeth
- Outcome of selective retreatments

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#### Chapter FIVE

- The elephant in the room

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Patel et al. Editorial- IEJ 2020  
Outcome of endodontic treatment- the elephant in the room

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The “elephant” is:

- “ the question whether asymptomatic apical periodontitis is an important disease, and whether persistent radiolucencies identified on CBCT images are associated with significant risks of local flare-up or systemic consequences, and if so, whether particular patient groups are at risk. These uncertainties become increasingly relevant as populations age ...”

IEJ 2020 : Patel et al.

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Apical Periodontitis Is Associated with Elevated Concentrations of Inflammatory Mediators in Peripheral Blood: A Systematic Review and Meta-analysis.

Conclusions: The existing literature indicates that AP adds on to systemic inflammation by elevating C-reactive protein, interleukin 6, asymmetric dimethylarginine, and C3 levels.

JOE 2019 : Giorgiou et al.

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The influence of apical periodontitis on circulatory inflammatory mediators in peripheral blood: A prospective case-control study.

Conclusions: The immunologic profile of chronic AP in one tooth and its healing profile reveals a systemic low-grade inflammation through compensatory immunosuppression. A larger lesion or multiple lesions could disrupt the balance that the system is trying to maintain, resulting in loss of homeostasis.

Tomorrow 11:15 Prof. E. Cotti

IEJ 2022 : Giorgiou et al.

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Individually designed treatments

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<p><b>Patient-centered outcome:</b> Quality of Life Costs/ pain Functionality</p>	<p><b>Disease-centered outcome:</b> Healing of the periapical lesion</p>
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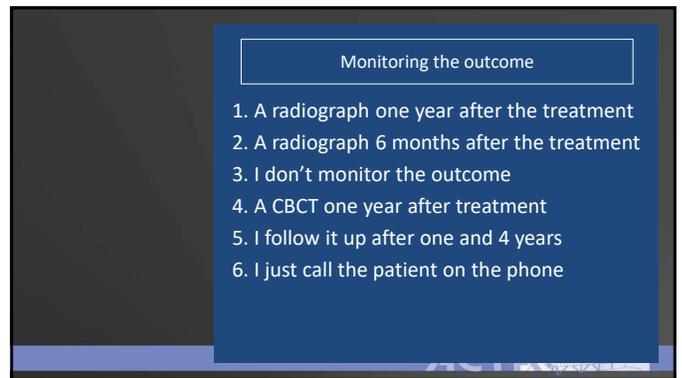
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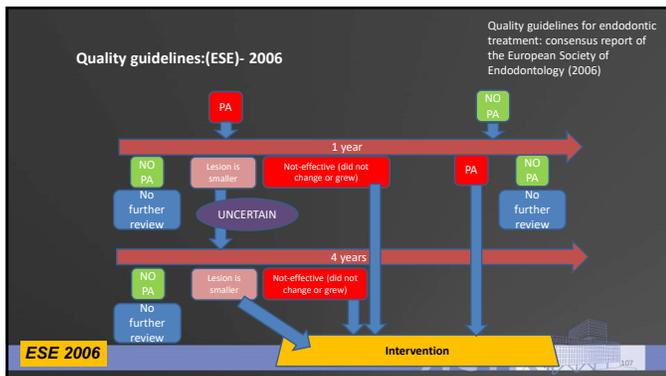
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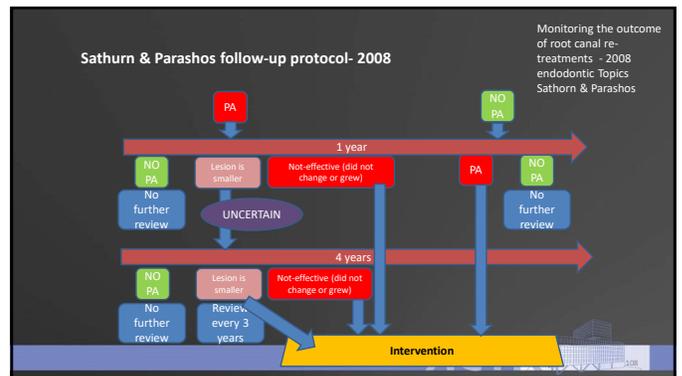
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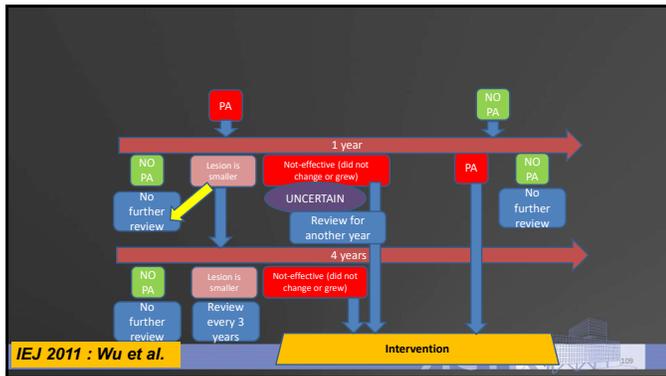
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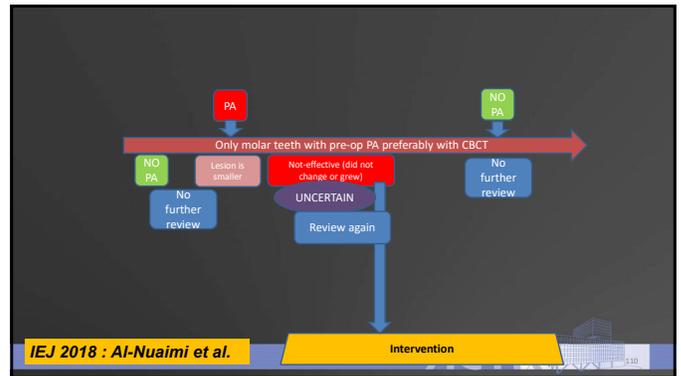
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ESE Guidelines on the Treatment of Pulpal and Apical Disease  
Steering Group  
Chairperson: Hal Duncan

ese

Today 16:00 Dr. Hal Duncan

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Chapter SIX

Monitoring the outcome:

- Different protocols, no consensus
- Ranges from not monitoring to 1,2,4 years

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Chapter SEVEN

The scoping reviews of 2022

JOE 2022 : Azarpazhooh et al. IEJ 2022 : Kirkevang et al.

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What is a "scoping review" ?

- Exploratory research project that systematically map the literature on a topic by identifying key concepts, theories and sources of evidence that inform practice in the field.
- Main objectives of scoping reviews are to identify gaps in the current research and highlight areas that require further inquiry.
- Systematic reviews ask a specific question and answer it by summarizing evidence that meets a set of pre-specified criteria.

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A scoping review of 4 decades of outcomes in nonsurgical root canal treatment, nonsurgical retreatment and apexification studies- Part 1,2,3

Highlights the diversity of studies and the inconsistency in reporting

JOE 2022 : Azarpazhooh et al.



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A core outcome set (COS) is an agreed standardized set of outcomes that should be measured and reported, as a minimum, in all clinical trials in specific areas of health or health care.

JOE 2022 : Azarpazhooh et al.



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Part 3: A proposed framework for standardized data collection and reporting of endodontic outcome studies



JOE 2022 : Azarpazhooh et al.



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Outcomes reporting in systematic reviews on non-surgical root canal treatment: A scoping review for the development of a core outcome set



IEJ 2022 : Kirkevang et al.



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- The presented information on reported outcomes, measurement tools and scales, and length of follow-up may guide the planning of future research and inform the development of a COS for non-surgical root canal treatment.

IEJ 2022 : Kirkevang et al.



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- Outcome studies are the essence of clinical studies in endodontology because they can give answers to most clinical questions
- Healing of the periapical lesion on radiograph is mostly used to assess the outcome
- Patient centered outcomes are also being used *(and should be used more often?)*
- CBCT as a new tool to assess outcome (limited!)
- Hopefully more uniform outcome studies will be conducted (COS)
- ESE will formulate new guidelines (for assessing the outcome)

IEJ 2022 : Kirkevang et al.



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