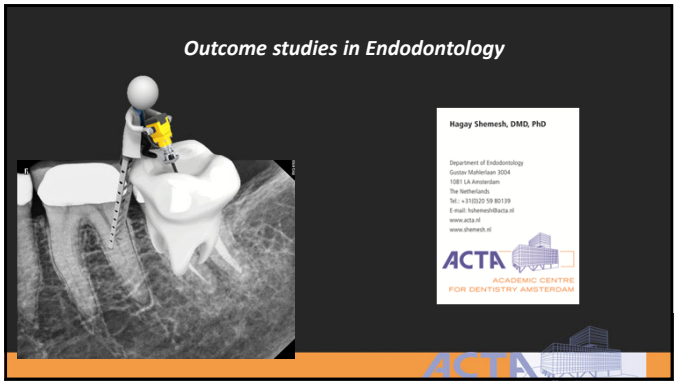

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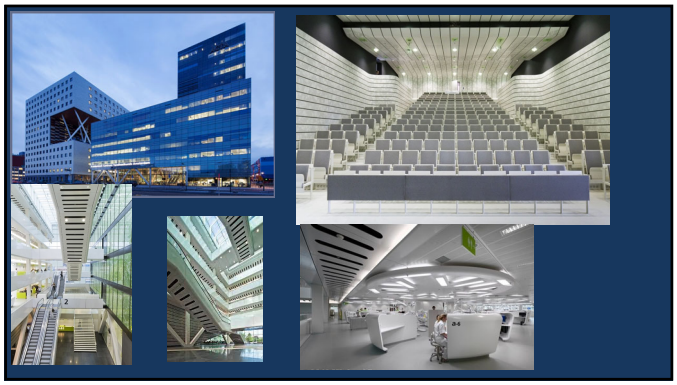


3

Program

- Outcome studies- Intro
- Lunch break
- Outcome studies PART 1= classical articles (Toronto, Ng)
- Outcome studies PART 2= CBCT
- Exercise
- Outcome studies APRT 3= Monitoring the outcome in my clinic
- Coffee break

4

Outcome studies in Endodontology

- Importance and general concepts
- Definitions
- The Toronto studies
- The Ng Studies
- CBCT studies
- How to assess an outcome study myself?

5

Why are OUTCOME studies so important ?

Which irrigation protocol?
Ultrasonic irrigation necessary?
Pulpotomy or direct pulp capping ?
Which file should I use?
Screening before bone marrow transplantation
Which obturation ?
Use calcium hydroxide?
MTA or Biodentine?
Which sealer?
Which concentration of hypochloride?
Bleaching with which material ?
Microscope necessary?
Follow up period ?
Perforations- what to do?
Pulpotomy or pulpectomy?
CBCT before every treatment?
Full crown of composite ?
To re-treat or not to re-treat?
Broken instruments- what to do ?

6

- The Association between Choice of Diagnostic Imaging Modality and Long-term Treatment Outcomes for Patients Undergoing Nonsurgical Root Canal Treatment on Maxillary First Molars

Ptak et al. J Endod 2021

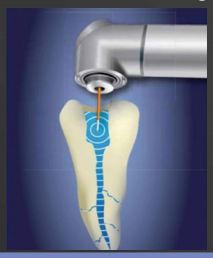
The decision to use CBCT imaging appears to serve as a proxy for case complexity and the associated increase in risk of posttreatment disease. This is important to keep in mind when assessing treatment prognosis.

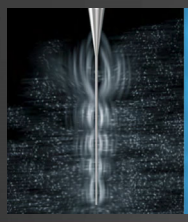
7

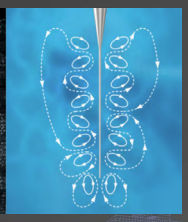
- Outcome studies show us sometimes how careful we must be when making clinical recommendations based on in-vitro studies

8

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







9

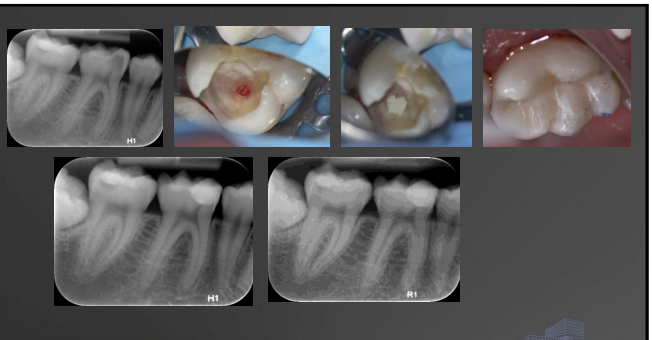
Căpută PE et al. J Endod. **2019**

…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…

10



11

Outcome was mostly determined by radiographs.

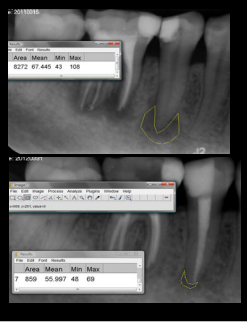
Evidence shows that radiographs show only half of the truth…

12

- **Radiographic success: half true half false**
  - **Evidence:**
- Absence of AP on radiograph: half true half false or 2/3 true 1/3 false (Brynolf 1967, Barthel et al. 2004)..
- Absence of AP on radiograph: 60% true 40% false (Estrela et al. 2008, Christiansen et al. 2009).

13

How do we measure/ determine healing?

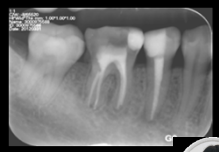


-Qualitative (strict)
-Simple measurements
-Scoring systems
-PAI
-CBCT-PAI
-3D measurements

14

Qualitative assessment

- Healed or not healed ("strict criteria") –
- no measurement of the lesion, just present or absent.



Who used this system ?
Ng et al. 2011

15

Advantages

- Quick and cheap method
- Gives clinically relevant information

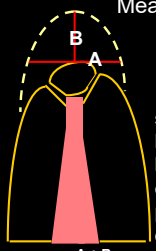
16

Disdvantages

- Subjective
- No meaning for "shrinkage"
- On CBCT- lower healed rate on teeth with pre-treatment lesions (Liang et al. 2012: less than 50% after 2 years)

17

Measurement of periapical lesions



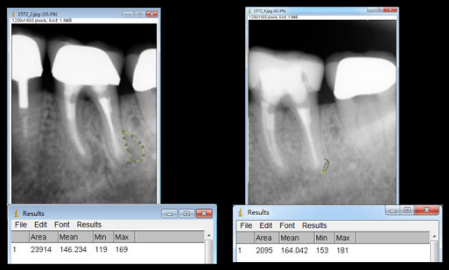
size of each lesion was calculated by taking the average of the lesion's largest dimension and its extent in the direction perpendicular to the largest dimension.

$$\text{Size} = \frac{A + B}{2}$$

Sjorgen et al. JOE 1990

18

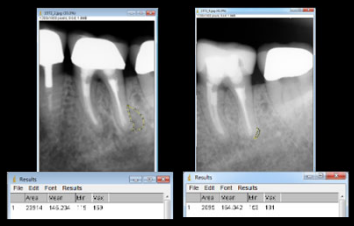
Measurement of periapical lesions



19

Advantages

- Cheap method
- Quantitative



20

Disdvantages

- Time consuming
- Not accurate- difficult to standardize

21

Scoring systems

- Periapical scores for treatment outcome. Periapical destruction:
- 1= definitely NOT present
- 2= probably NOT present
- 3= unsure
- 4= probably present
- 5= definitely present

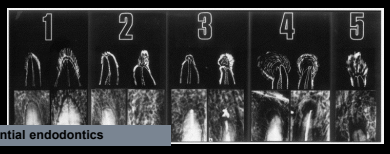
Who used this system ?
Peters & Wesselink 2002

Reit & Gröndahl IEJ 1983

22

PAI Score

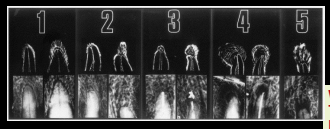
- PAI score (Ørstavik et al. 1986)
- "The PAI scoring system offers a visual reference scale for assigning a health status to the periapex. "



Essential endodontics

23

- In order to evaluate periapical section according to the PAI score, you have to compare periapical radiographs with a set of 5 radiographic images derived from Brynolf's histological-radiographic correlation study

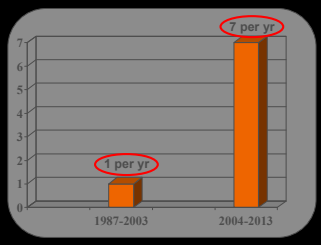


Who used this system ?
The Toronto studies
Marending et al. 2005
And
More than 70 studies !

Brynolf, 1967

24

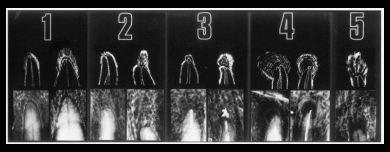
PAI has been used in more than 70 outcome studies since 1987



25

Advantages

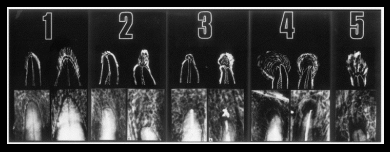
- Relatively easy to perform
- Many studies and experience with this method
- Uniformity



26

Disadvantages

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

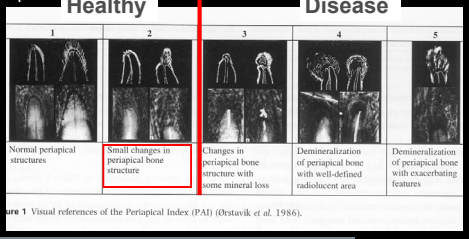


27

"Scores 2 to 5 represent increasing extent and severity of apical [illegible]."

Toronto studies 2003-2006
Healed: PAI ≤ 3

Healthy | Disease



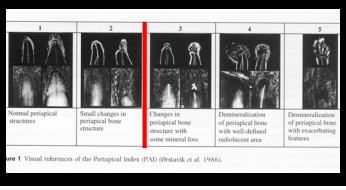
ure 1 Visual references of the Periapical Index (PAI) (Ørstavik *et al.* 1986).

Ørstavik et al. Endod Dent Traumatol 1986

28

Prognostic value of the full-scale Periapical Index. Kirkevang et al. Int Endod J. 2014

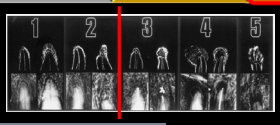
Repeated radiographic assessments of teeth using the full-scale PAI reveal that each of the five scores had distinct prognostic value for the course of periapical disease …



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

29

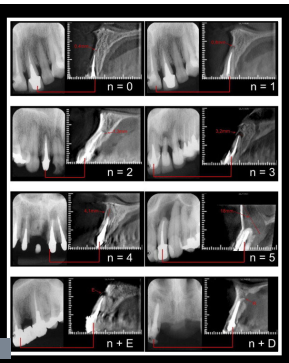
Success=	PAI 1+2	PAI 1
ALL	90	58
NO Pre-op PA	94	70
Pre-op PA	79	26



Ørstavik et al. *Eur J Oral Sci* 2004

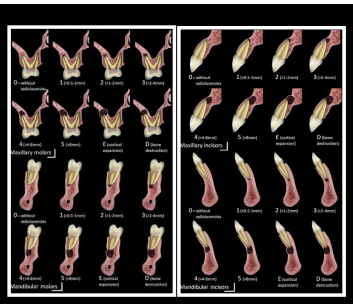
30

The CBCT-PAI score



Estrella et al. JOE 2008

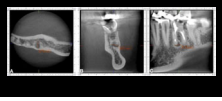
31



Estrella et al. JOE 2008

32

The sizes of radiolucent periapical lesions were measured on CBCT scans in 3 dimensions: buccopalatal, mesiodistal, and diagonal . The CBCT-PAI was determined by the largest extension of the lesion. A 6-point (0–5) scoring system was used.

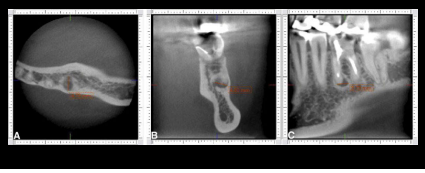


Who used this system ?
Esposito et al. 2011

33

Advantages

- Based on findings from all teeth
- Based on 3D information
- Take 3 planes into consideration



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Disadvantages

- Measurements are still based on personal interpretation and 2D concepts
- Radiation
- Artifacts like metal posts and radiodense materials
- Time consuming

35

3D volume measurements

1. Threshould technique
2. The expansion technique

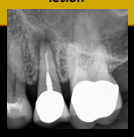
Who used this system ?
Metska et al. 2013
Van der Borden et al. 2013

36

Terminology

Patient-centered outcome: Survival, functionality

Disease-centered outcome: Healing of the periapical lesion



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Outcome terminology

- Success & failure
  - Too general ?
- Healing & healed
  - Disease centered
- Effective & ineffective
  - Patient centered
- Favourable and unfavourable outcome
  - Too general ?
- Survival & Functionality
  - Patient centered

38

So how do <u>you</u> assess the results of your endodontic treatments ?

39

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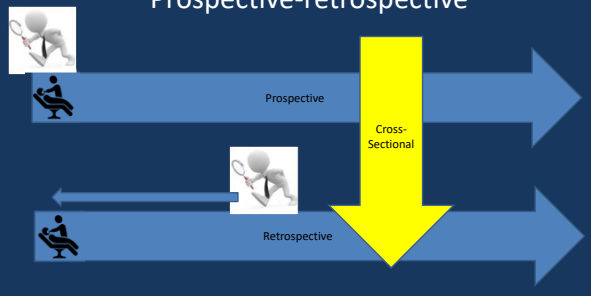
Prospective-retrospective



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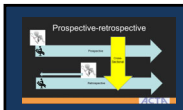

- Advantage of prospective : all treatment factors could be controlled and planned- fewer potential sources of bias and confounding
- Advantage of retrospective: easier to preform because you look at charts of previous patients

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Toronto studies

43

The Toronto Study Project, established in 1993, is a continuous prospective investigation of the 4- to 6-year outcome of endodontic treatment performed by graduate endodontics students in a university clinic environment.

Patient recall has been divided into 2-year phases.

This modular design provides cumulative data with the completion of each successive phase, with the aim of amassing a sufficient sample to study the prognostic value of various factors.

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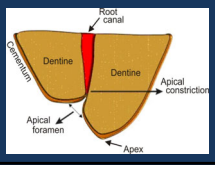
TERMS

- NO success or failure !!!
- Healed and healing
- Functional
- Difference between functional and survival



45

Toronto studies - JOE

1. Treatment outcome in endodontics: the Toronto Study. Phase 1: initial treatment. Friedman S, Abitbol S, Lawrence HP. 2003
2. Treatment outcome in endodontics- the Toronto Study. Phase II: initial treatment. Farzaneh M, Abitbol S, Lawrence HP, Friedman S. 2004
3. Treatment outcome in endodontics: the Toronto study. Phases I and II: Orthograde retreatment. Farzaneh M, Abitbol S, Friedman S. 2004
4. Treatment outcome in endodontics- The Toronto Study. Phases I and II: apical surgery. Wang N, Knight K, Dao T, Friedman S2004
5. Treatment outcome in endodontics: the Toronto Study. Phase III: initial treatment. Marquis VL, Dao T, Farzaneh M, Abitbol S, Friedman S. 2006
6. Treatment outcome in endodontics: the Toronto study--phases 3 and 4: orthograde retreatment. de Chevigny C, Dao TT, Basrani BR, Marquis V, Farzaneh M, Abitbol S, Friedman S. 2008
7. Treatment outcome in endodontics: the Toronto study--phase 4: initial treatment. de Chevigny C, Dao TT, Basrani BR, Marquis V, Farzaneh M, Abitbol S, Friedman S. 2008
8. Treatment outcome in endodontics: the Toronto study--phases 3, 4, and 5: apical surgery. Barone C, Dao TT, Basrani BB, Wang N, Friedman S. 2010

46

- Accumulation of results mean that the last 3 articles that report the accumulated results of all phases are the most important in terms of results and outcome predictors

6. Treatment outcome in endodontics: the Toronto study--phases 3 and 4: orthograde retreatment. de Chevigny C, Dao TT, Basrani BR, Marquis V, Farzaneh M, Abitbol S, Friedman S. 2008
7. Treatment outcome in endodontics: the Toronto study--phase 4: initial treatment. de Chevigny C, Dao TT, Basrani BR, Marquis V, Farzaneh M, Abitbol S, Friedman S. 2008
8. Treatment outcome in endodontics: the Toronto study--phases 3, 4, and 5: apical surgery. Barone C, Dao TT, Basrani BB, Wang N, Friedman S. 2010

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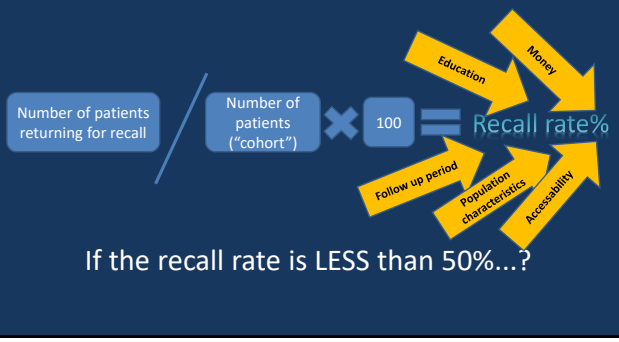
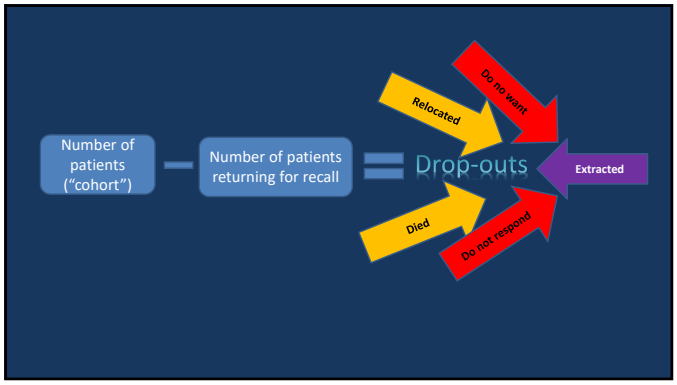


If the recall rate is LESS than 50%...?

48



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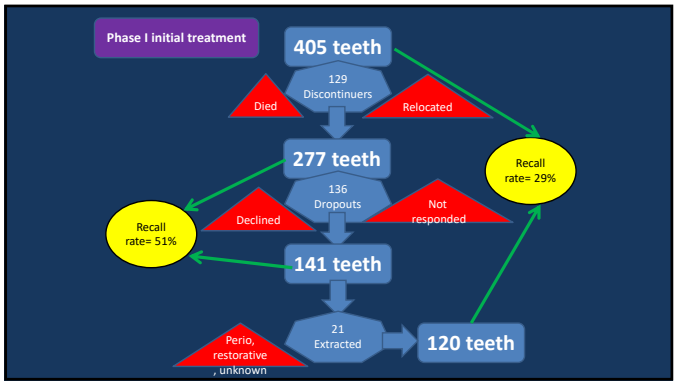
Calculation of recall rate by Friedman Phase I –initial treatment

- **INCEPTION COHORT**: **405** teeth in 350 patients
- **DISCONTINUED**: deceased or relocated and could not be reached : 128 teeth. They are EXCLUDED from the cohort. We remain with 405-128= 277
- **DROPOUTS**: Declined or did not respond : 136 teeth, of the 277
- **RESPONDING :** 277-136= 141
- **RECALL RATE:** 51% of the 277
- **STUDY SAMPLE**= RESPONDING – EXTRACTED

50



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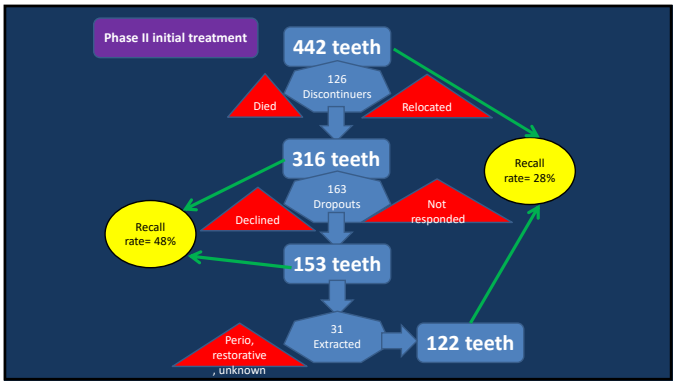

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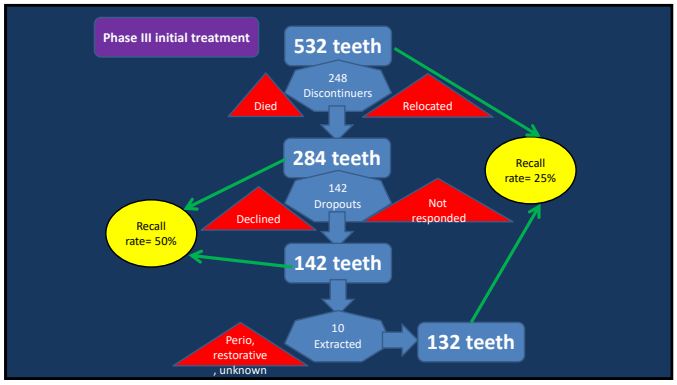

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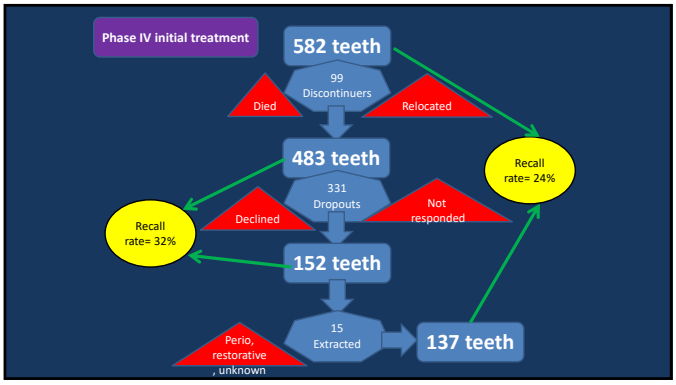
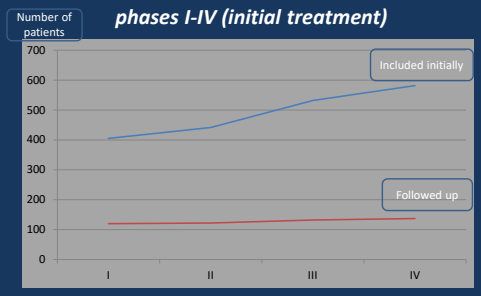


54

"Erosion of patient population"

phases I-IV (initial treatment)



55

"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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Came for the recall

Drop-outs

Population diversity : age, sex, smokers
Tooth characteristics : Type, diagnosis

57

Results- Toronto studies

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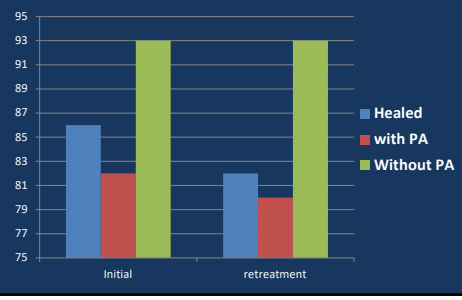
Outcome phases 1-4

Healed precentage



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Conclusions Toronto studies

- Importance
- Methodology
- Relevance
- Future

60

The Ng Studies

61

Ng studies- IEJ

1. "Outcome of primary…part 1 " Ng, Mann, Rahbarab, Lewsey & Gulabivala 2007
2. "Outcome of primary…part 2 " Ng, Mann, Rahbarab, Lewsey & Gulabivala 2007
3. "Outcome of s… Ng, Mann & Gulabivala 2008
4. "Tooth survival…" Ng, Mann & Gulabivala 2010
5. "A prospective study…part 1 "- Ng, Mann & Gulabivala 2011
6. "A prospective study…part 2 "- Ng, Mann & Gulabivala 2011

Reviews

Outcome studies

62

A prospective study of the factors affecting outcomes of nonsurgical root canal treatment: part 1: periapical health. - Ng, Mann & Gulabivala 2011

- The goal was to identify the prognostic factors for root canal (re) treatment.
- Observational design : factors cannot be controlled but only accounted for.
- All patients undergoing RCT of retreatment from 1st October 1997 until June 2005. By residents in Eastman. (Toronto : 1993-2001)
- Excluded from the study: perio or if the apex was not discernible on the x-ray
- Excluded from the analysis: follow-up less than 2 years, extracted, not enough data

63

- All treatments with anesthesia
- Various instrumentations
- GP + Roth canal sealer
- Various filling techniques
- Was magnification (microscope) used ?!

64

Classification

- Preoperative: 1. intact PDL 2. Widened PDL, 3. Lesion
- Diameter of the lesion measured with a ruler
- Diameter of widened PDL 0.5 mm

65

Outcome measurements

- Ng does not agree with Friedman and contantly uses the term "success rate".
- Primary: Clinical and radiographic : absebce or healing of lesion for each root
- Secondary: survival
- Succeess: 1.strict criteria : no pain, sympthoms and complete healing
- 2. Loose criteria- healing lesion.

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PAI score

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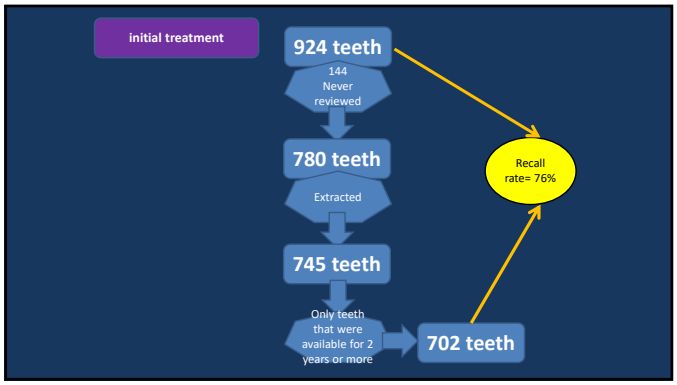
Numbers

- Total: 924 teeth for initial treatments and 1113 teeth for retreatments

	Initial-Ng		Retr-Ng	
Cohort	924		1113	
Analysis	702		750	

68



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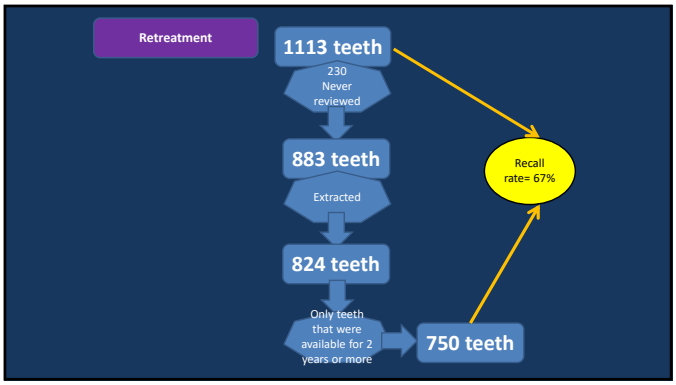

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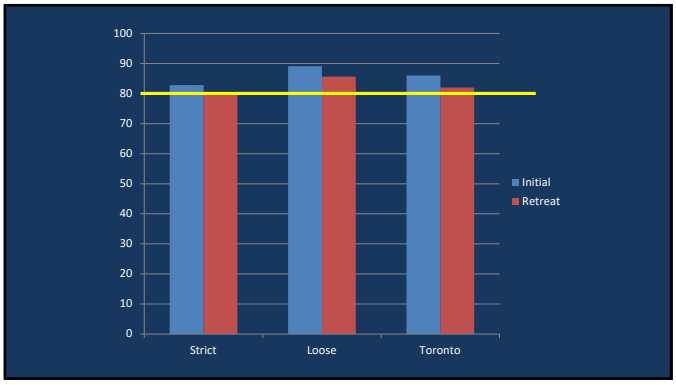
Results Ng

	Initial	retreatment
Strict	82,8	80,1
Loose	89,1	85,6
Toronto pooled	86	82

71



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The root as a unit

- Friedman claimed that you SHOULD NOT use the root as a unit of measure because it had a tendency to OVERESTIMATE success.
- This study and Hoskinson et al. 2002 do not support this.
- Reason: root-level independent variables are more relevant

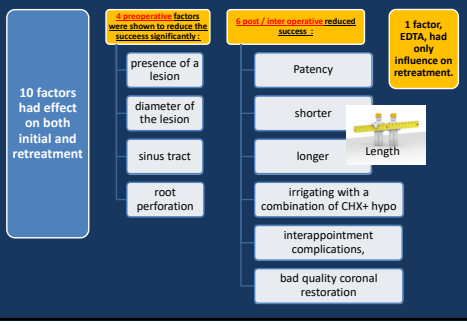
73

Sensitivity of the radiographs

- CBCT

74

Factors



75

On what do Ng and Friedman dissagree?

- Root level- tooth level
- PAI score
- Calculation of the recall rate
- Factors

Still, their results are similar !!!

76

The Ng Studies II : Survival

77

Definitions

- Survival –time to extraction after RCT
- Functional survival (Friedman & Mor 2004)

78

Tooth survival- Review (2010)

1966-2007

31 articles identifies, 14 included

Pooled survival 2-10 years 86-93%

79

Questions

- Why are there so few studies on survival compared to studies on healing of periapical lesion ?
- Sample size is larger than studies on periapical healing. Why ?
- Influence of follow up time on the survival. Pooled results for 3-10 years but if you look at 8-10 years it is lower than 2-4 years.

80

Endodontic treatment outcomes in a large patient population in the USA: an epidemiological study.

Salehrabi R, Rotstein. JOE 2004

- outcomes of initial endodontic treatment done in 1,462,936 teeth of 1,126,288 patients from 50 states across the USA was assessed over a period of 8 yr.
- Overall, 97% of teeth were retained in the oral cavity 8 yr after initial nonsurgical endodontic treatment.
- In conclusion, it appears that initial nonsurgical endodontic treatment is a predictable procedure with high incidence of tooth retention after 8 yr.

81

Problems

- Tooth exists in the mouth.
- But in which condition? Unclear (but irrelevant for “survival”)
- No prognostic factors checked

82

Prognostic factors influencing survival

according to the review :

- 1. Crown restoration
- 2. Proximal contacts
- 3. Not an abutment
- 4. non-molar teeth

83

Tooth survival- Study (2011)

- Follow up 2-4 years
- Initial treatment & retreatment
- Initial : 95%
- Retreatment: 95%
- 13 prognostic factors were identified

84

- "The extraction outcome was reported either by the patient at the follow-up appointment, or without their attendance by phone or letter through the patient or referring dentist "
- Is this a big limitation ???
- No, because the recall rate was high.

85

Prognostic factors

- Diabetes
- Steroid therapy
- Probing depth
- Pain
- Discharging sinus tract
- Perforations (2nd treatment only)
- Perforations
- Patency
- Extrusion of filling material
- Cast restoration vs. temporary
- Post & core
- Proximal contacts
- Terminal location of the tooth

Patient factors

Pre-op factors

Intra-op factors

Post-op factors

- 1. Crown restoration
- 2. Proximal contacts
- 3. Not an abutment
- 4. non-molar teeth

Periapical healing

86

Why was the most important factor for healing (*pre-op periapical lesion) NOT a factor for survival ?

- "A mere presence of a periapical lesion was NOT a sufficient reason for active treatment" (Reit & Gröndahl 1988)

87

Conclusions Ng studies

- Importance
- Methodology
- Relevance
- Future

88

89

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Outcome studies with CBCT


International Endodontic Journal

EDITORIAL

Shanon Patel[1], Francesco Mannocci[1], Hagay Shemesh[2], Min-Kai Wu[2], Paul Wesselink[2] and Paul Lambrechts[3]

[1]Department of Conservative Dentistry, King's College London Dental Institute, London, UK, [2]Department of Cariology and Endodontology, ACTA, Amsterdam, the Netherlands and [3]Department of Dentistry, Section of Endodontology, K.U.Leuven, Leuven, Belgium

Radiographs and CBCT – time for a reassessment?

International Endodontic Journal

REVIEW

Limitations of previously published systematic reviews evaluating the outcome of endodontic treatment

M-K. Wu, H. Shemesh & P. R. Wesselink

Department of Endodontology, Academic Centre of Dentistry Amsterdam (ACTA), University of Amsterdam and VU University, Amsterdam, The Netherlands

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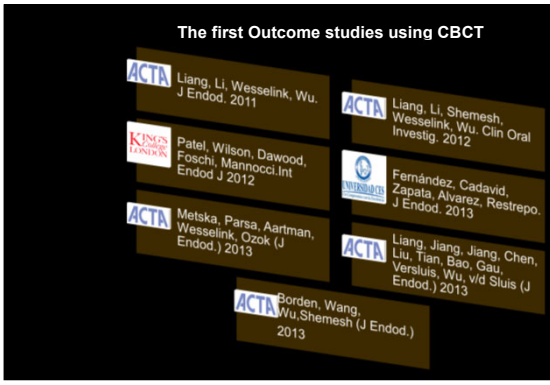
The first Outcome studies using CBCT



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INTERNATIONAL ENDODONTIC JOURNAL

The detection of periapical pathoses using digital periapical radiography and cone beam computed tomography in endodontically retreated teeth – part 2: a 1 year post-treatment follow-up

A. Davies[1], S. Patel[1], F. Foschi[1], M. Andiappan[2], P. J. Mitchell[3] & F. Mannocci[1]

[1]Department of Endodontology, Kings College Dental Institute at Guy's King's and St Thomas' Hospital, London, and [2]Statistics and Research Methods Centre, Kings College Dental Institute, London, UK

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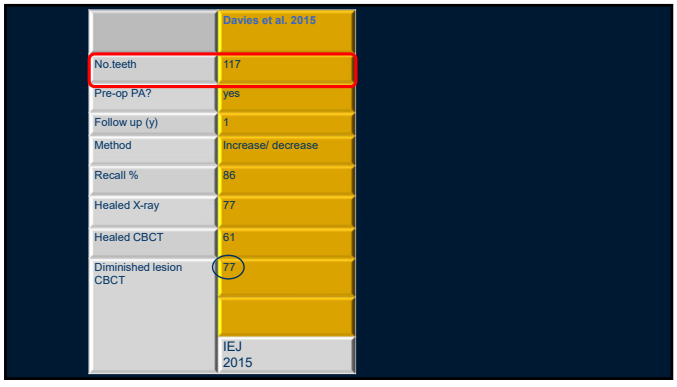

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ESE guidelines advise 1 year follow up

- Due to the generally high number of favourable outcomes, and the insensitivity of radiogrphs in detecting unfavourable outcomes it is reasonable to question whether a 1 year follow up with radiographs is justified especially in cases with small/ no pre-op radiolucencies

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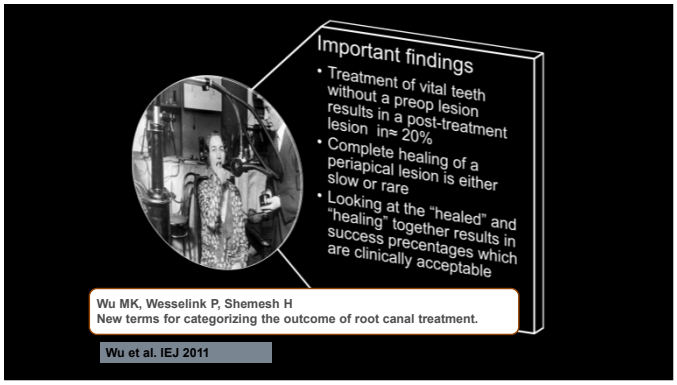

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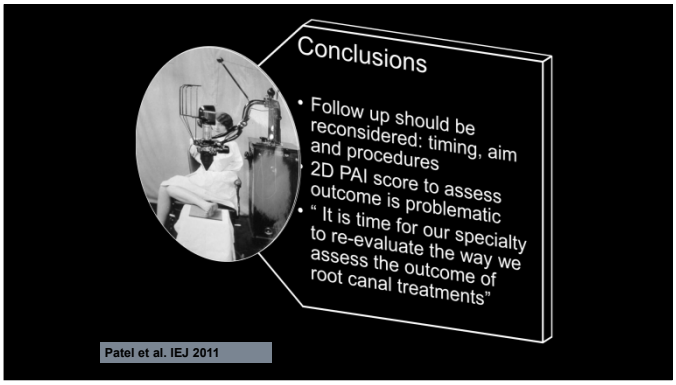

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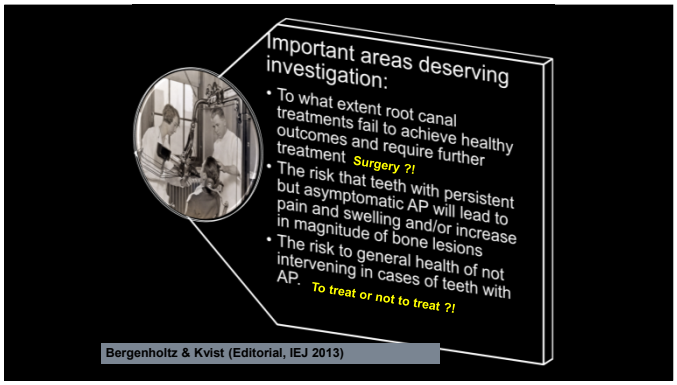

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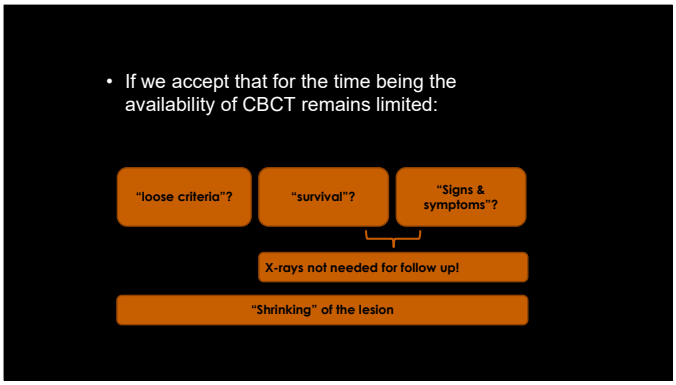

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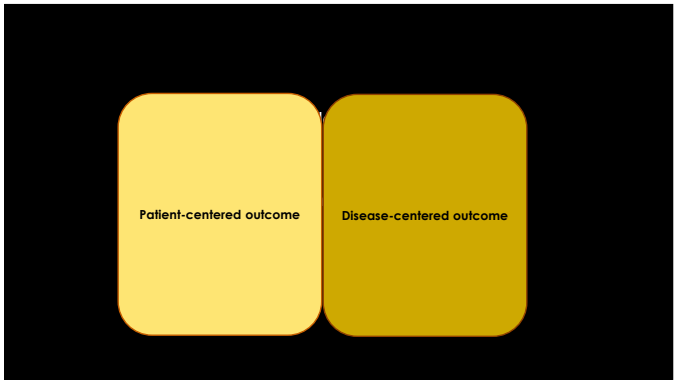

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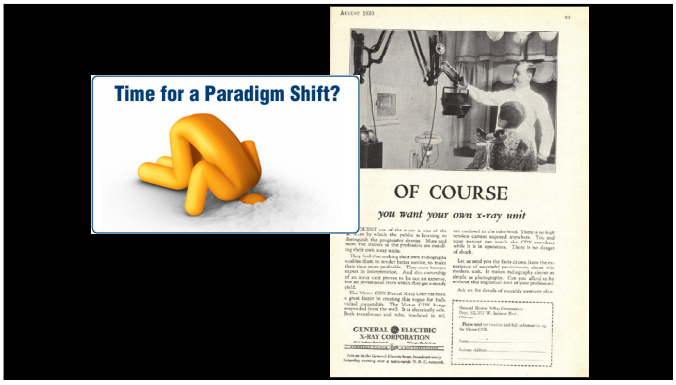

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Limitations of CBCT should be taken into consideration:

- Cost
- Radiation
- Time
- Software

103

Clin Oral Investig. 2014
Two- and tridimensional analysis of periapical repair after endodontic surgery.
Tanomaru-Filho et al.

Repair of 73 % was obtained after 8 months

104

CBCT and periapical lesions: a systematic review analysing studies on diagnostic efficacy by a hierarchical model.
Kruse C, Spin-Neto R, Wenzel A, Kirkevang LL.
Int Endod J. 2014

- Most clinical studies with CBCT have no golden standard (histology)
- No evidence that CBCT affects the prognosis of the treatment
- Cost-benefit of a CBCT as a diagnostic tool for periapical lesions

105

IEJ 2017
Pooled analysis of 1-year recall data from three root canal treatment outcome studies undertaken using CBCT

N. Al-Nuaimi et al.

- The **outcomes** assessed with CBCT is always worse when assessed with CBCT

- Because of the very high favourable outcomes of anterior & premolar teeth future outcome studies shou,d focus on molar teeth with CBCT

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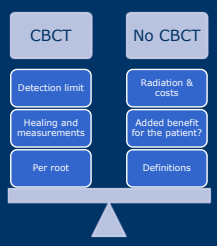
Why *(not) evaluate* outcome with CBCT ?

For :
Patel & group
Wu/Liang & group
Von Arx

Against:
Tsesis (Rosen et al. 2015)
Kirkevang (Kruse et al. 2015)
Pope et al. 2013



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Summary

- Toronto studies
- Ng studies
- CBCT studies
- Outcome terminology and measurements
- Recall rate
- Outcome of root canal treatment

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Now ***you*** :
Assess the following outcome article by yourself!

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Long-term Outcomes of Endodontic Treatment Performed with Resilon/Epiphany

Strange et al. 2019

Read it in www.shemesh.nl (see " seminars and lectures")

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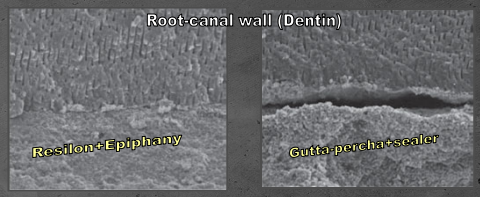
Resilon-Epiphany

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



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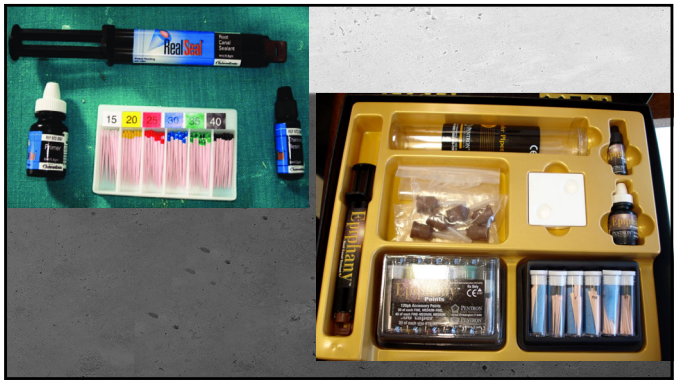

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"monoblock" concept

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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
Diferent conditions and models!	Pasqualini et al. 2007	Baumgartner *et al.* 2007

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Number of teeth originally	
Number of teeth at recall	
Recall rate	
Follow-up period	
Operator (who performed the treatments?)	
Radiographs or CBCT ?	
Outcome terminology (success ? healed ? …)	
Outcome measurement (PAI, strict, shrinking…)	
Results :	
HEALED (“success”)	
Conclusions	

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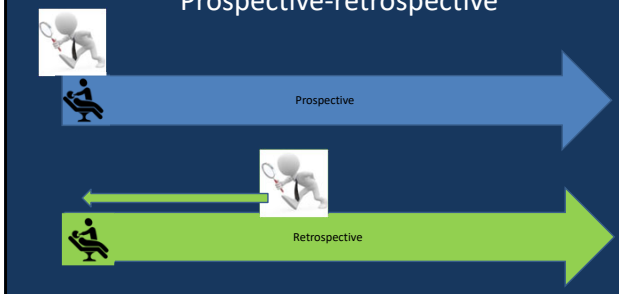
Prospective-retrospective



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Number of teeth originally	
Number of teeth at recall	
Recall rate	
Follow-up period	
Operator (who performed the treatments?)	
Radiographs or CBCT ?	
Outcome terminology (success ? healed ? …)	
Outcome measurement (PAI, strict, shrinking…)	
Results :	
HEALED (“success”)	
Conclusions	

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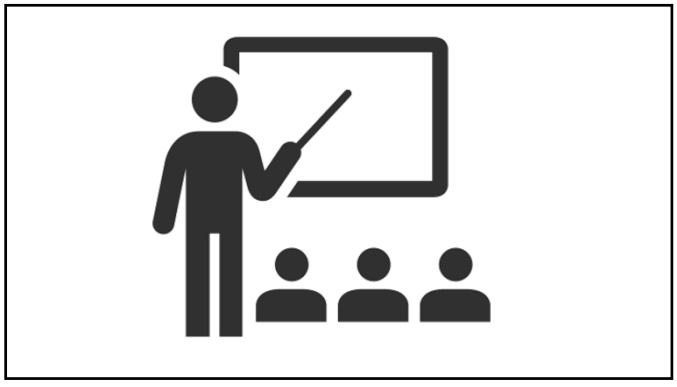

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So how do ***you*** monitor the results of your endodontic treatment?

120

Monitoring the outcome

1. A radiograph one year after the treatment
2. A radiograph 6 months after the treatment
3. I don't monitor the outcome
4. A CBCT one year after treatment
5. I follow it up after one and 4 years
6. I just call the patient on the phone

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- Monitoring the outcome of root canal re-treatments - 2008 endodontic Topics
- Sathorn & Parashos


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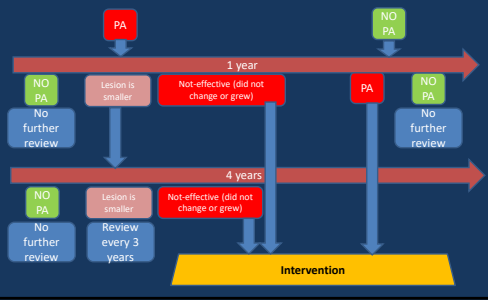
Non-surgical retreatment :(Sathurn & Parashos follow-up protocol)



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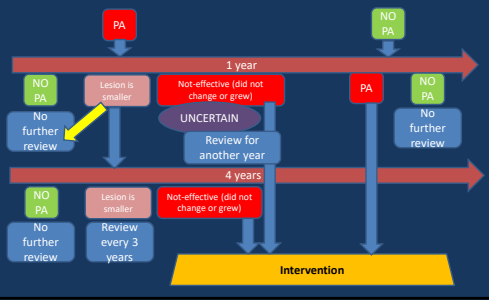
Effectivity (Wu, Shemesh, Wesselink)- 2011



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Take home message

- 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!)
- Important concepts of outcome assessment were discussed

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Editorial
Outcome of endodontic treatment – the elephant in the room
S. Patel et al. International Endodontic Journal 2020

www.shemesh.nl

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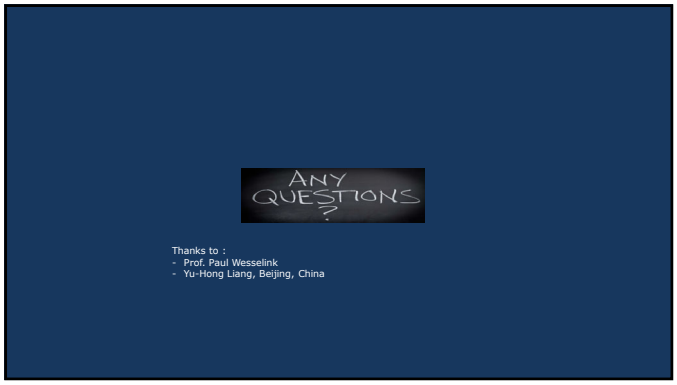

Thanks to :
- Prof. Paul Wesselink
- Yu-Hong Liang, Beijing, China

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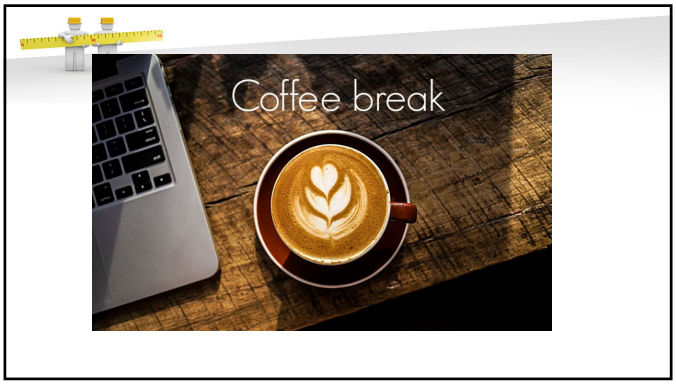

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