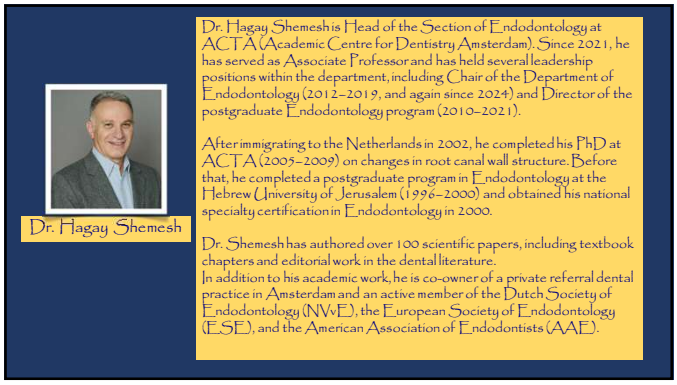
Dr. Hagay Shemesh is Head of the Section of Endodontology at ACTA (Academic Centre for Dentistry Amsterdam). Since 2021, he has served as Associate Professor and has held several leadership positions within the department, including Chair of the Department of Endodontology (2012–2019, and again since 2024) and Director of the postgraduate Endodontology program (2010–2021).
After immigrating to the Netherlands in 2002, he completed his PhD at ACTA (2005–2009) on changes in root canal wall structure. Before that, he completed a postgraduate program in Endodontology at the Hebrew University of Jerusalem (1996–2000) and obtained his national specialty certification in Endodontology in 2000.
Dr. Shemesh has authored over 100 scientific papers, including textbook chapters and editorial work in the dental literature.
In addition to his academic work, he is co-owner of a private referral dental practice in Amsterdam and an active member of the Dutch Society of Endodontology (NVvE), the European Society of Endodontology (ESE), and the American Association of Endodontists (AAE).
Dr. Hagay Shemesh

1


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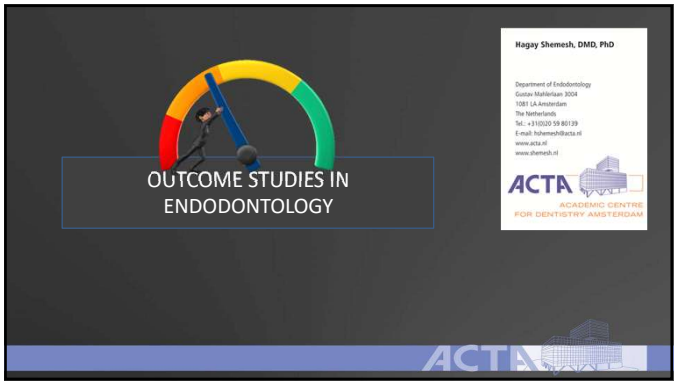
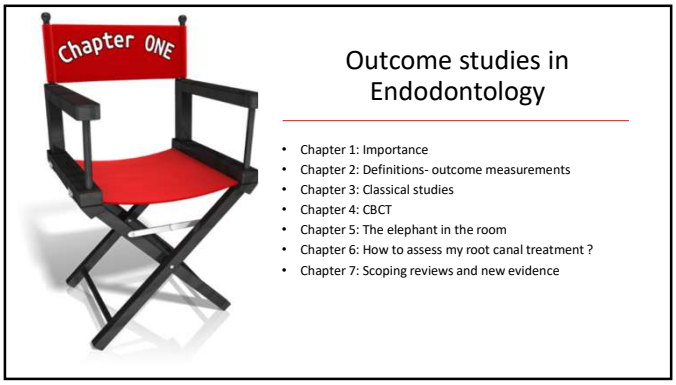
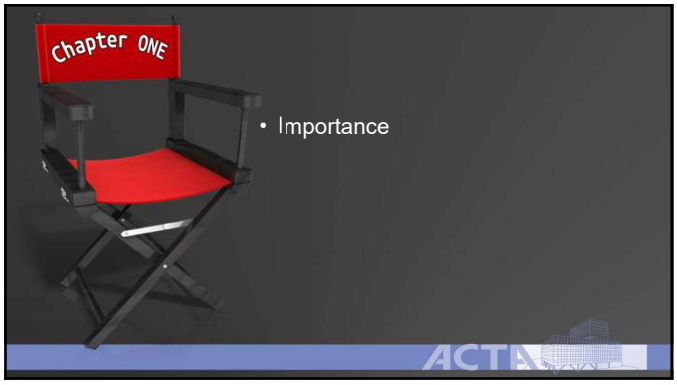

OUTCOME STUDIES IN ENDODONTOLOGY
Hagay Shemesh, DMD, PhD
ACTA
ACADEMIC CENTRE FOR DENTISTRY AMSTERDAM

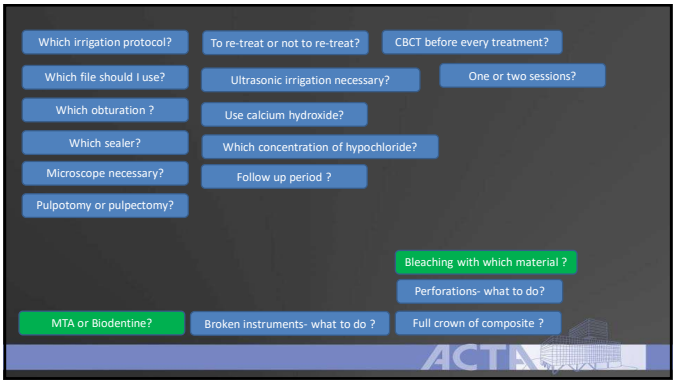
3


Chapter ONE
Outcome studies in Endodontology
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: Scoping reviews and new evidence

4


Chapter ONE
Importance

5


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

6

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

Example : ultrasonic irrigation

7

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.

8

JOE 2019 : Căpută et al.

" …no strong clinical recommendations could be formulated"

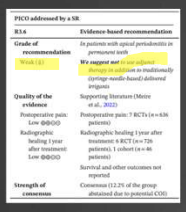
BDJ 2019 : Silva et al.

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

9

Effectiveness of adjunct therapy for treatment of apical periodontitis (R3.6)

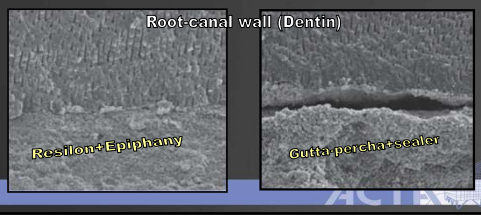
LAI, PIPS, Ultrasonic, Sonic…



10

Resilon-Epiphany

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



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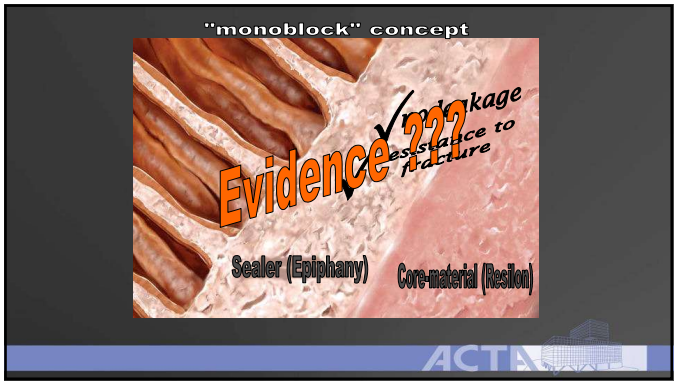

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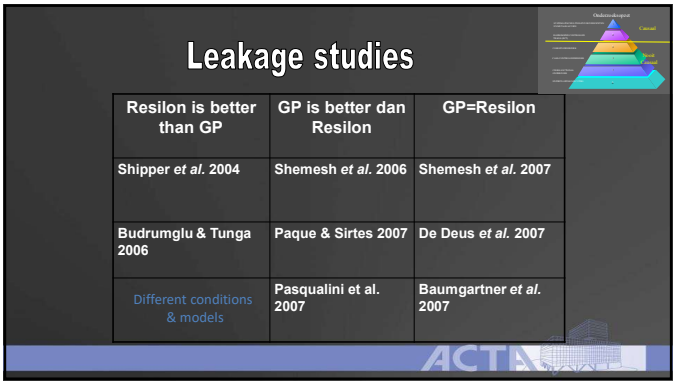

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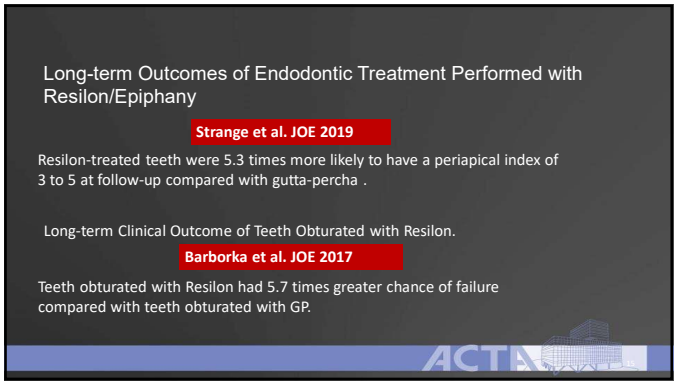

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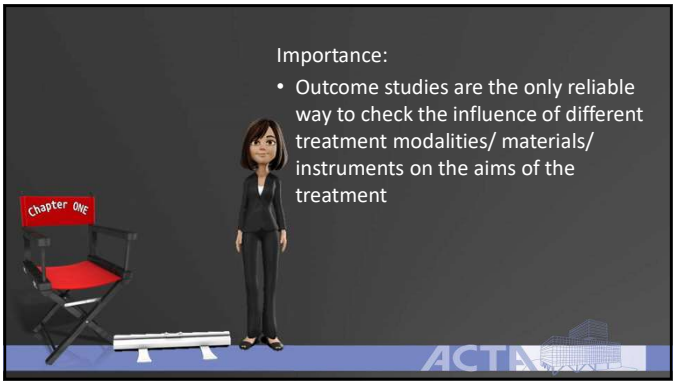

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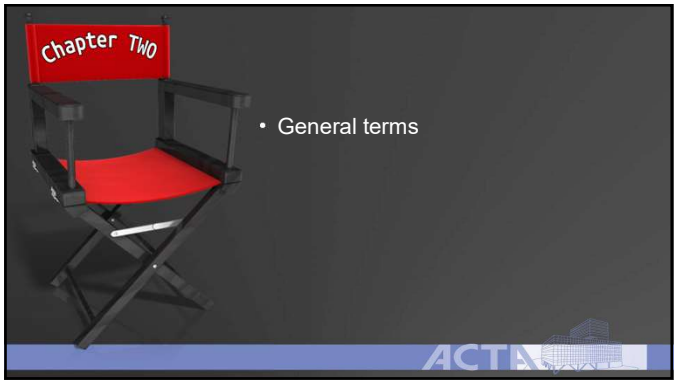

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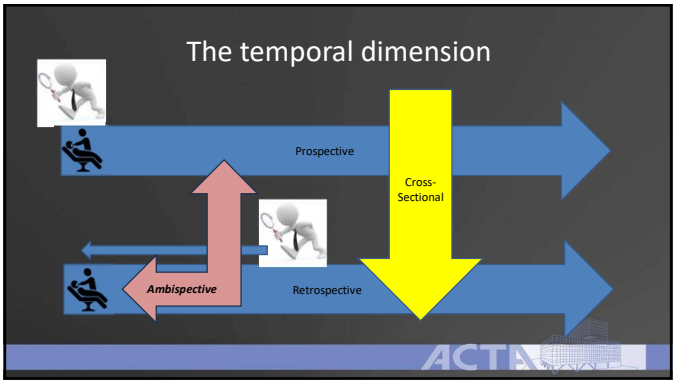

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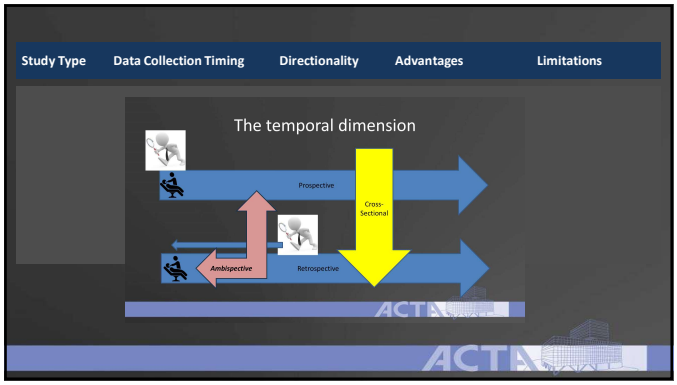

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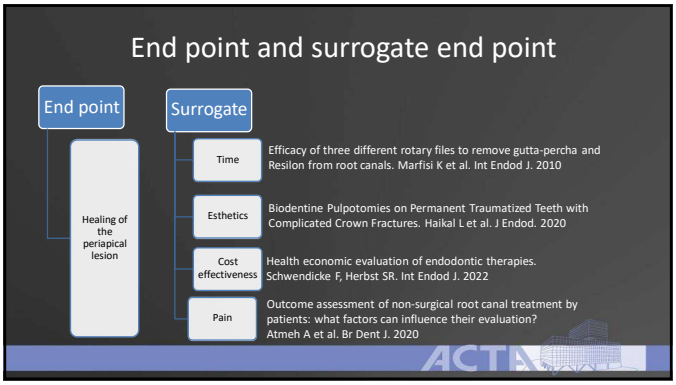

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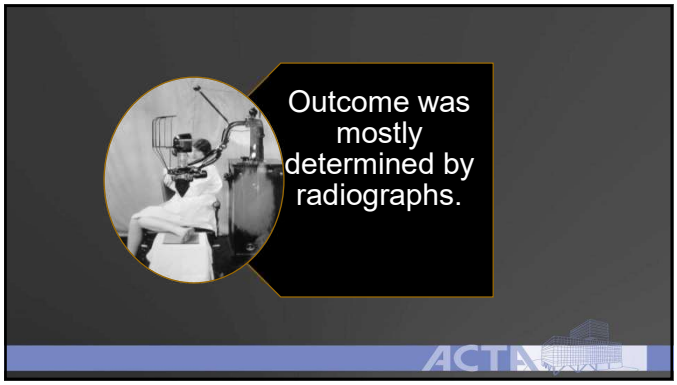

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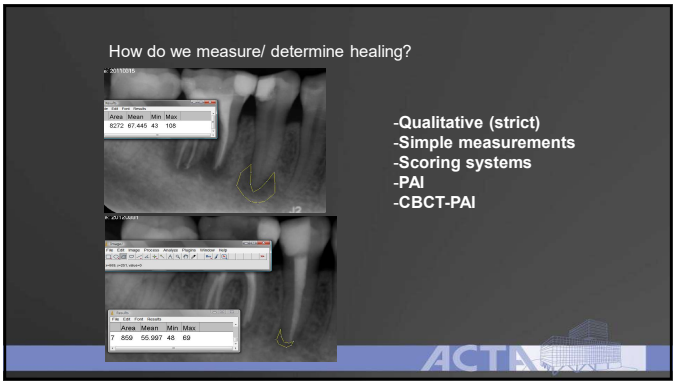

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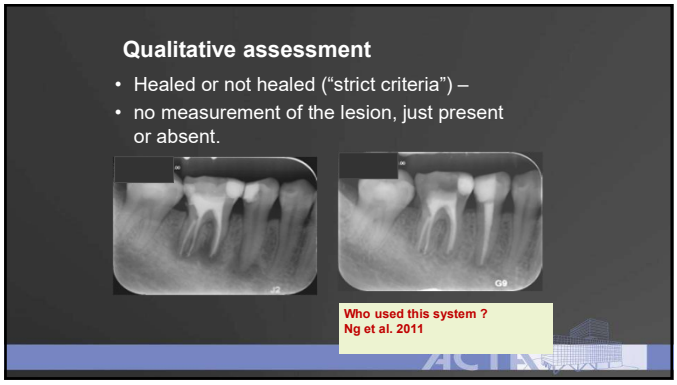

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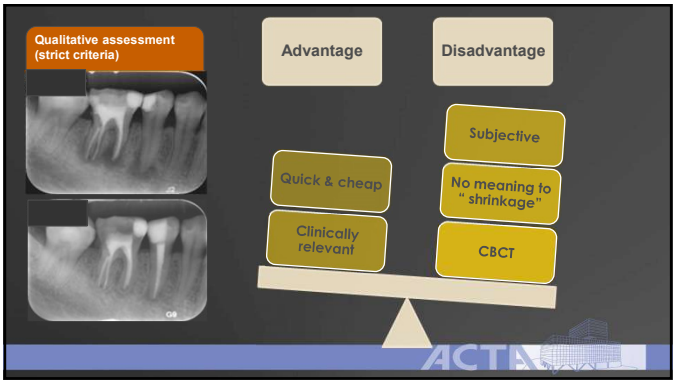

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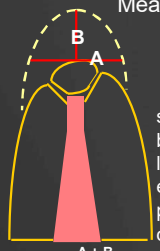
Measurement of periapical lesions



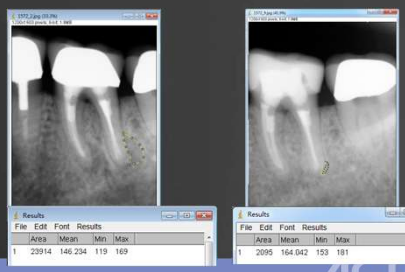
size of each lesion was calculated by taking the average of the lesion's largest dimension and its extent in the direction perpendicular to the largest dimension.

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

JOE 1990 : Sjogren et al.

25

Measurement of periapical lesions



26

Simple measurements

Advantage	Disadvantage
cheap	Inaccurate
Quantitative	Time consuming
	Standardization of the radiographs

27

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

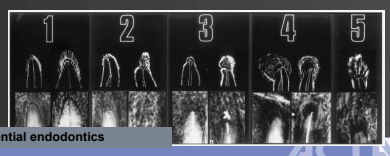
Who used this system ?
Peters & Wesselink 2002

IEJ 1983 : Reit & Gröndahl

28

PAI Score

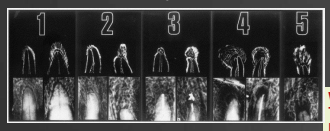
- PAI score (Ørstavik et al. 1986)
- "The PAI scoring system offers a visual reference scale for assigning a health status to the periapex. "



Essential endodontics

29

- 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

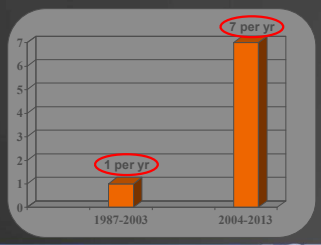


Who used this system ?
The Toronto studies
Marending et al. 2005
And
More than 70 studies !

PhD thesis 1967 : Brynolf

30

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

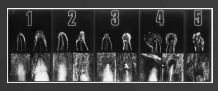


31

PAI score

Advantage

Disadvantage



Uniform

Easy to do

Maxillary incisors

Radiographs, 2D

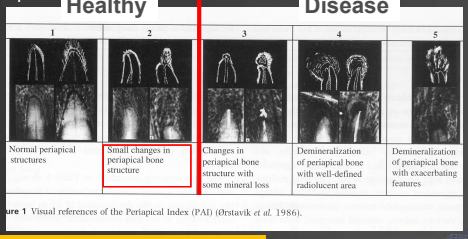
Dichotomization

32

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

Toronto studies 2003-2006
Healed: PAI < 3

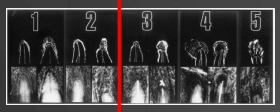
Healthy | Disease



Endo Dent Traumat 1986 : Ørstavik et al.

33

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

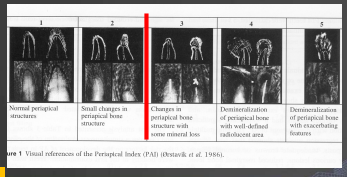


Eur J Oral Sci 2004 : Ørstavik et al.

34

Prognostic value of the full-scale Periapical Index.

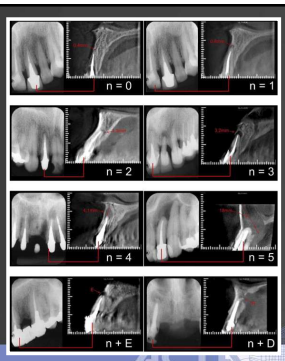
Repeated radiographic assessments of teeth using the full-scale PAI reveal that each of the five scores had distinct prognostic value for the course of periapical disease …



IEJ 2014 : Kirkevang et al.

35

The CBCT-PAI score

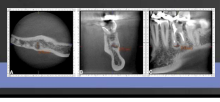


JOE 2008 : Estrella et al.

36

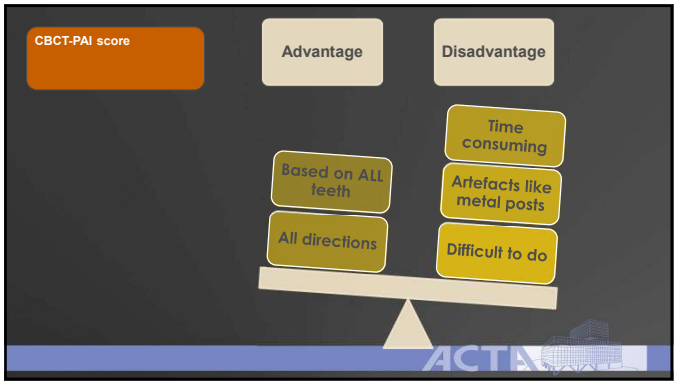
37

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

38

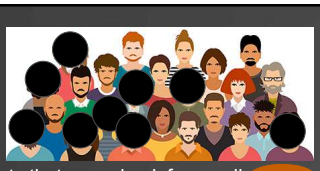


39

Outcome terminology

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

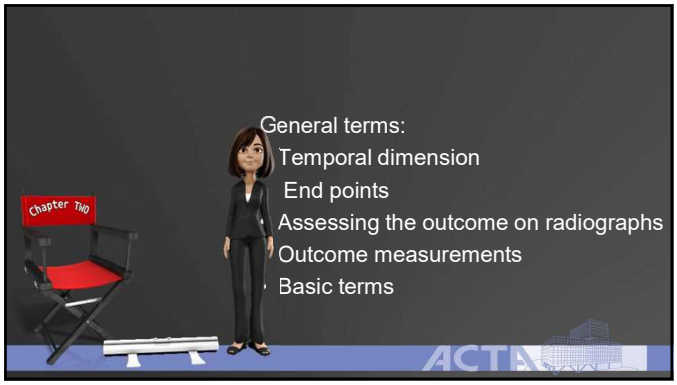
40



- Cohort 24
- Drop outs 9
- Recall rate- % of cohort patients that came back for recall 62.5%
- Recall rate < 70% decreases the accuracy of the conclusions
- recall rate ↑ accuracy ↑
- Follow-up period ↑ recall rate ↓

41

42



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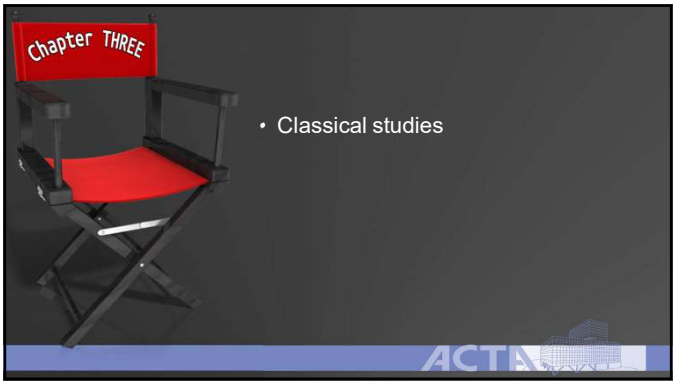


44

45

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

46

TERMS

- NO success or failure !!!
- PAI score
- Healed and healing

47

Toronto studies – JOE 2003-2010

Treatment outcome in endodontics: **the Toronto Study**. Phase 1: 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 S2004

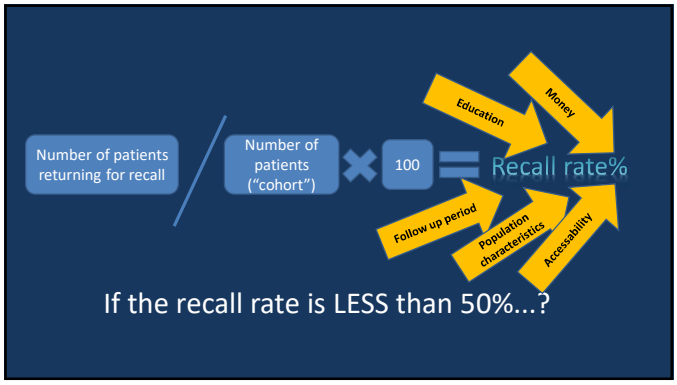
Treatment outcome in endodontics: **the Toronto Study**. Phase III: initial treatment. Marquis VL, *Dao T*, Farzaneh M, Abitbol S, Friedman S. 2006

Treatment outcome in endodontics: **the Toronto study**--phases 3 and 4: orthograde retreatment. de Chevigny C, *Dao TT, Basrani 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, Basrani 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, Basrani BB*, Wang N, Friedman S. 2010

48



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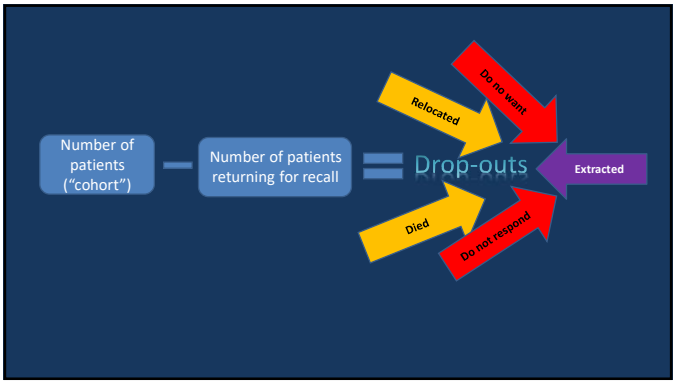
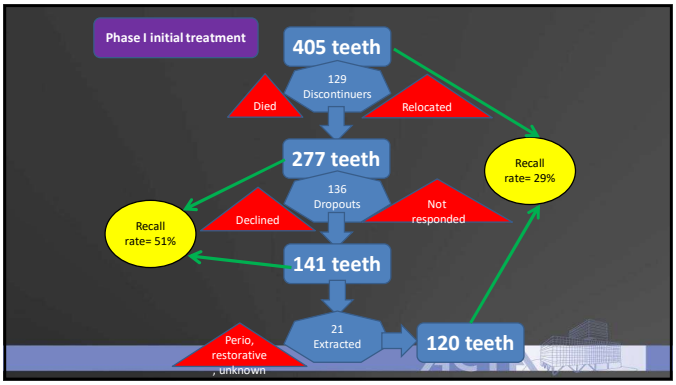


50

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

51



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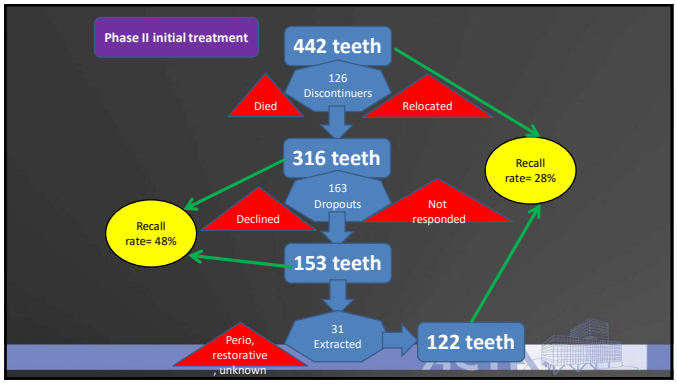

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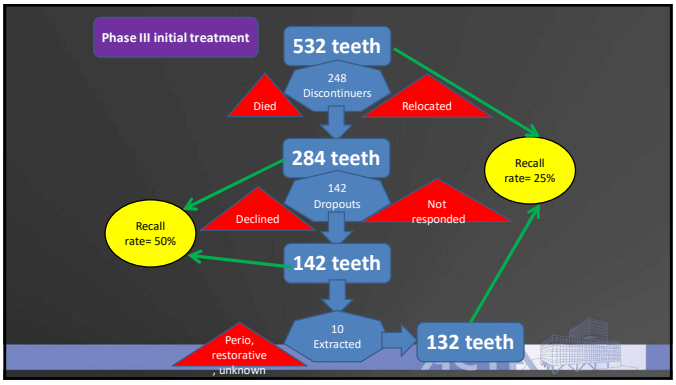

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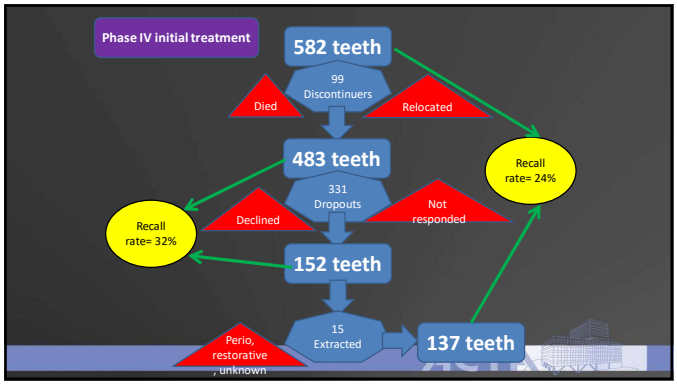

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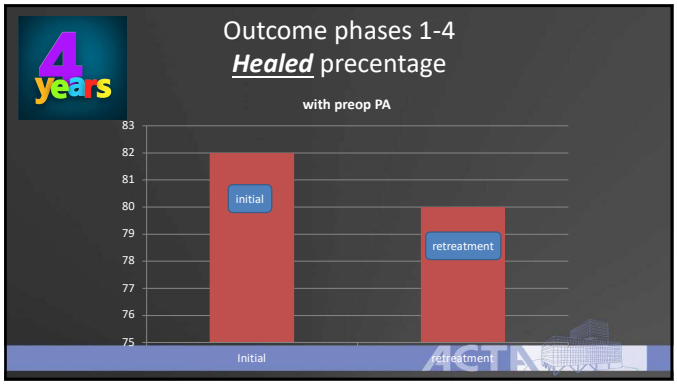

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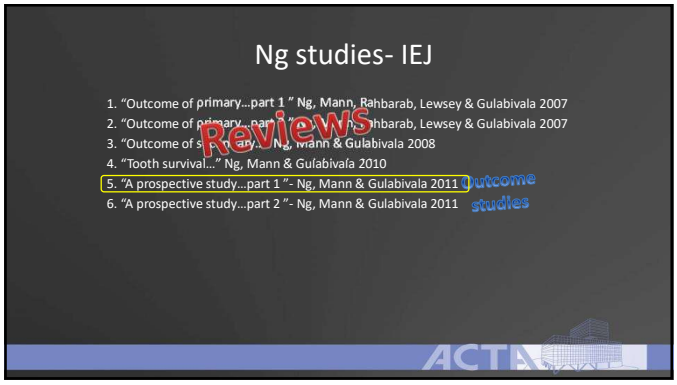

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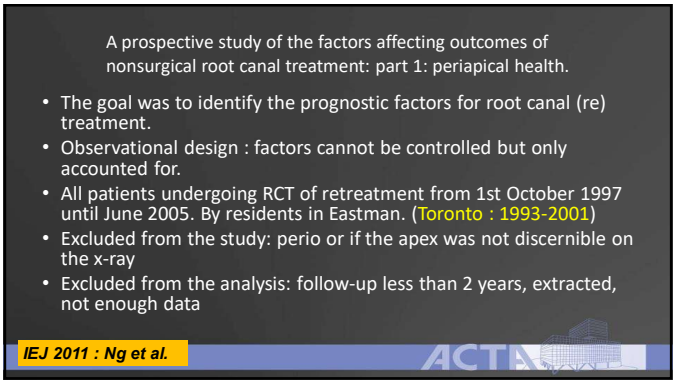

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Classification

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

IEJ 2011 : Ng et al.

61

Outcome measurements

- Ng does not agree with Friedman and contantly uses the term "success rate".
- Primary: Clinical and radiographic : absence or healing of lesion for each root
- Secondary: survival

Succeess:

- 1.strict criteria : no pain, sympthoms and complete healing
- 2.Loose criteria : healing lesion.

IEJ 2011 : Ng et al.

62

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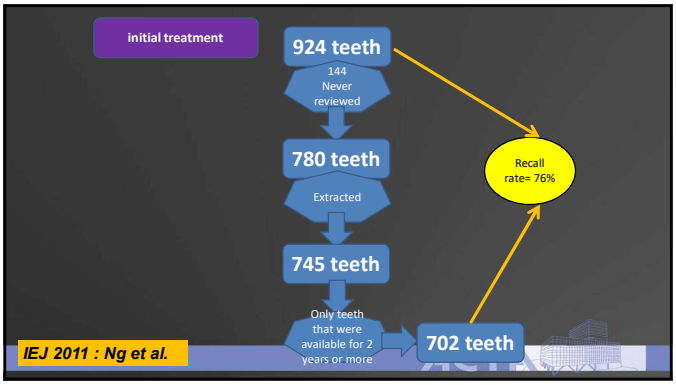

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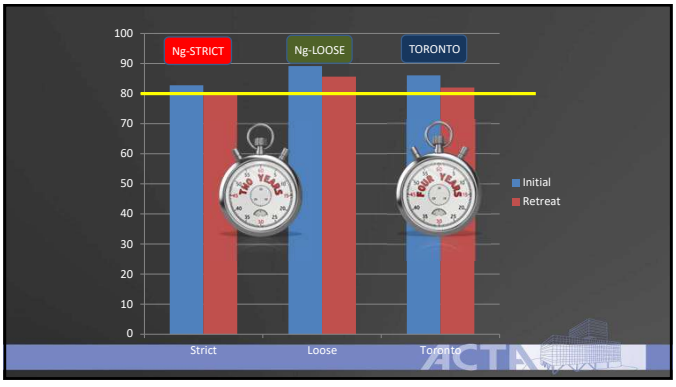
Results Ng

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

IEJ 2011 : Ng et al.

65



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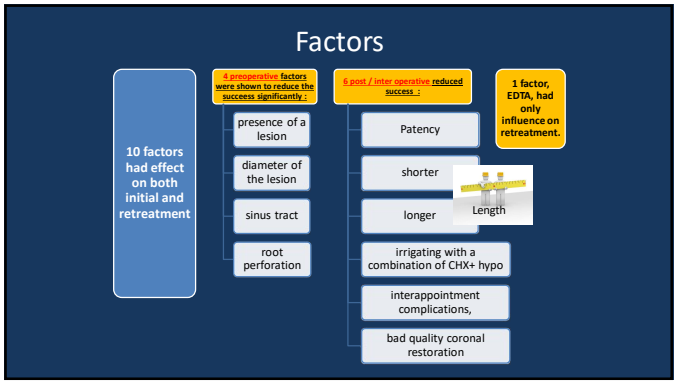

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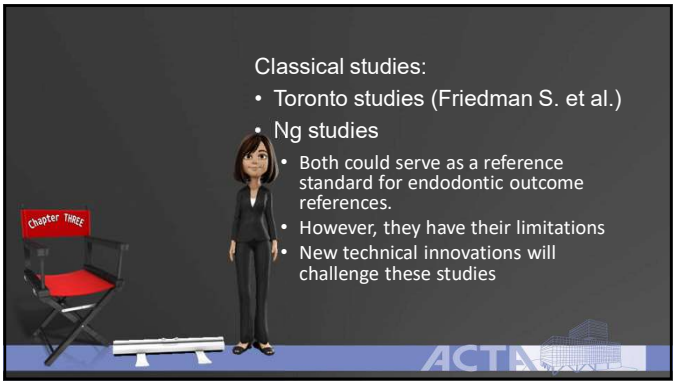

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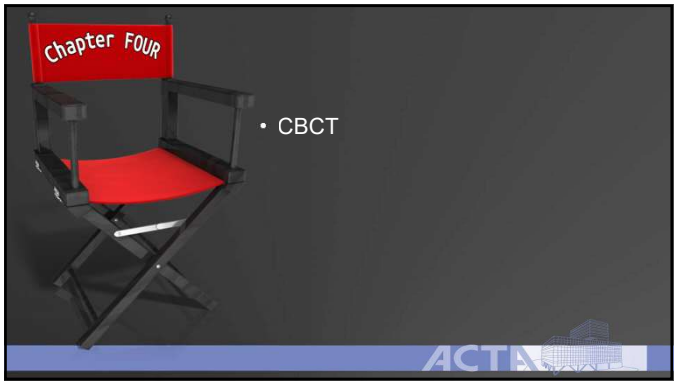

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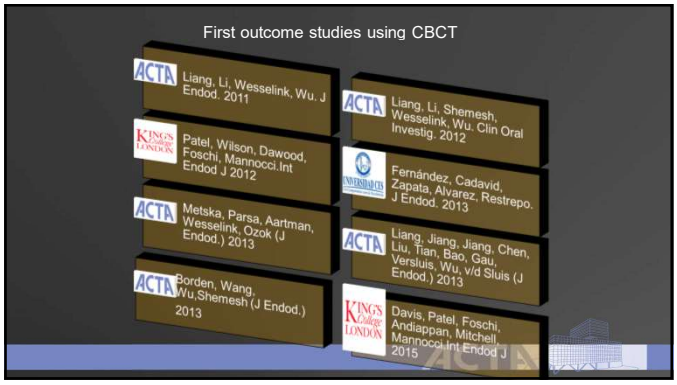

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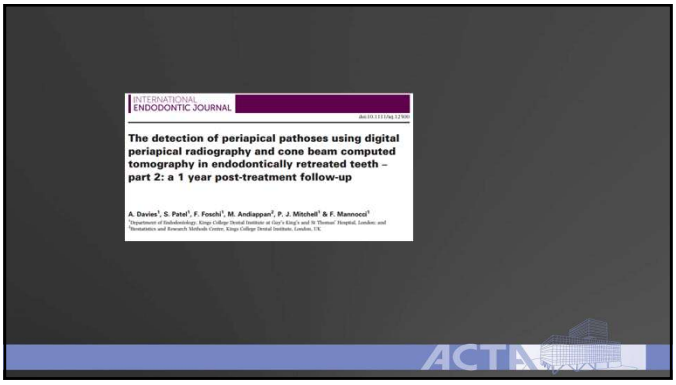

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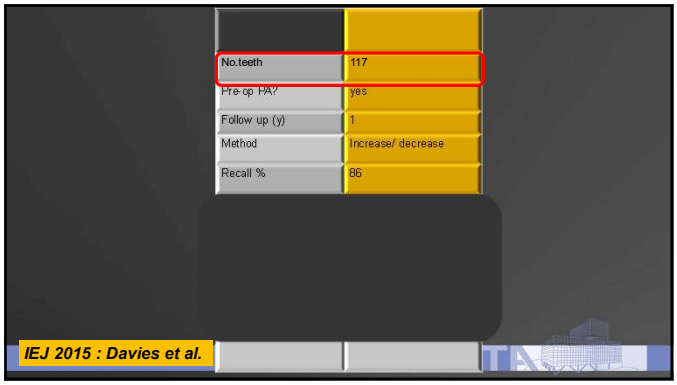

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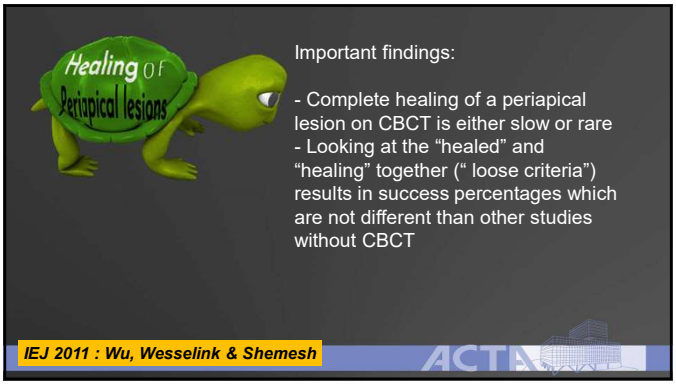

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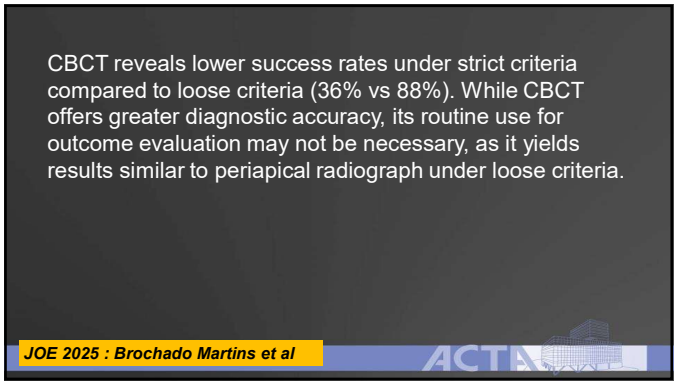

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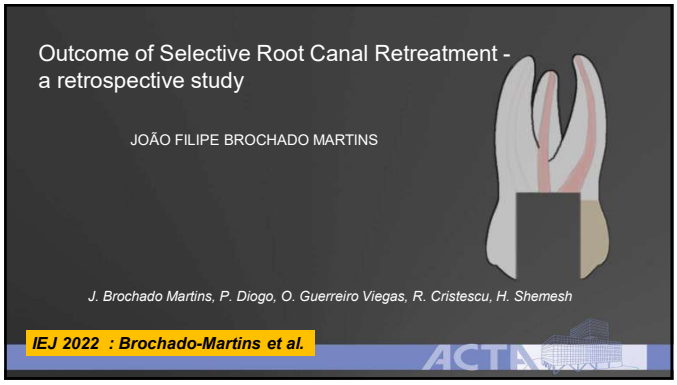

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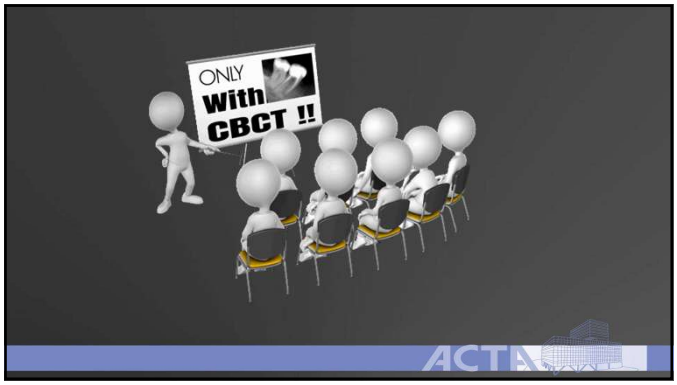

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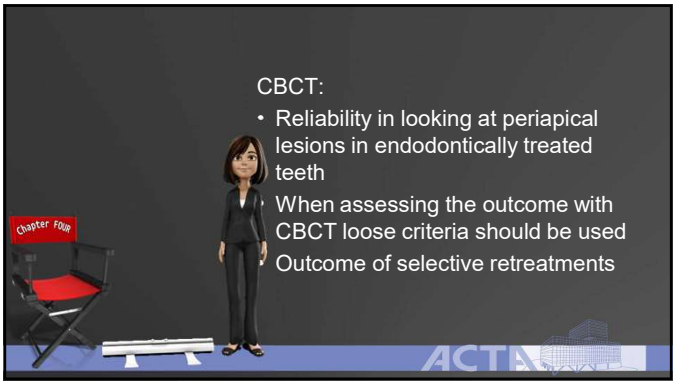

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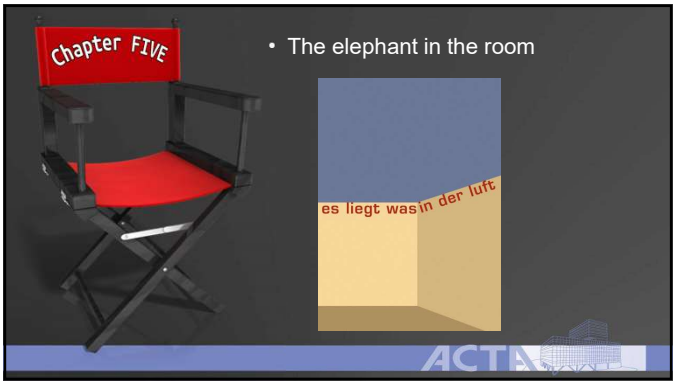

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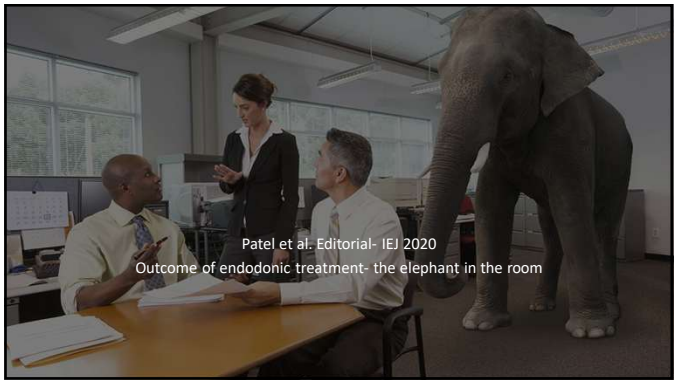

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The "elephant" is:

- " 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.

85

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 : Georgiou et al.

86

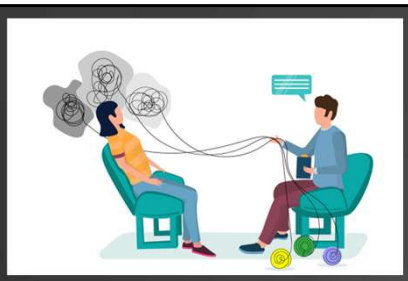
The influence of apical periodontitis on circulatory inflammatory mediators in peripheral blood: A prospective case-control study.

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 : Georgiou et al.

87



Individually designed treatments

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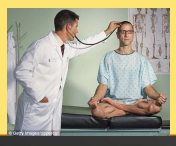
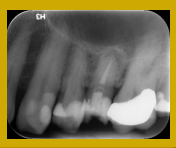
Patient-centered outcome: Quality of Life Costs/ pain Functionality



Disease-centered outcome: Healing of the periapical lesion



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The elephant in the room:

- How important is an asymptomatic periapical lesion and should we treat it ?

90

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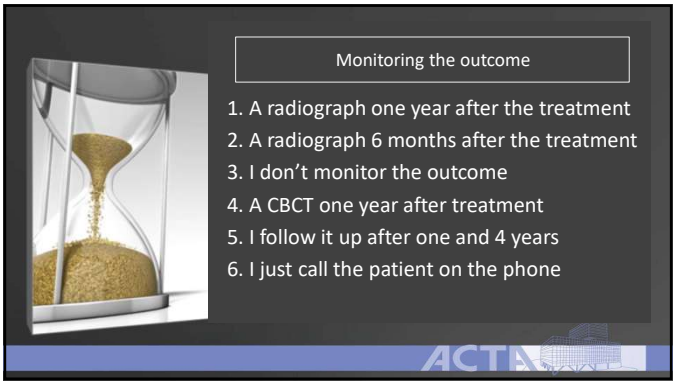

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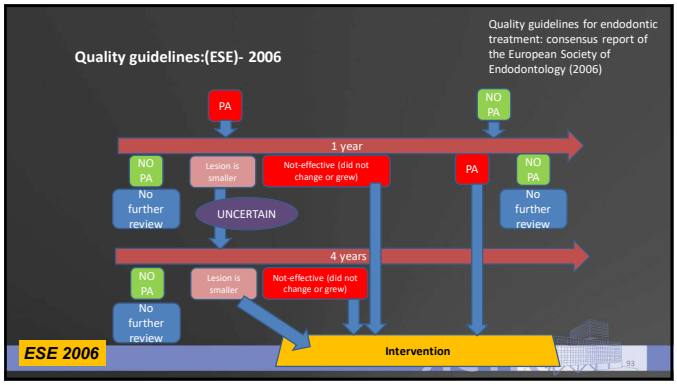

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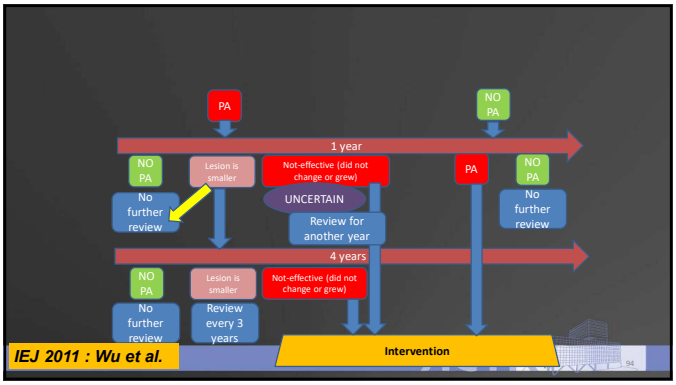

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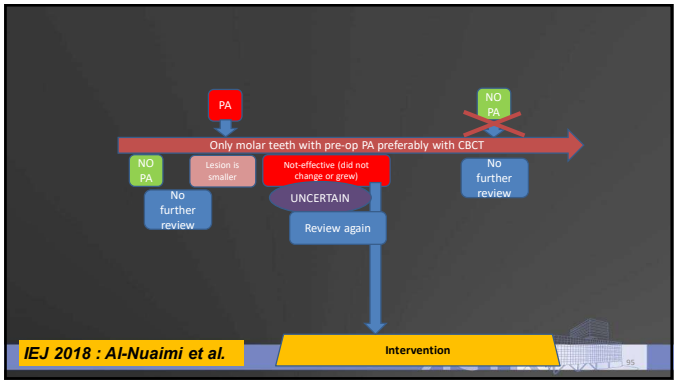

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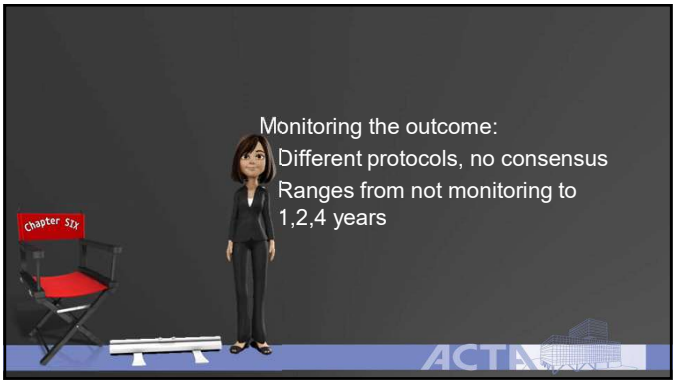

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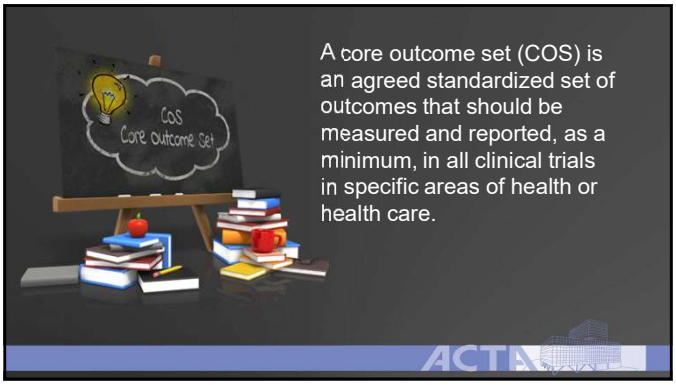

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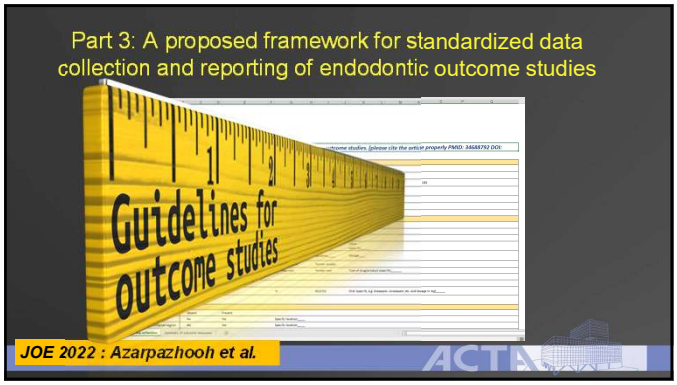

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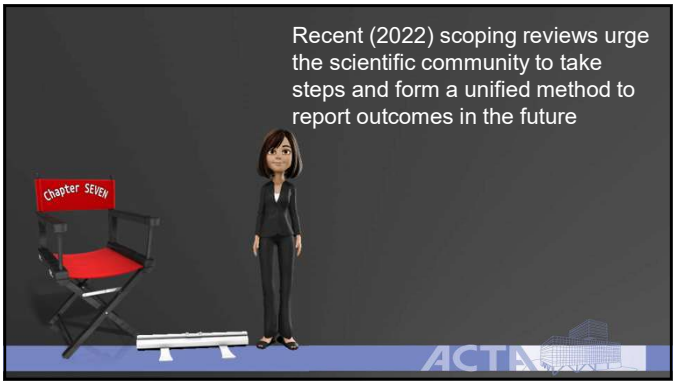

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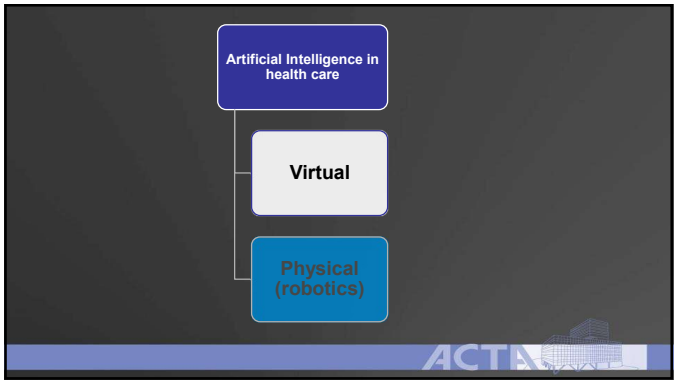

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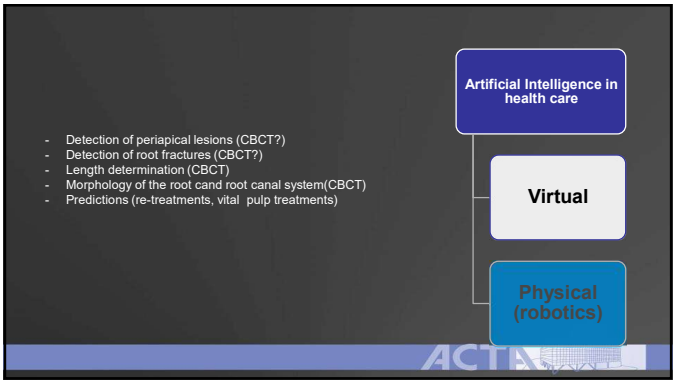

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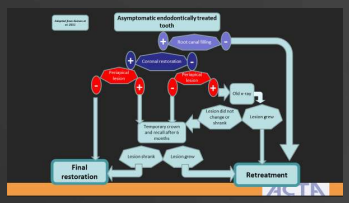
Artificial intelligence (AI) has the potential to replicate human intelligence to make predictions and complex decision making in the health care systems



Artificial Intelligence in Endodontics: Current Applications and Future Directions.

JOE 2021 : Aminoshariae et al.

103

Development and evaluation of a deep learning segmentation model for assessing non-surgical endodontic treatment outcomes on periapical radiographs: A retrospective study

Plos One 2024: Dennis et al.

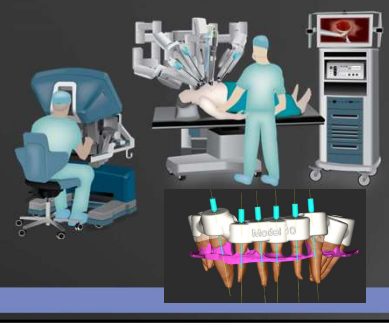
104

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.

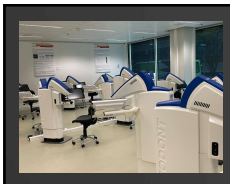
105



Artificial Intelligence in health care

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

106



Artificial Intelligence in health care

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

First experiences with patient-centered training in virtual reality.

J Dent Educ 2020: Serrano, Wesselink, Vervoorn

107

- 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!)
- The importance of persistent asymptomatic periapical lesions is still unknown
- Hopefully more uniform outcome studies will be conducted (COS)
- AI will be able to predict the outcome in the near future

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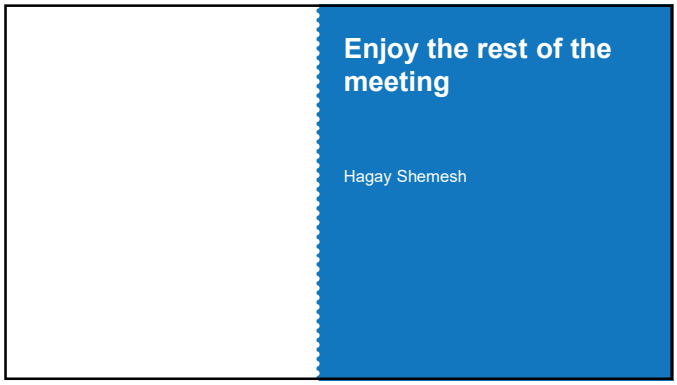

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