Periapical Microsurgery: Hard Tissue Management
De Rigueur Root-end Assessment & Management

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“You may believe in the retrieve, but true redemption is through resection”
S. Mieczyslaw, circa 1991

“Nothing in life is to be feared.
It is only to be understood”
Marie Curie
Endodontics
The Prevention & Treatment of
Apical Periodontitis

The Seal is the Deal
Oral Microorganisms: Bacteria, Virus, Fungi

It’s all about the Seal
Retrospective Evaluation of Surgical Endodontic Treatment: Traditional versus Modern Technique
Success for Modern microsurgical techniques: 91.1%
Success for Older traditional techniques: 44.2%

It’s all about the Seal
Outcome of Endodontic Surgery: A Meta-analysis of the Literature—Part 1: Comparison of Traditional Root-end Surgery and Endodontic Microsurgery
- Meta-Analysis of human studies from 1966 to 2009
- Endodontic Microsurgery: 94% outcome
- Traditional root-end surgery: 59% outcome

2006 JOE
2010 JOE
Periapical Microsurgery: Hard Tissue Management
De Rigueur Root-end Assessment & Management

- Root-end resection & inspection
- Root-end cavity preparation
- Root-end filling materials

Seeking Alpha in Education of Periapical Microsurgery

Alpha:
A measure of performance on a risk-adjusted basis

Indirect Vision in Periapical Microsurgery

KEEP RIGHT
In endodontic microsurgery, the **tooth position** and **arch type** have a greater influence on the healing outcome than intra and post operative factors.
Getting Direct Vision for Dentinal Defects Assessment & Management

The Basic Misconception

Tidmarsh et al. 1989 → #Tubules misconception
Gilheany et al. 1994 → #Seal misconception

#Tubules misconception

Dentinal tubules at the root ends of apicected teeth: a scanning electron microscopic study.

H. G. Tidmarsh & M. G. Murrowsmith Department of Restorative Dentistry
University of Otago School of Dentistry, Dunedin, New Zealand

Two groups of teeth, one of which contained teeth of known age.
Scanning electron microscopy to count numbers of dentinal tubules.
Mid-root: 27,000 tubules per mm
Close to the dentine-cementum: 13,000 tubules per mm

#Tubules don’t matter

Dentinal tubules at the root ends of apicected teeth: a scanning electron microscopic study

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# Tubules don’t matter → healing matters

Periapical Microsurgery: An In Vivo Evaluation of Endodontic Root-End Filling Materials

Tawil et al 2009

# Seal misconception

Apical Dentin Permeability and Microleakage Associated with Root End Resection and Retrograde Filling

Gagliani et al 1998

An apical cavity of 3mm or more along the vertical axis can produce a safe and effective seal regardless of the resection angle.

Gilheany et al 1994

Fig 4. Graph showing differential leakage versus depth of the retrograde filling, including the line equation for each angle of root resection. Line equation was derived with Y = leakage, D = depth, and B = slope of best fit straight line.

In-Vitro Hydraulic Leakage model, testing Ketac Silver

In-Vitro Dye Leakage model, testing SuperEBA
Ultrasonic preps seal the system

Getting Direct Vision for Dentinal Defects Assessment & Management

The best risk adjusted performance (Alpha) in apical microsurgery is obtained through direct vision

#BringBevelBack

Root-End resection & inspection

In High Definition → Direct Vision

- Microscope articulation
- Seating position
- Bevel
- Clinical Execution

3mm root-end resection

Canal ramifications and deltas are located in the apical area of the root

De Bruijn 1975, reprint 1997
Seltzer et al 1966
3mm root-end resection

Root-end resection
Cutting VS Shaving → Why not both…?

Biopsy
Is the apical lesion harmless?

American Association of Endodontists
Indication for a biopsy

- Adequate amount of tissue removed from surgical site
- Pathosis inconsistent with endodontic disease
- Medical history indicates the merits of biopsy
- At no time should a surgeon remove tissue and accept the responsibility of its diagnosis based on its appearance, color, or consistency

- VS
Reverse Bevel Technique

Getting Direct Vision

- Start with a 45° bevel and visualize the whole root
- Use methylene blue to confirm the circumferential PDL
- Adjust the bevel as much as practical to keep direct vision
- Ensure 3mm removal from the lingual wall
- Ready for root-end inspection & management
Root-end resection

Use new surgical length carbide burs to avoid excessive heat generation (Culverwood 1964)

Diamond burs are inefficient at cutting bone and create excessive heat (Libon 1963)

Inspection of the resected root

- Magnification, illumination and methylene blue staining
- Identification of un-negotiated canals & isthmuses is the first and most important step after root-end resection
- Dentinal defects and cracks at the cut root surface decrease the outcome

Von Arx et al 2011, Tawil et al 2015

Transillumination

M. Cordeiro, S. Card, P. Tawil, 2016
Transillumination

- Ensure complete resection of the root
- Visualize the isthmuses
- Investigate for any potential fracture or dentinal defects

Methylene Blue

- Ensure complete resection of the root
- Visualize the isthmuses
- Investigate for any potential fracture

Inspection of the resected root

- Visual: the resected root

Periapical Microsurgery: Root-End Inspection
Periapical Microsurgery: The Effect of Root Dentinal Defects on Short- and Long-term Outcome

Significant **superior clinical outcome for intact roots** when compared with roots with dentinal defects.

Intact roots: 97.3% complete healing at 3 years.

Dentinal defect roots: 31.5% complete healing at 3 years.

Tawil P.E. et al. 2015
What's causing dentinal defects?

Root-orienting dentinal defects: methodological aspects and clinical relevance

Damage tolerance reduction of radicular dentin with increasing age.
Related to changes in the microstructure, chemical composition and increase collagen cross-linking.
Most severe near the apex.

Can Root Canal Retreatment Clinically Cause More Dentinal Defects?

Retreated teeth had more dentinal defects (p < 0.001)
Multivariate analysis showed only the type of treatment to be significant (p<0.001)
Multivariate analysis included: age, gender, tooth location and treatment
Root-end cavity preparation

- Deeper root-end preparation
- Parallel walls in the axis of the root
- More retention
- Less bevel is needed
- Smaller bony crypt

Ultrasonic root-end preparations are safe to use on intact roots.

Preexisting dentinal defects can be propagated by ultrasonic root-end preparations.

Through the use of LED, dentinal defects can be detected, special root-end management can be implemented, & more predictable outcomes may be achieved.

Root-end cavity preparation

When treating teeth with thin roots:
- Use lower setting on the ultrasonic unit
- Use diamond coated ultrasonic tips
- Use light apical pressure, letting the instrument go to the path of least resistance along the path of the canal

Layton, Marshall, Morgan and Baumgartner 1996
- When root have cracks, more cracks were generated with a high setting of the ultrasonic
Root-end cavity preparation
Use the right tip to avoid iatrogenic perforations

Surgical Ultrasonic Tips

Periapical Microsurgery
Retro-preparation
Endo Success Surgical Ultrasonic tips

Periapical Microsurgery: Hard Tissue Management
De Rigueur Root-end Assessment & Management
- Root-end resection & inspection
- Root-end cavity preparation
- Root-end filling materials

Root-end fillings
Needs to be biocompatible and needs to offer a good apical seal (in order to cut off the nutrients from the anaerobe bacteria)
- MTA
- Zinc oxide (SuperEBA / IRM)
- BioCeramic (EndoSequence)
- BioDentin (Septodont)
- Resins (Retroplast, Gersistore)
- Silver

MTA
- Cost effective
- Easy to mix, similar to wet sand on the beach
- Easiest to place when used with proper instruments
- ProRoot MTA working time: 3-5 hours
- MTA Angelus working time: 10-15 minutes
- Easy to place: If used with proper instrument (MAP system or Dovgan carrier)
MTA carriers
MAP system

MTA
Clinical Outcome Studies

Von Arx Thomas & al
✓ 1 year follow up with 90% success for MTA

Chong and Pitt Ford 2003
✓ 2 year follow up with 92% success for MTA

Tawil P.Z. et al 2009
✓ Dog study showed new PDL regeneration for both MTA & IRM

Tawil P.Z. et al 2015
✓ 3 year follow up with 97% success for MTA & IRM

MTA
Literature

Parirokh & Torabinejad 2010
Part 1 Chemical, physical and antibacterial properties

Torabinejad & Parirokh 2010
Part 2 Leakage and biocompatibility investigations

Parirokh & Torabinejad 2010
Part 3 Clinical applications, drawbacks and mechanism of action

Zinc oxide: SuperEBA & IRM

- Cost effective materials
- SuperEBA is hard to mix, but once properly mixed it handles well
- To avoid your instrument from sticking to these materials: Dip the tip of your condenser in the powder or in saline
Zinc oxide: SuperEBA & IRM
Are ideally polished when the set

*Fitpatrick & al 1997*
Retrofillings finished with a finishing bur displayed significantly better marginal adaptation (EBA & IRM)

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Zinc oxide: SuperEBA & IRM
Clinical outcome studies

*Rubinstein & al 2002*
✓ 5-7 year follow with 91.5% success for SuperEBA

*Maddalone et al 2003*
✓ 3 year follow up with 92.5% success for SuperEBA

*Zuolo et al 2000*
✓ 1-4 year follow up with 91.2% success for IRM

*Tawil P.Z. et al 2009*
✓ Dog study showed new PDL regeneration for both MTA & IRM

*Tawil P.Z. et al 2015*
✓ 3 year follow up with 97% success for MTA & IRM

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**BioCeramic**
Setting time: 4h or 20 minutes

- New “BioCeramic” material
- Made out of calcium silicate (like MTA), zirconium oxide, tantalum oxide, calcium phosphate and filler agents
- Comes in a putty in a jar or in an injectable syringe
- Most publications are case reports or in-vitro studies
- Great promising material, but we still lack published outcome studies from independent sources

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**BioDentine**
Setting time: 10-12 minutes

- New “Active Bio-Silicate Technology”
- Made out of Calcium Silicate (like MTA), Calcium Carbonate, Calcium Oxide, Iron Oxide and Zirconium oxide
- Most publications are case reports or in-vitro studies
- Great promising material, but we still lack published outcome studies from independent sources
**Resins**

- A dome/concave retro-preparation shape is usually used
- Useful in cases with long metal posts where a deep retro-preparation is impossible to obtain
- These bonding techniques are moisture sensitive and clinically challenging to use in a surgical site
- Retroplast has good clinical outcome studies
- Geristore has conflicting results in clinical outcome studies

**Clinical outcome studies**

- **Rud J, Rud V 1997**
  - 4 year follow up with 92% success for Retroplast
- **Fox Arc et al 2018**
  - 1 year follow up showed 79.5% success for Retroplast
  - 1 year follow up showed 91% success for MTA
- **Tawil P.E. et al 2009**
  - Dog study: Geristore had worst results in histology when compared to IPM & MTA

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**Amalgam**

**Problems**

- It initially leaks due to the metal primary shrinkage
- Produces corrosive by-products
- Risk of mercury contamination
- Moisture sensitive
- May cause tissue tattooing
- Scattered particles are not absorbable by the body
- Galvanic effect when in contact with metal posts

**Dorn and Garnier 1990**

- 10 year follow up showed a significant higher failure rate for amalgam
- Success: 75% for amalgam, 95% for Super EBA