Contemporary Strategies in Root Canal Treatment

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- 1917
- access, cleaning & shaping, gutta percha, radiographs
- even some instruments look exactly the same as today
Items for Consideration

- “Success/Failure” concepts
  - comparison to implant data (“retention”)
  - numbers may change with advent of CBCT

- Overall health considerations
  - data not clear regarding cardiovascular events and endo
  - emergence of host defense as an important factor

- Treatment modalities
  - conventional root canal, improved version
  - biologic treatment, such as regenerative endodontics

Follow-up studies (2000-2012)

![Graph showing success rate over follow-up studies.](image)

Initial Treatment

- Healed (%)

![Graph showing healed percentages.](image)
Which Are Key Strategies?

- **Access**
  - ideal configuration BUT “do not harm”
  - prevent preparation errors, *e.g.*, ledges etc.

- **Cleaning and shaping**
  - balance size, antimicrobial effect, debris production
  - irrigation efficacy, antimicrobials

- **Obturation**
  - occlusion of space and leakage pathways

- **Follow-up care**
  - understand success and failure
  - select retreatment vs surgery vs implant

Key 1: Access

- **Basics**
  - size of pulp chamber
  - shape of pulp chamber
  - design of root canal system
  - demands of instrumentation technique
How Are We Doing?

- We are able to do beautiful work

Introduction

Strategies

Discussion

Law of centrality (1)
- pulp chamber floor is centered at the CEJ

Tooth Development

- Programmed and detailed succession of events
  - morphogenesis and differentiation
### Geometrical Principles

- Outer root surface follows cross sectional pulp shape
  - remember morphogenesis and differentiation!

**CLINICAL HINT:** Track root contour with explorer

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### Straight-Line Access

- Instruments are constrained cervically
  - WL shortens during procedure
  - preparation is affected by coronal tension

- Rotary instrument fatigue more
  - coronal curves are more dangerous
  - should go straight into middle 1/3

- Transition from chamber to canal
  - cutting NiTi: lateral, push
  - US tips: sanding, digging, troughing, undercutting
  - SS White Access burs

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### Searching for Evidence

- Evidence-based dentistry….
  ... is the conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients.

- For practical reasons:
  - 1/3 literature, 1/3 clinician, 1/3 patient
  - searched databases, reference lists

- Issues with written evidence
  - levels of evidence: clinical trials vs bench top
  - “biological plausibility”, “surrogate outcomes”
  - room for interpretation, conflicting results

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*Sackett 1996*
Searching for Evidence

- www.ebd.ada.org
  - large compilation of access portals and materials
  - an attempt to help general dentists

- Some centers have their own collection
  - San Antonio: CATs
  - Detroit: evidence-based endodontics

- Search for original data
  - pubmed, Cochrane group and others
  - hand search from textbooks and reviews

Key Evidence

- Overall shape
  - dictated by anatomy, tooth development
  - visibility of all orifices

- Overall size
  - dentin removal equals loss in stiffness
  - largest contributor MOD cavity (63%) vs access (5%)

- Crown down strategy
  - better tactile feedback: working length determination
  - essential for many rotary instruments

- Clinical
  - no studies identified
**The Classics**

- Stiffness and fracture load depend on preparation extent
  - most tests address catastrophic failure load

![Graph showing stiffness and load](image)

**What Is Important?**

- Be centered
  - based on: laws of symmetry
- Understand the long axis
  - based on: “Do not harm”
- Find all orifices
  - based on: microbiological principles
- Provide straight-line access
  - based on: engineering principles
- All of the above
  - based on: common sense
Key 2a: Cleaning & Shaping

- Overall shape
  - "Schilder-type" shape
  - "standardized" shape

- Apical size
  - small: conserving dentin, providing tapered seat
  - larger: providing more access for irrigants

- Apical end point
  - location and determination of “length”
  - patency a goal/dangerous?

"... the Root Canal Must be Shaped so That a Tapering Funnel is Created With its Narrowest Diameter at the Periodontal Ligament and the Largest at the Coronal Opening."

Schilder 1967


- Aim
  - to investigate the effect of two methods of canal enlargement on apical seal

- Methods
  - 46 teeth, 4 controls, 22 specimens prepared to .02 taper (standardized) & 20 specimens to .10 taper (step back)
  - obturation with lateral compaction, ZOE sealer
  - leakage evaluated using $^{45}$Ca & micro-radiography
  - teeth were immersed to allow apical and coronal penetration of isotope
  - spreader insertion depth recorded
Allison et al. JOE (1979)

- .02 taper group: mean spreader penetration was to 3.5 mm (0.5 - 5 mm)
  - 5/22 teeth allowed deep spreader insertion (+2 mm) and had no leakage
  - 6/22 had gross leakage (> 4.8 mm) and 11/22 had leakage to app. 3.6 mm
- .10 taper group: mean spreader penetration was to within 1 mm (20/20)
  - no significant leakage overall
  - 2/20 had leakage to > 1 mm
- coronal aspect was sealed to isotopes in all cases

Discussion
- for lateral compaction, spreader penetration is correlated with leakage
  - deeper penetration possible with .10 taper compared to .02 taper
- spreader should penetrate to 1 mm or less

Results

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Spångberg 2001

Why Small Is Beautiful...
**Why Small Is Beautiful...**

From: Card et al 2002  From: Buchanan 2001

A MAF 60, 80  B MAF 20

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**Increased Apical Enlargement**

- One conclusion
  - "...it may be recommended to keep the apical size of curved canals as minimal as possible provided that a sufficient irrigation is feasible."
  - El Ayouti, 2011

- Experimental data overall
  - numerous variables, unclear outcomes
  - "complete" canal preparation unlikely

- Clinical data
  - mixed results, very difficult to tease out real information
  - a rare prospective study suggested larger sizes

  Raj Saini, 2012

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**Nair PNR, Henry S, Cano V, Vera J (2005)**

Microbial status of apical root canal system of human mandibular first molars with primary apical periodontitis after “one-visit” endodontic treatment


- **Aim**
  - to assess the microbiological status after single visit root canal treatment

- **Methods**
  - 16 lower molars with periradicular periodontitis were treated with K-Files or LightSpeed (apical sizes 25 and 40, respectively) and lateral compaction
  - irrigation was with 5.25% NaOCl and 17% EDTA
  - immediately after root canal filling, mesial apices were resected
  - histological evaluations were done on LM and TEM levels
  - positive and negative controls were teeth extracted due to periradicular periodontitis and orthodontic reasons, respectively
**Discussion**
- it appears that canals treated in a single visit such as in this study cannot be rendered bacteria-free, regardless of the apical size (but it is unclear if multiple visits could have rendered canals sterile from this study)
- the presence of immune cells suggests chemotaxis and a fluid phase in some phases of pulpal necrosis, allowing immune cells to be active

**Results**
- 14/16 treated canals harbored bacteria in their root canal systems
- 8 of the specimens each had bacteria in the canal enlarged with K-Files to size 25 and with LightSpeed to size 40
- 11/16 mesial roots had an isthmus region, 10 of which were contaminated with microorganisms, as were 6 of 8 accessory canals
- numerous PNMs were found in the isthmus region

**Further Considerations**
- **Length determination**
  - which principle, landmarks?
  - how to determine?

- **“Best practices”**
  - instrument and case selection
  - clinical usage parameters

- **Preparation errors**
  - block and ledge
  - role of instrument fracture
Apex “Locators”

Clinical Practice

Introduction
Strategies
Discussion
How did I get there...

Staged Preparation

Pettiette MT, Olutayo Delano E, Trope M (2001)


- **Aim**
  - to compare effects of RCT with 2 types of files on changes in bone density

- **Methods**
  - 60 molars treated by 30 undergraduate students were followed for 1 yr
  - all teeth were initially associated with an apical radiolucent area
  - treatment was with either stainless steel or NiTi K-files to similar shapes in both groups and all other peri-treatment variables were similar
  - individualized bite blocks were fabricated to allow subtraction radiography and densitometric measurement of changes in apical bone architecture
  - grey levels were enumerated for the apical and a normal area in each case
  - corresponding ratios were calculated and compared with Fisher’s tests
Results
- 40 teeth were available for 1yr recall, with no difference in initial scores
- success was associated with a grey level change of app 78% in NiTi cases and 45% in stainless steel cases; failures, indicated by grey level decrease, were 20% (NiTi) and 55% (stainless steel), respectively
- success probability was 15/19 with NiTi and 9/21 with stainless steel
- this difference was significant and was associated with a higher number of procedural errors in the stainless steel group (i.e., strip perforations)

Discussion
- for novice clinicians, the potential of NiTi hand files to prevent preparation errors results in dramatically improved clinical prognosis (OR=5, CI 1.3,20)
- the authors concede that skilful operators would have had a better chance to avoid such errors with stainless steel instruments
ProTaper rotary root canal preparation: effects of canal anatomy on final shape analysed by micro CT

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Abstract


Introduction

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Results

Volume and surface area increased significantly and similarly in mb, db and p canals, and gross preparation errors were found infrequently. Root canal diameters, 5 mm coronal to the apex, increased from 0.75 to 0.85 mm, 0.62 to 0.86 mm and 0.62 to 0.79 mm for mb, db and p canals, respectively. Apical canal transection, marked from 0.62 to 0.80 mm and independent of canal type, wide canals had a significantly higher (P < 0.05) proportion of unprepared surfaces than narrow canals.

Conclusions

Canals in maxillary molars were prepared using ProTaper instruments with minor coronal errors. These instruments may be more effective in shaping narrow canals than wider, immature canals.

Keywords: canal morphology, ProTaper, shape, transection.

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Conventional Instruments

ProTaper Next History

2001

2006

2013
Movement

How to use ProTaper Next?
Since the beginning of modern day endodontics, there have been numerous concepts, strategies, and techniques for preparing canals. Over the decades, a staggering array of files has emerged for negotiating and shaping canals. In spite of the design of the file, the number of instruments required, and the surprising multitude of techniques advocated, endodontic treatment has been typically approached with optimism for probable success.

The clinical endodontic breakthrough was progressing from utilizing a long series of stainless steel (SS) hand files and several rotary Gates Glidden drills to integrating nickel titanium (NiTi) files for shaping canals. Regardless of the methods utilized, the mechanical objectives for canal preparation were brilliantly outlined almost 40 years ago by Dr. Herbert Schilder. When properly performed, these mechanical objectives promote the biological objectives for shaping canals, 3-D disinfection, and filling root canal systems (Figure 1).

The purpose of this article is to identify and compare how each new generation of endodontic NiTi shaping files served the shaping movement.

**Strategy**

- ProTaper philosophy remains:
  - single basic sequence of files
  - variable tapers to optimize crown-down
  - recognized finishing diameters

- Motor settings per manufacturer
  - torque range (2-5Ncm)
  - continuous rotation @300rpm

- Clinical handling
  - glide path
  - “brushing”

**ProTaper Next DFU**

- Canal scouting
- Glide path
- Optional

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**Introduction**

**Strategies**

**Discussion**