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The Forgotten Dimension and Working Width - Dr. Steve Senia

The term "Working Width" first coined by Dr. Yi-Tai Jou, Dept. of Endo, U of Pennsylvania. Dent. Clin of N. Am (2004)

Endodontic Myths:

Myth 1. **"Root canal treatment is 95-99% successful."**

Senia says research this is opinion and not supported by the research. Success averages from 84% to 70 % depending on whether or not bacteria are present after instrumentation – >Sjogren IEJ '97 A study of 34 other studies showed success rate 90.7% w/o AP and 10-15% lower with AP –> Friedman 1998 (In the textbook Essential Endodontology)

Senia says that we need to focus our efforts of obtaining better success in infected cases.

Myth 2. **"Canals are small in the apical 1/3rd."**

Senia then defined the terms apex and apical foramen. He emphasized that the apex is not the end of the canal. The apical constriction is the narrowest diameter near the apex. Its position may vary but is usually 0.5-1.0 mm short of apical foramen. Senia is bothered by the term "Apex Locator". He prefers more precise terminology. The Apex locator is really a "Foramen Locator" and he believes the manufacturers should be told of this confusing terminology. The "Forgotten Dimension" refers to the area of the canal coronal to the apical constriction – an area that is often much larger than we think it is – much larger than the constriction. Therefore in order to both clean and shape the entire canal- you must go to a much larger size than the constriction. This requires instruments that are larger than the constriction. For example: If the constriction is size #30, using a #15 patency file keeps only 25% of the constriction patent.

Briseno JOE 2004 Morphology of the Physiological Foramen

The "Physiological Foramen"

- = apical constriction
- = narrowest diameter of the canal
- Located at the CEJ *(Editor: at this point Fred Barnett whispered to me that this was technically not true in all cases. The narrowest part of the canal is not ALWAYS at the CEJ.)*
- Considered to be the apical limit of canal preparation
- 447 Maxillary molars and 510 mandibular molars were studied. Maximum dimension of the apical constrictions (usually oval) were (N) = Narrowest (W) = widest part of oval :

Maxillary First Molar		Mandibular First Molar	
MB = .35 (N)	.73 (W)	MB = .39 (N)	.54 (W)
DB = .38 (N)	.73 (W)	ML = .31 (N)	.52 (W)
P = .56 (N)	.69 (W)	D = .44 (N)	.64 (W)
Maxillary Second Molar		Mandibular Second Molar	
MB = .37 (N)	.60 (W)	MB = .29 (N)	.48 (W)
DB = .44 (N)	.52 (W)	ML = .31 (N)	.47 (W)
P = .51 (N)	.83 (W)	D = .43 (N)	.60 (W)

Mizutani et al JOE July 1992 Labiolingual diameter ay the apical constriction (range)

- Maxillary Central .28 - .74 mm
- Maxillary Lateral .21 - .92 mm
- Maxillary Canine .12 - .65 mm

Kuttler (1955)

- Constriction averages : 18-25 y/o = .33mm
- Constriction averages : 55+ y/o = .29 mm
- Foramen average size .60 mm

SO – the foramen is NOT as small as many people would like us to believe.

Suggested maxillary apical preparation sizes (* = not at constriction but 1, 2, 3, 5 from the apex)

	Compendium 1991	Lightspeed 1997	OOO 2000	J Endo 1971
Central and Lateral	**80**	**60-70**	**50-90**	**60-90**
Canine	**80**	**60**	**60**	**50-70**
Premolar	**45-80**	**50-60**	**40-65**	**35-90**
Molar MB	**45**	**45**	**35-60**	**35-60**
DB	**45**	**40**	**35**	**40-60**
P	**60**	**50**	**40**	**80-100**
*** JOE 10/99 (Kerekes and Tronstad)**	**MB 40-55**	**DB 40-55**	**P 55-80**	

Suggested mandibular apical preparation sizes (* = not at constriction but 1, 2, 3, 5 from the apex)

	Compendium 1991	Lightspeed 1997	OOO 2000	J Endo 1977 *
Incisors	**60**	**60**	**55**	**40-70**
Canine	**80**	**55**	**45**	**50-70**
Premolar	**45-80**	**55**	**40**	**50-70**
Molar MB	**45**	**40-45**	**45**	**35-45**
ML	**45**	**40-45**	**45**	**35-45**
D	**60**	**50**	**40**	**50**

- Canal sizes change with age. Sizes vary from very large to very small

Senia believes that this large range of canals sizes simply can't be cleaned with just a few instruments

Senia recommends Spangberg's one page article "The wonderful World of Rotary Root Canal Preparation" OOO Nov 2001. -> "Root canals are a lot like most other things in life – one size does not fit all".

Myth 3. Irrigants alone clean the entire canal
Senia wishes that they did but he thinks they don't.
He quoted Yang, Rivera et al JOE Oct 1996

NaOCl is ineffective because of:

- limited surface contact
- limited volume
- limited exchange of solution

Results: No significant differences between NaOCl and unmedicated groups in either the 1 or 7 day time intervals. This was true in both the main canal and inaccessible areas at the apical middle and coronal levels.

Senia did his Master's thesis on the Solvent Action of NaOCl on pulp tissue of extracted teeth. It was published in the OOO (Senia, Marshall, Rosen Jan 1971). He showed a cross section of a tooth with a lateral canal. He claimed that even after main canal instrumentation for 30 minutes and with an additional 30 minute NaOCl soak (replenished every 5 mins) – it was not effective in removing the lateral canal tissue. He concluded that there was no significant difference between saline and 5.25% NaOCl at the 1 mm and 3 mm level.

Shuping et al JOE Dec 2000
NaOCl cannot predictably disinfect canals if bacteria in the tissue or debris are sheltered from the disinfection action of the NaOCl. NaOCl became effective only when canals were prepared to larger apical sizes.

Senia does not believe the statement that Instruments shape and Irrigants clean.

Myth 4. Obturation is the most important part of treatment

Senia suggests that some of the techniques taught place emphasis on the desired shape to obdurate rather than focusing on cleaning. He quoted the classic (?) Sjogren 97 IEJ study of 94 % success of negative cultured obturations vs. <70% positive cultured obturations.
He then showed a cross section of a D root 1 mm from the apex. It showed necrotic tissue adjacent to the gutta percha obturation. He suggested that a cleaned canal without obturation can result in the healing of a lesion.
The role of obturation is to secure the long term treatment of the canal and to prevent further bacterial contamination.

Myth 5. **The Foramen is at the Apex** - Senia says many lecturers use the terms interchangeably and wrongly. Gutierrez and Aguayo OOO June 1995: Foramina are rarely at apex. Multiple foramina present – from one to 16 foramina shown.
Mizutani et al, JOE July 1992 : Location of foramina with relation to apex. Apical foramen not at apex in the following teeth Max. centrals 84%, Max. Laterals 93% Max. Canines 84%

Senia suggests that if you instrument to the radiographic apex you will be "in trouble".

Myth 6. Apical "Circumferential Filing"

Senia used to teach this. He says this doesn't happen. He says that there is no research anywhere to show that you can control a file apically. You can only control the file to "the curve". After the curve, the canal anatomy tells the file where to go. If there is no research to support this – how are the canal walls instrumented? Senia suggests that in order to clean the walls of the canal you must use instruments equal to or larger than the canal diameter.
Senia uses the concept of the Canal Cleaning Objective. Most foramina are oval. If you have an uninstrumented oval canal with the greatest diameter of a size 50, you need a minimum of a size 50 instrument to clean it properly. He calls that the "correct working width". Senia emphasizes that the original canal diameter dictates the final apical size.

Hulsmann, Paque, Versumer et al IEJ 2001-2005 (5 studies)
Molar canals were instrumented to final apical sizes of 30, 40 or 45. The 5 studies evaluated these files: Quantec, Hero, Profile 0.4T LightSpeed, Flexmaster, RaCe, and ProTaper.
Methodology:
2ml NaOCl 3% after each instrument
5 ml NaOCl 3% as final rinse
Chelating agent used during instrumentation
Roots were cross sectioned and pre treatment canals were compared with post treatment canals (Bramante technique)
Results: Avg. of 5 studies - At 3mm from apex - all canal walls instrumented -> only 44% of samples
At 3mm from apex – less than 50% instrumented -> 14% of samples
Senia concludes from this that

- Apical cleaning is poor
- Apical diameters are larger than once thought
- Final apical sizes need to be larger
- The canal diameter is the forgotten Dimension

Questions to ponder from this research:

1. Is it possible to instrument all canal walls with instruments smaller that the canal? – NO
2. Is using a predetermined final apical size a good idea? – NO
3. Did LightSpeed do better than the others? NO – because the "12 peck rule" was not used and the canals were "underprepared" according to Senia.
4. Are sizes #30, 40 and 45 considered normal? YES – therefore researchers need to use bigger sizes and not settle for predetermined apical size before they start. Prepare according to the canal anatomy.

Advantages of preparing to larger apical sizes:

1. More bacteria removed
2. Cleaner Canals
3. More effective irrigation
4. Easier obturation

The problems with endo relate to the fact that they have 3 dimension curves. Senia blamed his ledges, zips and transportations on the rigidity of Stainless Steel files.

Senia then showed some cases with "proper" working length, shape and obturation. Why did they fail? In all cases the canals were underprepared (improper diameter) and the remaining necrotic debris/bacteria caused the failure.

Working Length – Is there a biological tolerance for working length? Yes, apical anatomy is too complex to expect perfect instrumentation every time. Senia does not believe that simple overextension (excess filling material when a canal is properly cleaned) is a problem. The body is resilient - and implants would not work if the body was not so tolerant of "foreign bodies". Senia is not concerned with whether you work with instruments out the foramen ½ mm or 1 mm – as long as the clean the canal and "close the door" to further contamination.

Single Appointment Treatment and the Forgotten Dimension
Senia advocates single appointment treatment whenever possible. He has been doing this since his days as a student under Dr. Jim Marshall. But there are exceptions to the rule. No Single appointment Tx when:

1. Cellulitis present
2. AAA requiring incision and drainage
3. Periradicular periodontitis with severe pain to touch
4. A weeping canal that cannot be dried

5. Difficult cases that extend beyond the appointment time and the patient (and Senia's !) tolerance i.e. due to patient or operator fatigue.

Card et al JOE Nov; 28(11):779-83 - The effectiveness of increased apical enlargement in reducing intracanal bacteria.
Canals cleaned with larger apical preparations may allow for single appointment treatment rather than a two stage procedure utilizing an intracanal dressing.

Thorough cleaning of the canal is the essence of single visit endodontic success. If the canal is well cleaned on the first appointment - why is a 2nd appointment necessary?

The late Dr. Carl Hawrish was the one who first said that: "In Endodontics, the Canal Diameter is the Forgotten Dimension."

Baugh and Wallace JOE May 2005 - The role of Apical instrumentation in Root Canal Treatment

- 110 references
- Larger Apical preparations reduce bacterial count
- Larger Apical sizes yield cleaner canals
- Failing to clean canals, especially in the apical region cans result in treatment failure.

Senia reiterated Spangberg's OOO claim that the most important part of the preparation in the apical part of the canal.
Trope JOE May 1999 – "To ensure a high degree of endodontic success, obdurate only after bacteria have been substantially eliminated."

Canals are three dimensional. Canal length and diameter are important. Instrumenting to the perfect length is not enough.

Apical Preparation sizes: Should they be "as small as possible" or "as small as practical"?

Senia believes that Apical sizes:

- Should be at least as large as the canal diameter.
- Should be as large as required by the original canal size.
- Advocating small apical sizes represents the past. Rigid stainless steel instruments had to be small (or risk ledges, zips perforations, etc.)
- With rotary instrumentation we do not have to compromise apical preparation size
- "Final Apical Size" is the way he describes the final instrument that cleans to the end of the canal (not "MAF")

The new LightSpeed LSX Instrument (LSX= LightSpeed Extra Safe)

These new instruments addressed the perception of:

1. Too Many Instruments –>LightSpeed reduced the number of instruments
2. Fractured Too often – Senia claims that they actually fractured less than other Rotary instruments
3. Took Too much time -> Simplify the technique but maintain quality

The difference between the old LightSpeed instrument and the newer LSX:

1. Manufacturing -
   The old LightSpeed instrument was created using a **GRINDING (cutting)** process to create the file.
   The new LSX is **STAMPED OUT by machine** - a "coining" process)
   No cutting = no generation of superficial microfractures or weak points -> creates a stronger instrument, more resistant to fracture.
2. New blade design a "spade blade" -
   Rather than a U shape you have a spade– eliminates the flutes (instrument doesn't fill with debris)
   Reduces the cutting edge = greater efficiency and less torsional load
   Eliminates the necessity of the "intermediate" sizes".

3. LSX has been shown to be significantly more flexible that the original version

4. Available in length of 21mm (shaft ends at 16 mm), 25 mm (shaft ends at 18 mm), 31 mm (shaft ends at 24 mm), 50 mm Veterinary files (shaft ends at 43 mm)

Senia showed that even if the LSX is misused, it will either twist up in to a pretzel at the end of the instrument (but not break) OR break at the handle. In either case, he calls them "retrievable" instrument failures.

LSX Technique

Senia then showed a video of the LSX technique on a plastic block.
He divides the block into three sections – 1. the Coronal 2. the Middle and 3. the Apical sections.

Step 1 – Use GG drills #2 (size 70), #3 (size 90) and #4 (size 110) (or the instrument of your choice.) are used to flare the coronal aspect of the canal
Step 2 – Determine WL with at least a size #15 K file. He instruments and obturates 1 mm short of this length in combination with EFL confirmation. Patency with #15 is essential.
Step 3 – Sequentially larger LSX instruments are placed into the canal (#25, 30 and 35) until resistance is felt. If no resistance is felt proceed to the next larger size. Once resistance is felt, pause before slowly pushing to WL.
Step 4 - Since in this case it is the #35 instrument – this instrument engages the canal walls and generates debris. Therefore we irrigate. Irrigate until the solution is clear. Applying suction enhances debris removal. Reflood the canal.
Step 5 – The next instrument is used – a #40. Once resistance is felt, pause before slowly pushing to WL. Irrigate as before.
Step 6 – The next instrument is used – a #45. Once resistance is felt, pause, before slowly pushing to WL. A firm push is required. Irrigate as before. Because the #45 required a firm push in the final 5 mm. The oval canal has now been cut round, indicating that all walls had been cut. This is considered the Final Apical Size. (FAS) FAS will vary with the tooth and canal.
Senia then showed a video of the cross section of a root as the instruments worked.
Step 7 – A #50 instrument is used 4 mm from the WL. This shapes the apical part of the canal so a Simplifill Obturator fits properly.
Step 8 – Then next 3 instruments are used to shape the Middle section of the canal. #55 is advanced to resistance and pushed 2 mm apically. Be careful not to advance any midroot instrument to within 5 mm of WL as this may cause a loose fitting Simplifill plug. Each larger sequential instrument meets resistance more coronally resulting in a tapered preparation. This completes the midroot preparation. Replace the FAS. It should go easily to WL without obstruction. Then stop the handpiece and confirm the presence of an apical stop. Try to push the FAS past the WL. If the preparation has been done properly, it should NOT advance.
Step 9 – Irrigate with NaOCl, CHX or the irrigant of your choice. Suction and do a final rinse with EDTA. Dry the canal with paper points. Once the canal has been confirmed to be clean and free of debris it is ready for obturation.

Simplifill Technique

Simplifill plugs a re available in both Gutta Percha and in Resilon formula.

Select the Simplifill apical plug that matches the FAS. Do not use sealer when trial fitting. Set the rubber stop at working length. Slowly and gently advance the plug apically. Pause when feeling a slight resistance. Ensure that the plug is no less than 2 or more than 4 mm from WL.

When using Resilon, apply primer to canal. Remove excess primer with a paper point. Mix Resilon sealer. Use a paper point to coat the canal walls with sealer. Set the stop to the WL and coat the Simplifill plug with sealer. Advance the plug apically and pause when resistance is felt. Slowly and firmly push the plug to WL. Hydraulics force the sealer into the lateral canals and apical deltas. Release the plug from the carrier with 4 counterclockwise rotations. Senia uses a second application of sealer and a separate cone of the same size to do the backfill. He also adds accessory cones and sears off the most apical part of the backfill cones with a heated instrument. Senia emphasizes that this is the only carrier based obturation system that does NOT leave the carrier in the canal – allowing for easy post space and retreatment.

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