A case of diagnosis by access

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Fig. 1_Pre-op radiograph showing a well-performed root-canal therapy on tooth #19 (conservative access preparation and coronal shapes, dense fills to each canal terminus). Tooth #20 was treatment planned for root-canal therapy after the patient's pain had not been alleviated by treatment of #19.
Fig. 2_Pre-op radiograph of the maxillary arch, showing relatively large pulp horns in the chambers of teeth #13, 14 and 15, with restorations near each of them.

_She was related to my practice neighbour, a good friend and a very talented oral surgeon (OS), and was visiting him in Santa Barbara for the holidays. She was experiencing intractable pain in her left facial region. Could I see her today?

Two weeks before, her general dentist had referred her to an endodontist, who treated the root canal in tooth #19. However, the pain continued to escalate thereafter and endodontic treatment of tooth #20 was his secondary treatment plan. Fortunately, she left before that tooth was invaded.

When I met her at my front desk, I questioned her about her chief complaint—the chronology, eliciting factors and the pain referral pattern of her symptoms. She stated that the pain had been intensifying for the last two weeks, was spontaneous in onset and, for the most part, she was not aware of thermal sensitivity.

The patient felt pain in her upper and lower left teeth and down her neck. I immediately thought that this might be a classic case of myofascial pain masquerading as an endodontic problem. While dying pulp will refer pain indiscriminately to both upper and lower jaws, it never refers pain below the lower border of the mandible or above the patient's cheekbone. I call it the endodontic zone (EZ). When asked whether she had any history of myofascial or joint pain, the patient informed me that her temporomandibular joint clicked and that she had an occlusal night guard, which she had not been wearing lately.

So, not reactive to thermal stimulus, pain referred outside the EZ and a history of temporomandibular dysfunction—interesting. I thought that I had diagnosed this case in my reception area and that I had the wonderful opportunity to tell the patient that she did not need another root-canal treatment.

My assistant took the patient back to an operatory, took conventional X-ray (Figs. 1 & 2) and CBCT images, and gathered clinical findings and pulp testing data. No peri-radicular pathosis was seen in any of the X-rays, cold tests of all teeth on the left side of the patient's face were within normal limits (WNL), and I was itching to find the myofascial trigger-point that had been making her miserable. I had her open half-way—as per Dr Janet Travel—then palpated her left masseter and temporalis muscles but they were stellar—surprising!

I then felt like I was in the "Twilight Zone" instead of the EZ. The patient had not reported thermal sensitivity and had pain referred beyond where dying pulp refers. But I was unable to reproduce the pain by palpating her muscles of mastication.

At this point, I had no option but to turn to my standard process of pulp testing to rule pulpitis out as the aetiology of her symptoms (although the previous endodontist had ruled out tooth #19). I did cold testing (with an H_2O ice pencil formed in an autoclaved empty anaesthetic carpule) on all of her teeth on the upper and lower left side of her face, and while they all responded WNL, teeth #18, 14 and 15 responded sharply, but transiently—not definitive by any means.

The possibility of more than one tooth being irreversibly inflamed was virtually zero. I still did not know what was going on, although tooth #14 was very slightly sensitive to biting pressure and percussion. It had been restored recently with composite and was nearly in crossbite and therefore more likely to be affected by bruxism.

Therefore, I was left to my best next move in these kinds of situations. I heat tested all of the upper and lower teeth (except #19 of course) with my System B Heat Source (SybronEndo). SybronEndo sells a special heat-testing tip for Touch 'n Heat and System B Heat Source that allows users to apply a sustainable heat stimulus to both quadrants of teeth in under a minute, with gutta-percha on the tip and the sources set to 200 °C.

In my experience, using sustainable sources of thermal stimuli to test pulp is the *sine qua non* of endodontic diagnosis. With transient sources of thermal stimuli—spray refrigerants and flame-heated gutta-percha—the temperature is never the same, which adds another variable to an already subjective data point. Additionally, it sometimes takes a bit of time to elicit a response when insulating acrylic, porcelain or calcification of the pulp chamber delays the response of a tooth with a relatively healthy pulp.

I tested teeth #18, 20, 21, 12 and 13 and achieved WNL responses (little or no response to heat is normal). However, when I heated #14, I reproduced the patient's chief complaint *exactly* and it had a prolonged effect. This was a huge relief and far better than having to say "I just don't know what is making your sister-in-law miserable." We scheduled the patient for an emergency appointment the next day, as her pain was at a manageable level when she had taken an adequate dose of ibuprofen and as my schedule was already full, with three other emergency appointments.


Fig. 3


Fig. 4

My OS buddy called me the next morning to inform me that his sister-in-law was nervous about another possible misdiagnosis and erroneous treatment plan. In my mind, this concern qualified her as passing the IQ test. I repeated the thermal testing just to be certain that I was not going to be the second endodontist that would perform a needless root-canal treatment on a dentist's relative, while failing to resolve her chief complaint. Cold testing gave the same vanilla responses, but heat testing on the mesiobuccal (MB) line angle of #14 reproduced her pain, and it was also a bit more sensitive to percussion and bite.

I felt even more confident in my diagnosis when the patient's pain was totally alleviated by infiltration with 1.5 carpules of 2% lidocaine 1/100k epinephrine on the buccal side of tooth #14 and 0.5 carpule on the palatal side—given comfortably with extremely slow administration of the anaesthetic using the STA Anesthesia Delivery System (Milestone Dental)—in this very tight tissue.

As an aside: I really do not trust local anaesthesia as a diagnostic procedure. It is not specific enough to rule out a single tooth, it may mask adjacent myofascial aetiology and, after giving any local anaesthesia, further diagnostic work is not possible.

Fig. 3_CT axial view, showing the MB root of tooth #14 with two canals.
Fig. 4_CT sagittal view, of the MB root from the mesial direction. Note the common orifice of the MB1 and MB2 canals that immediately bifurcate and are apically confluent where the canal terminates in a severe curve in the hidden palatal plane.

Fig. 5_CT sagittal view of the DB root from the mesial direction. Note the multiplanar curvatures ending in an apical bend to the hidden buccal direction.
Fig. 6_CT sagittal view of the palatal root, showing nearly perfect tapered canal shape.


Fig. 5

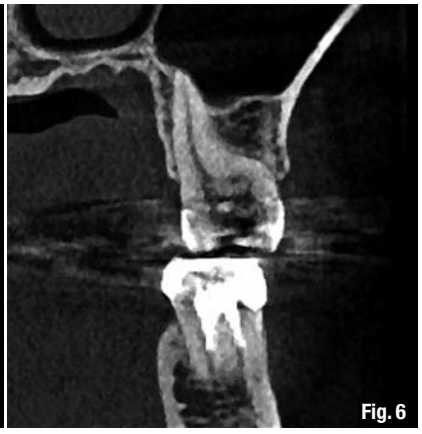


Fig. 6


Fig. 7


Fig. 8

Fig. 7_Dental pulp extirpated from the palatal canal. A bent #25 broach was rotated as it was carefully inserted into the canal, after which it was gently and slowly removed with the intact pulp wrapped around it. Bending a #25 broach causes its mid-portion to sweep around the periphery of the canal wall of medium and large canals regardless of their size and taper, obviating the need for other sizes.

Fig. 8_Access cavity in tooth #14, showing the preparation limited to the mesial half of the occlusal surface. Note the Khademi Groove cut into the mesial wall for easier treatment of the MB2 canal—the only canal in the upper molars without an access line angle to guide instruments and materials. The small amount of time needed to cut this groove pays dividends throughout the procedure, especially during negotiation when lubricant is filling the access cavity.

As a confirmation of our definitive pulp testing results, however, the elimination of her symptoms after anaesthesia was good to see.

After anaesthesia had been confirmed by heat testing and percussion, tooth #14 was isolated with a rubber dam and an access cavity into the pulp chamber was cut. As was expected from the tooth's sensitivity to heat stimulus, the pulp was partially necrotic—the MB and distobuccal (DB) canals having fully degenerated tissue and the palatal canal pulp virtually intact (Fig. 7).

The volumetric images gathered with my Accuitomo (J. Morita) revealed that the MB root held two canals that diverged from a single orifice and then joined again in the apical third, where it appeared to have a severe palatal curve (Figs. 3–6). As I had learned from my friend and colleague Dr John Khademi, I cut a shallow MB2 groove in the mesial access wall to facilitate treatment of the only canal in the upper molars that does not have an access line angle dropping into it (Fig. 8).

All canals were negotiated with rotary NiTi instruments—first with a Vortex (DENTSPLY Tulsa) 15/.06 file to mid-root, followed by a Vortex 15/.04 to length in each canal except the MB1 and MB2, which required the more flexible PathFiles (DENTSPLY Tulsa) to reach the terminus owing to their abrupt apical curves. Rotary negotiation (in most cases without using hand files beforehand) has been a gratifying procedural upgrade in my practice. While I have not found the PathFiles to be dependable as first instruments in tight canals, Vortex files accomplish this in a way that is counter-intuitive to my previous paradigm (using # 8, 10 and then 15 K-files to length in the presence of a lubricant). By a fluke I found that in all but the most severely curved canals (of course those with impediments as well) these small Vortex instruments usually cut to length in less than a half-minute.

I am not exactly certain why Vortex files work so well for handpiece-driven negotiation, but my best guess is that their triangular cross-sectional geometry has enough space between the three cutting flutes to auger, rather than compact, vital pulp tissue from the apical thirds of small canals. I have yet to block a canal with these instruments, although I am very careful to stop using them at the slightest hint of apical resistance. If the 15/.06 meets resistance, I use the 15/.04. If the 15/.04 becomes stuck, I bring in hand files in sizes 08 and 10 C-files to length, and then I use the # 1, 2 and 3 rotary PathFiles to length (all 0.02 tapered with tip diameters of 0.13, 0.16 and 0.19 mm).

I used the Root ZX II (J. Morita) with all initial files taken to length, thereby knowing at all times when I had reached the termini, and obviating the need for a length determination X-ray. As usual, I used the straight apex locator probe instead of the test clip version. Even with hand files, I dislike the spring clip file probe, as it interferes with my tactile sense and it gets in the way of the rubber dam field. With rotary negotiation, the straight probe with its v-cut tip makes it very easy to pick up as estimated length is approached with the rotary negotiating file, and its tip notch rides smoothly on the rotating file. The final reason I prefer this probe set is because it is thinner and fits more easily between the stop and handle and it is very effective at positioning the stop exactly at the reference point once length has been indicated. An additional advantage of doing the initial negotiation procedure with Vortex 15/.06 and 15/.04 files is that with these tapers being greater than the typical 0.02 tapered hand files, there is less change in curved canal lengths during the shaping procedures to follow.


Fig. 9

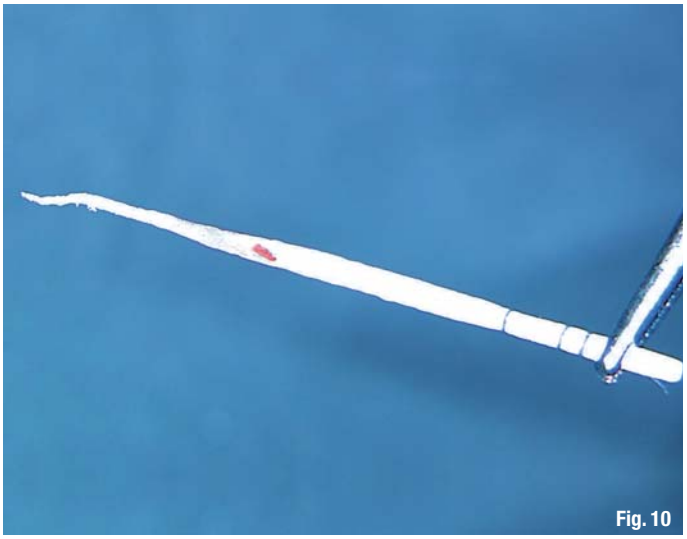


Fig. 10

Fig. 9_Rotary GTX File with variable-width lands—thinner at the tip and shank, thicker in its middle region. This geometry optimises the radial lands to cut much more efficiently than rotary files with consistent-width lands, while maintaining identical fidelity to canal curvatures.
Fig. 10_Paper point used to dry the palatal canal, showing blood mark only on its middle region.

I *never* do initial negotiation procedures with NaOCl irrigant in the access cavity. While all the current apex locators work in the presence of conductive fluids, none of them work as well as when relatively non-conductive lubricants are used instead. NaOCl short-circuits the apex locator to metallic restorations and even without metal nearby, the readings in the presence of this irrigant are much less stable.

A note of caution: while non-landed shaping instruments are safe in the smallest sizes, I would not recommend using them for shaping canals. To prevent apical damage, I use only radial-landed rotary files (Fig. 9) to cut final shapes after initial negotiation. Final shapes were cut in the palatal canal with a single 30/.08 GTX File, with a 20/.06 and a 30/.06 GTX File in the DB canal, and three instruments in the apically curved MB canals. I cut a crown-down shape in these canals with first a 20/.06 and then a 20/.04 GTX File.

After confirming that there was apical continuity of taper in each canal, by using NiTi K-files as radial feeler gauges—this is done in the presence of 17% EDTA (to remove the smear layer)—my efforts turned to cleaning the root-canal system with pre-heated 6% NaOCl. I began by ultrasonically vibrating the irrigant with a #10 K-file taken 1 mm beyond the terminus—this prevents the micro-ledging that occurs when the vibrated file tip is held inside the apical third—for a couple of minutes in each canal, and then switched to active irrigation with the negative pressure EndoVac System (Discus Dental).

Despite heating the solution, using ultrasonication and a state-of-the-art delivery method, in an inflamed vital case like this I still feel that the NaOCl needs additional time to digest any tissue that may remain in lateral and accessory canals. Failure to clean the lateral aspects of root-canal systems containing severely inflamed pulp remnants adequately is what causes some of these patients to complain of persistent pain to biting and percussion despite apparently ideal root-canal treatment results evidencing no peri-radicular pathosis.

Obturation was accomplished after cleaning with the System B/Elements Obturation Unit (SybronEndo) using the Continuous Wave of Obturation Technique. Interestingly, when I was drying the palatal canal in preparation for cementing the pre-fit master cone of gutta-percha, the paper points were coming out soaked in blood. While this may be disconcerting to clinicians, it does not mean anything has necessarily gone awry, it just means that the bleeding must be stopped.

I soaked a paper point in 30% ferric sulphate (known by the brand name Cutrol or the pharmaceutical name Monsel's Solution), placed it to the end of the canal and a bit beyond, and after 10 or 15 seconds removed it, irrigated with NaOCl, gained patency with a K-file that could be passively placed beyond the terminus, and resumed drying the canal. Sometimes this must be done two or three times to staunch bleeding, but I have never seen it fail. In this case, while the paper point stopped absorbing blood at its tip, it continued to show a spot of blood in the middle of the cone (Fig. 10). The post-operative X-ray images revealed a lateral canal filled in the middle of the palatal canal (Figs. 11 & 12).

A piece of sponge and Cavit (3M ESPE) were placed in the access cavity and the patient was dismissed after post-operative images had been taken and instructions given. As usual, the patient also received enough Aleve to last four days at two tablets BID and instructions about managing her pain of myofascial origin (finally located as ema-

Fig. 11

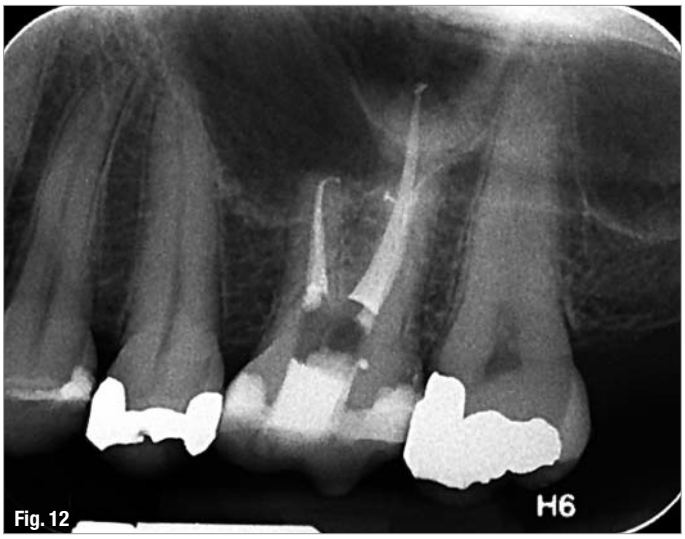


Fig. 12

Fig. 11_Post-op radiograph, revealing—to a limited degree—the multiplanar curvature of the DB canal and the apparently straight MB canal form. Note the conservative, mesially angulated access cavity preparation and the filling material in the distal pulp horn, which was intentionally left unroofed to preserve coronal tooth structure.

Fig. 12_Shallow, distally angulated post-op radiograph, revealing the severe apical curvature of the MB canal system and the mid-root lateral canal in the palatal canal that spotted the middle of the paper point in Figure 10 with blood.

nating from her left sternocleidomastoid muscle). A phone call four days later confirmed that she had no spontaneous pain referral, just the expected soreness to biting pressure.

So, looking back at this case, why the misdirection and wrong turns?

Firstly, my initial hypothesis about the aetiology of her chief complaint was misdirected by the lack of thermal sensitivity and by the pain she described in her neck region. Ironically, the patient did not relate thermal sensitivity because she does not care for really hot or cold foods or beverages and therefore had not thermally challenged tooth #14. As to the muscle tenderness outside the EZ, when I heard her describe this referral of pain below her mandible, I assumed she also had trigger-point myopathy in her masseter and temporalis muscles, the muscles that commonly refer pain *into* the EZ.

Regarding the first endodontist needlessly treating tooth #19 and failing to resolve the original aetiology of the patient's pain syndrome, it is a profound truth that endodontic disease becomes less obscure and easier to diagnose with time. Therefore, being the second one in on the case undoubtedly was an advantage at some level. With that said, a pulpal status like this one (partial necrosis) will return a WNL cold test response, albeit a delayed and vague one, virtually every time.

Interpreting sharp but transient responses to cold testing as indicative of irreversible pulpitis is a very common mistake. Until sharp, prolonged responses are seen—ideally with identical reproduction of the patient's pain—clinicians must obtain further pulp testing results outside of normal limits before they start diving into pulp chambers. In this case, every tooth—except #19 (no response) and 14 (delayed, vague)—responded in a very sharp but transient manner. I had no doubt that #19 responded the same way before it was treated, as evidenced by the endodontist's secondary treatment plan of accessing #20, a perfectly healthy tooth.

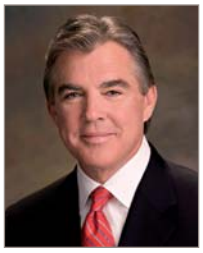
Partially necrotic pulp is nearly impossible to diagnose without using a sustainable source of heat. Classically, partially necrotic pulp responds to cold tests WNL, although sometimes cooling the tooth will alleviate the pain. Unless a heat stimulus is applied, thereby increasing the pressure inside the dead space, patients will be left in pain until the remaining pulp dies and clinicians will feel inclined to cut access cavities until the patient's pain is relieved.

We can and must do better than diagnosis by access._

Please visit www.endobuchanan.com for video clips of this case.

_about the author

roots



After 30 years, **Dr L. Stephen Buchanan** continues to enjoy his Santa Barbara, California, practice limited to conventional and microsurgical endodontics, as well as implant placement. He also teaches part-time at University of Southern California; University of California, Los Angeles; and every month in his state-of-the-art Santa Barbara teaching facility—Dental Education Laboratories.

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