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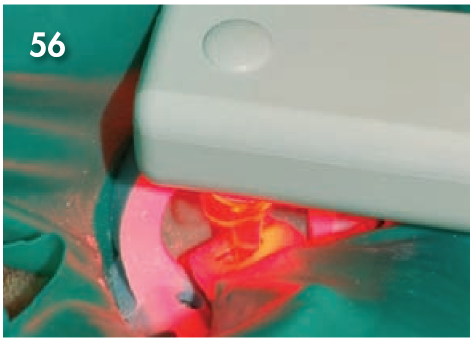
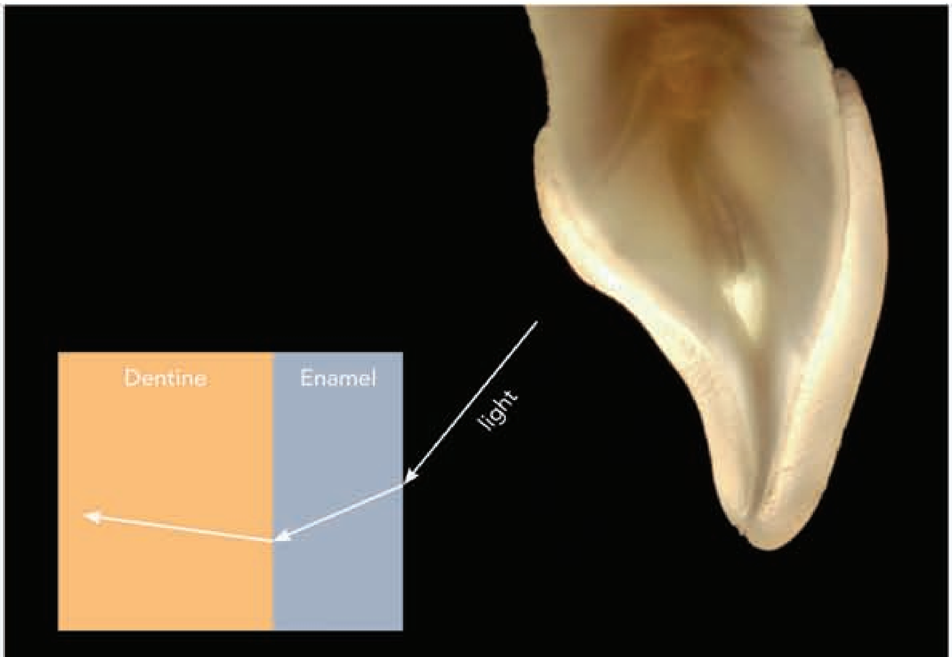


Essentia™ recognises that dentine and enamel react differently to light

Essentia™ introduces a new paradigm in composite filler design, with recognition that the filler structures of dentine and enamel shades should be different so they can more effectively replicate the complexities of light movement through dentine, enamel and the dentine enamel junction (DEJ). This is shown in the diagram below.



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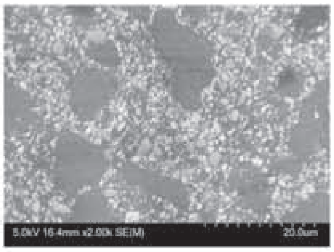
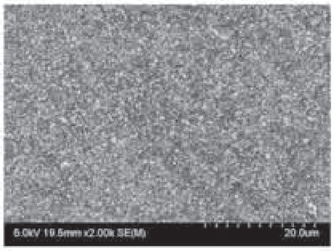


Dentine shades feature a diverse range of fillers, with wide light-scattering ability to ensure blending with surrounding dentine.



Enamel shades feature ultrafine, high density fillers that give exceptional strength, polish and wear resistance.

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On Sunday 5th June, the south-east coast of Australia was completely battered by a huge storm which produced flooding expected only once in a hundred years or more. Unfortunately, the result was devastating damage to many local communities in metropolitan and regional New South Wales, Victoria and Tasmania.

One region severely affected was the Wollondilly Shire of NSW, incorporating the Camden/Picton regions. The NSW Premier and Prime Minister of Australia visited the region in the aftermath and saw scenes such as these:

Together with a lot of other businesses in the area, Picton Dental was left completely gutted. The community has been working together but, even weeks after the floods, shop fronts and businesses remain boarded up and unattended. It will take a long time to fully recover from such a heartbreaking catastrophe.

The amazing team at Picton Dental were inspiring in the aftermath. Ashleigh, the Practice Manager, was at the forefront of the reconstruction, leading the task to get the practice back on its feet. Leveraging off support from pockets of the community, they began to re-build.

Henry Schein Halas is always willing to lend a helping hand where it's needed. Through the Henry Schein Cares Foundation, we were able to donate products to help Picton Dental on their way to recovery. On Monday 18th July, Picton Dental were able to re-open their doors to the community!

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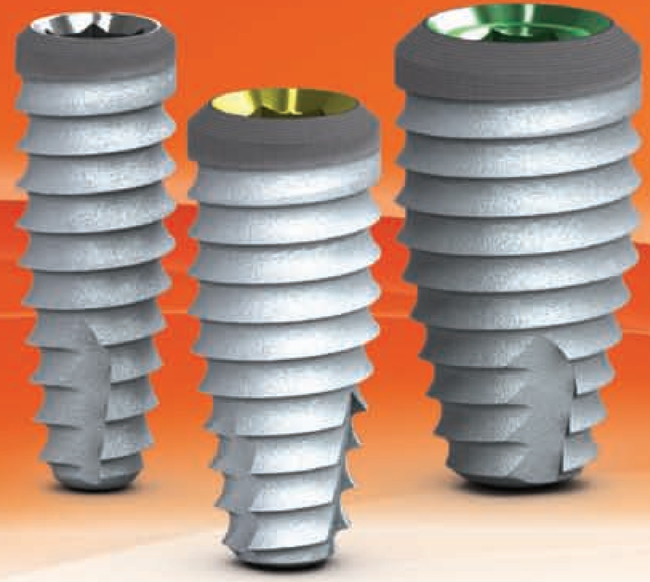

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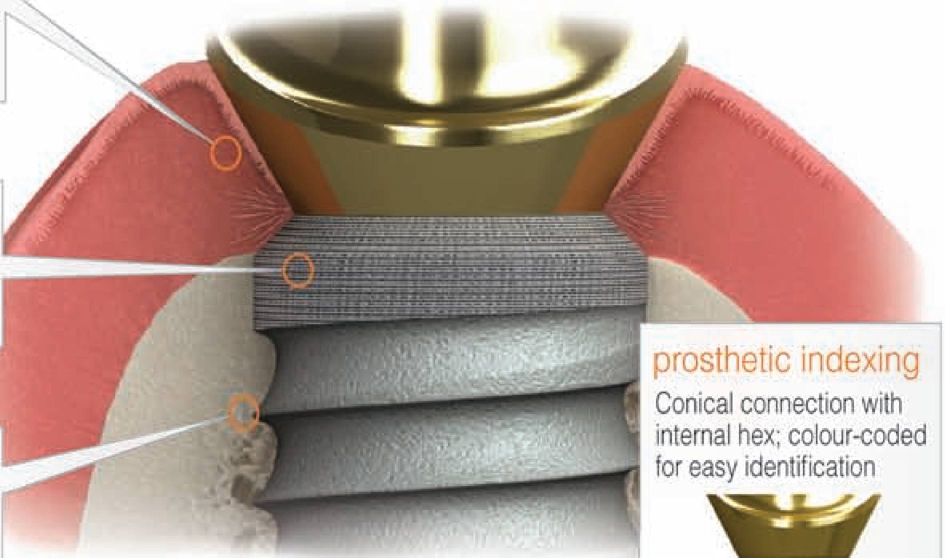

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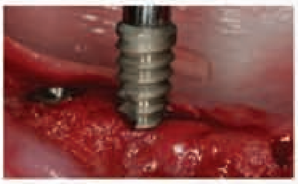

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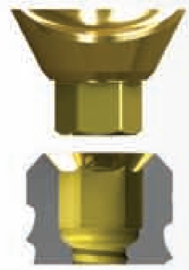

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Tactile controlled activation technique with controlled memory files

Antonis Chaniotis[1]

The ultimate biologic objective of endodontic therapy is the prevention of periradicular disease and the promotion of healing when disease is already established. Arguably, mechanical instrumentation and chemical disinfection of the root canal system are considered the foundational principles for the successful accomplishment of these objectives (Schilder, 1974). Although these principles cannot be considered separately, canal preparation is the essential phase that will determine the efficacy of all subsequent procedures (Peters, 2004).

Traditionally for gutta percha fillings, root canal shaping should satisfy specific design objectives:

- The shape of the main root canal should resemble a continuously tapering funnel from the orifice to the apex
- The cross-sectional diameter of the main canals should be narrower at every point apically
- Canal preparation should follow the shape of the original root canal
- The original position of the apical foramen should be preserved
- The apical opening should retain its original dimensions as much as possible (Schilder, 1974; Hulsmann, Peters, Dummer, 2005).

The biological objectives of root canal instrumentation consist of: the confinement of instrumentation to the limits of the roots themselves; the avoidance of extruding necrotic debris into the periradicular tissues; the removal of all organic tissue from the main canals as well as from the lateral extent of the root canal system; and the creation of sufficient space to allow irrigation and medication by simultaneously preserving enough circumferential dentine for the tooth to function (Hulsmann, Peters, Dummer, 2005).

Achieving these objectives in straight canals is considered a simple and straightforward procedure with all instrumentation systems available today. The problems of biomechanical instrumentation arise when the internal anatomy of human teeth is severely curved or even bifurcated and anastomotic (Figure 1).

In such teeth, the accepted basic endodontic techniques and instrumentation protocols might be challenging to follow.

The aim of this article is to describe the application of tactile controlled activation (TCA) technique with controlled memory files for the safer and more predictable instrumentation of severely curved and challenging canals.

The challenge of curved canal management

The internal anatomy of human teeth can be extremely complicated. Based on canal curvature, Nagy et al (1995) classified root canals into four categories: straight or I-form (28% of the root canals), apically curved or J-form (23% of the root canals), entirely curved or C-form (33% of the root canals) and multicurved or S-form canals (16% of the root canals).

Schafer et al (2002) found that 84% of the human root canals studied were curved and 17.5% of them presented a second curvature and were classified as S-shaped root canals. From all curved canals studied, 75% had a curvature of less than 27o, 10% had a curvature with an angle between 27o and 35o and 15% had severe curvature of more than 35o.

Traditionally, root canal curvatures were assessed by using the Schneider angle of

[1] Dr Antonis Chaniotis graduated from the School of Dentistry, University of Athens, Greece, in 1998. In 2003, he completed the three-year postgraduate programme in endodontics at the School of Dentistry, University of Athens. He is a clinical instructor affiliated with the undergraduate and postgraduate programmes in the endodontics department at the dental school, and owns a private practice in Athens limited to microscopic endodontics since 2003. He has been clinical fellow of dentistry at the University of Warwick since 2012. Dr Chaniotis has published articles in local and international journals and he has lectured at more than 40 local and international congresses. In 2010, he joined the Roots Forum and became well known for his clinical skills through his microscope-enhanced endodontic video case management series.

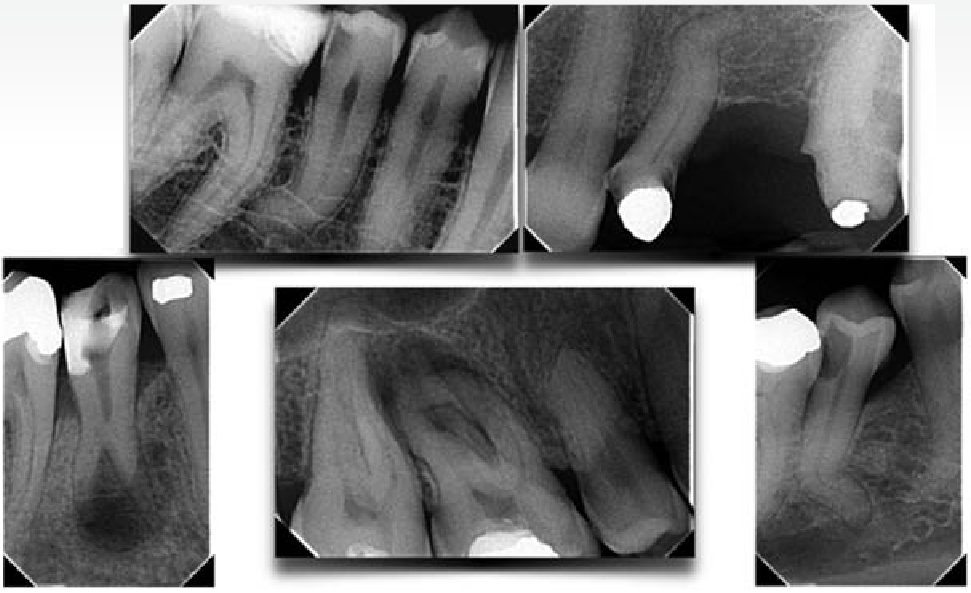

Figure 1: Complex root and root canal anatomical challenges in endodontics.

curvature concept (Schneider, 1971). According to Schneider (1971), root canals presenting an angle of 5o or less could be classified as straight canals, root canals presenting an angle between 10o and 20o as moderate curved canals, and root canals presenting a curve greater than 25o as severely curved canals.

Many decades later, Pruett et al (1997) reported that two curved root canals might have the same Weine angle of curvature, but totally different abruptness of curvature. In order to define the abruptness of curvature they introduced the concept of the radius of curvature. The radius of curvature is the radius of a circle passing through the curved part of the canal. The number of cycles before failure for rotary endodontic instruments significantly decreased as the radius of curvature decreased and the angle of curvature increased.

Further attempts to describe mathematically and unambiguously root canal curvatures in two-dimensional radiographs introduced parameters such as the length of the curved part of the canal (Schäfer et al, 2002) and the location of the curve as defined by curvature height and distance (Günday, Sazak, Garip, 2005).

Estrela et al (2008) described a method to determine the radius of root canal curvatures using CBCT images analysed by specific software. Radius of canal curvatures was classified into three categories: small radius (r≤4mm), intermediate radius (r>4 and r≤8mm) and large radius (r>8mm). The smaller the radius of a curvature is, the more abrupt it becomes.

All these attempts to describe the parameters of root canal curvature had one common denominator, the preoperative risk assessment for transportation and unexpected instrument separation.

The risks of canal transportation and instrument separation

According to the glossary of endodontic terms (American Association of Endodontists, 2012), transportation is defined as the removal of the canal wall structure on the outside curve in the apical half of the canal due to the tendency of the files to restore themselves to their original linear shape. For stainless steel hand files and conventional nickel titanium hand or engine-driven files, the restoring force of a given instrument is directly related to its size and taper. The bigger the size or taper of a given file is, the bigger the restoring force becomes due to the increase of the metal mass of the instrument.

If root canals were constructed precisely on the dimensions of our instruments, then transportation wouldn't be a problem and our instruments would be well constrained inside the root canal trajectories. Unfortunately, instruments are not well constrained by the canal in a precise trajectory, because instruments are not precisely shaped to fit the canal dimensions. As a result, each instrument may follow its own trajectory inside a curved canal guided by its restoring force and transporting the canal (Plotino et al, 2010). Usually, the greater increase in apical enlargement is targeted in curved canals, the more excessive the dentine removal towards the

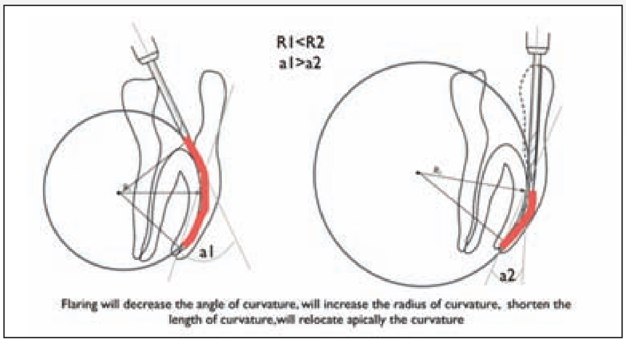

Figure 2: The effect of flaring in the curvature parameters.

more excessive the inner curvature (danger zone) widening can get.

In order to avoid these complications, the more severe the canal curvature is, the more we tend to increase flaring and reduce the apical instrumentation size (Roane, Clement, Carnes, 1985). Increasing flaring under such circumstances would result in the reduction of the angle of curvature, in shortening the length of curvature, in increasing the radius of curvature and in relocating the curvature apically (Figure 2). Smaller apical preparations in highly curved canals would be preferable for two reasons:

- Smaller diameter preparations are related to less cutting of the canal walls, less file engagement and consequently, a lesser likelihood for the expression of undesirable cutting effects
- Small diameter files are more flexible and fatigue resistant and therefore less likely to cause transportation during enlargement (Roane, Clement, Carnes, 1985).

The aforementioned instrumentation approaches, although safer, have inherent disadvantages. Unfortunately, flaring the canal entrance in order to achieve easier negotiation to the apical third of curved canals will result in unnecessary removal of dentine from a level that is considered irreplaceable. Moreover, smaller apical preparations may result in increased difficulties for the irrigation solutions to be delivered to an appropriate canal depth. In highly curved canals the ability of irrigation solutions to be delivered to the critical apical third depends directly on the ability of our instruments to create adequate apical preparations and on the selection of the appropriate delivery techniques (Boutsioukis et al, 2010).

Achieving adequate apical preparations for disinfection without over-flaring the coronal part of highly curved canals is one of the greatest challenges in endodontic instrumentation. This is very true especially under the current concepts of dentine preservation in endodontics.

Moreover, the risk of unexpected instrument separation of engine-driven nickel titanium files poses significant problems during curved canal management. There are two mechanisms that have been implicated with engine-driven instrument fracture, cyclic fatigue and torsional failure. As an engine-driven instrument is activated inside a curved canal, continuous tensile and compressive stresses at the fulcrum of the curvature may lead to instrument separation because of cyclic fatigue. If the tip of an engine-driven instrument is locked inside a canal and the shaft of the instrument keeps on moving, it may exceed an applied shear moment, resulting in torsional failure. Usually during curved canal management both mechanisms can co-exist. As the complexity of the curvature increases, the number of cycles before failure decreases for a given instrument, making complicated canal management a real clinical challenge.

Controlled memory files to minimise instrumentation risks

Nickel titanium alloys are softer overall than stainless steel, have a low modulus of elasticity (about one fourth to one fifth that of stainless steel), greater strength, are tougher and more resilient and show shape memory and superelasticity (Baumann, 2004). The nickel titanium alloys used in root canal treatment contain approximately 56% (wt) nickel and 44% (wt) titanium (Walia, Brantley, Gernstein, 1988). They can exist in two different temperature-dependent crystal structures (phases) called martensite (low-temperature phase, with a monoclinic B19′ structure) and austenite (high temperature or parent phase, with the B2 cubic crystal structure). The lattice organisation can be transformed from austenitic to martensitic and return again to austenitic phase by adjusting temperature and stress. During this reverse transformation the alloy goes through an unstable intermediate crystallographic phase called R-phase.

Preparation of the root canal causes stress to nickel titanium files and a stress-induced martensitic transformation takes place from the austenitic phase of conventional nickel titanium files to the martensitic phase within the speed of sound. A change in shape occurs, together with volume and density changes.

This ability of resisting stress without permanent deformation – going back to the initial lattice form – is called superelasticity. Superelasticity is most pronounced at the beginning of the applied stress, when a first deformation of as much as an 8% strain can be totally overcome. After 100 deformations, the tolerance is about 6% and after 100,000 deformations it is about 4%. Within this range, the so-called ‘memory effect’ can be observed (Baumann, 2004).


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Besides the stress-induced martensitic transformation, the lattice organisation of nickel titanium alloys can be altered also with temperature change. When a conventional nickel titanium austenitic microstructure is cooled, it begins to change into martensite. The temperature at which this phenomenon begins is called the martensite start temperature (Ms). The temperature at which martensite is again completely reverted is called the martensite transformation finish temperature (Mf). When martensite is heated, it begins to change into austenite. The temperature at which this phenomenon begins is called the austenite transformation start temperature (As). The temperature at which this phenomenon is complete is called the austenite finish temperature (Af), which means that at and above this temperature the material will have completed its shape memory transformation and will display its superelastic characteristics (Shen et al, 2011).

Before 2011, the Af temperature for the majority of the available nickel titanium endodontic instruments was at or below room temperature. As a result, conventional nickel titanium endodontic instruments were in the austenitic phase during clinical use (body temperature), showing shape memory and superelasticity. In 2011, so-called controlled memory files were introduced in endodontics. These files had been manufactured utilising a thermomechanical processing that controls the material's memory, making the files extremely flexible and fatigue resistant but without the shape memory and restoring force of other nickel titanium files (Coltene/Whaledent, 2012).

The Af transformation temperature of controlled memory files is found to be clearly above body temperature. As a result, these files are mainly in the martensite phase in body temperature (Shen et al, 2011). When the material is in its martensite form, it is soft, ductile, without shape memory, can easily be deformed yet it will recover its shape and superelastic properties upon heating over the Af temperature. Moreover, a hybrid martensite microstructure (like the Hyflex CM controlled memory files) is more likely to have more favourable fatigue resistance than an austenitic microstructure. At the same stress intensity level, the fatigue crack propagation speed of austenitic structures is much faster than that of martensite ones. A quantitative analysis based on the model of the fracture process zone showed that the martensite transformation in the shape memory nickel titanium alloy caused 47% increase in the apparent fracture toughness (Wang, 2007).

Very recently, controlled memory thermomechanical processing was combined with an innovative machining procedure for the manufacturing of rotary nickel titanium endodontic files. The procedure is called electrical discharge machining (EDM) and results in instruments of increased surface hardness cutting efficiency and extreme fatigue resistance. In the first paper published evaluating these files (Pirani et al, 2015), spark-machined peculiar surface was mainly noticed and low degradation was observed after multiple canal instrumentations. The authors also found high values of cyclic fatigue resistance and a safe in vitro use in severely curved canals. In agreement with these previews researchers, Pedulla et al (2015) reported higher values of fatigue resistance for EDM rotary files even when compared with reciprocating files made from M-wire.

The extreme flexibility and fatigue resistance of these files combined with the lack of restoring force render them ideal to be used for the instrumentation of highly curved and complicated canals. Whenever a conventional superelastic nickel titanium file is rotating inside a curved canal, it creates its own trajectory guided by the restoring force of the file and transporting the canal toward the outer apical curve (ElAyouti et al, 2011). The bigger the size or taper of the file used, the more dentine is removed from the outer apical curve, resulting in off-centred preparation at this level.

Leseberg and Montgomery (1991) studied canal transportation at the level of the curve and documented the distal (toward the midline) movement of the original canal. They showed that canal transportation is caused by a combination of forces resulting from the restoring force of the instrument that rotates around the clinical and proximal view curvatures. These forces produce a transportation vector distally and axially at this level. From their study it would appear that for the middle third of a given curved canal, the greater the clinical and proximal view curvatures the faster the transportation would

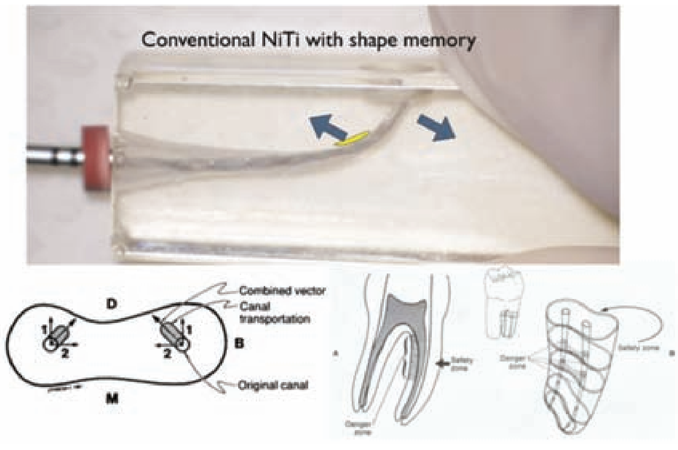

Figure 3: Transportation dynamics of shape memory nicklel titanium rotary files. Notice that the instrument removes material by touching the outer apical curve and the inner middle curve.

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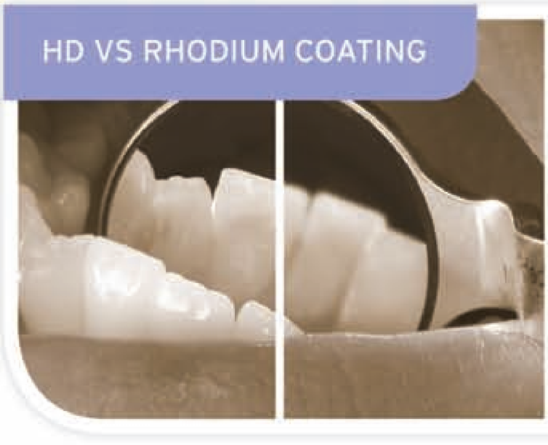

*"Vision Enhancement in the Operatory," Dental Economics, August 2006. **Data on file.

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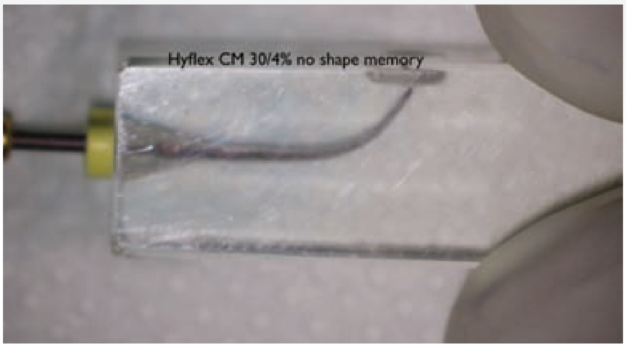

Figure 4.

progress toward the distal concavity of the root. The dynamics of apical and middle third transportation, as the result of the restoring force of the instrument and the degree of canal curvature, can be seen in Figure 3.

However, controlled memory files have no restoring force after bending in body and room temperature. Whenever an instrument with controlled memory characteristics is activated inside a curved canal, it moves passively inside the anatomy producing minimal forces of transportation. In highly curved canals, the lack of restoring force keeps the CM files rotating towards the outer canal wall at the fulcrum of the curvature (Figure 4).

Similar transportation dynamics with controlled memory were also demonstrated during the instrumentation of double curved canals (Burroughs et al, 2012). In simulated S-shaped canals, controlled memory files produced more overall transportation compared to SAF and M-wire instruments. Although the overall transportation was found bigger for no shape memory files, they always transported the double curved canal towards the outer curves. This is very important in highly curved and double curved canals because the initial dentinal thickness of human curved roots is always minimal at the convexity of the inner distal curves (danger zones) or the inner S-apical curves (Figure 5).

TCA instrumentation technique

Root canal instrumentation involves the use of hand- or engine-driven files to create sufficient space for irrigation and medication. The tactile feedback of the root canal anatomy felt by the operator during this procedure depends on various factors including: the initial canal shape (round, oval, long oval or flat canals), the canal length (the longer the canal the more frictional resistance is expected), the canal taper (tapering discrepancy between a gauging instrument and the canal may cause false binding sensation), the canal curvature (curved canals can cause deflection of the instruments and increase frictional resistance), the canal content (fibrous or calcified canal content can create different degrees of frictional resistance), canal irregularities (attached pulp stones, denticles and reparative dentine can create convexities on root canal walls) and the type of instrument used (rigidity, flexibility, tapering and restoring force can alter the frictional feedback) (Jou et al, 2004).

For a given root canal and a given file, the operator's tactile feedback during the instrumentation procedure differs according to the kinematics of the file used. Passively inserted files (non-activated) give a tactile sensation that is determined by the frictional resistance generated when the file engages the dentinal walls. The tactile sensation with an activated file (rotating or reciprocating) however, as the result of cutting, can more accurately be determined by the ability of the file

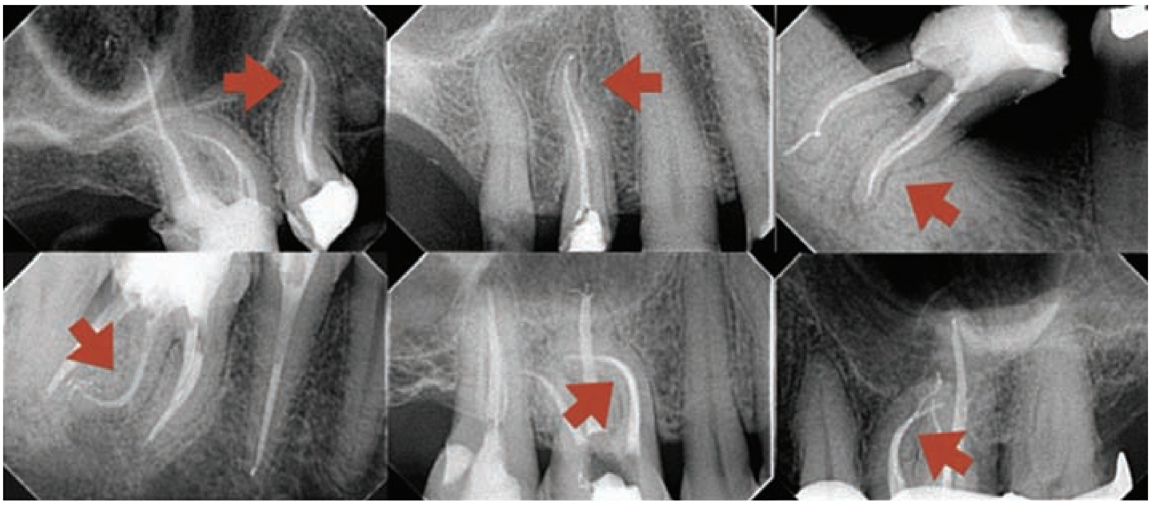

Figure 5: Cases treated with Hyflex CM files. The arrows point to the areas of dentine preservation.

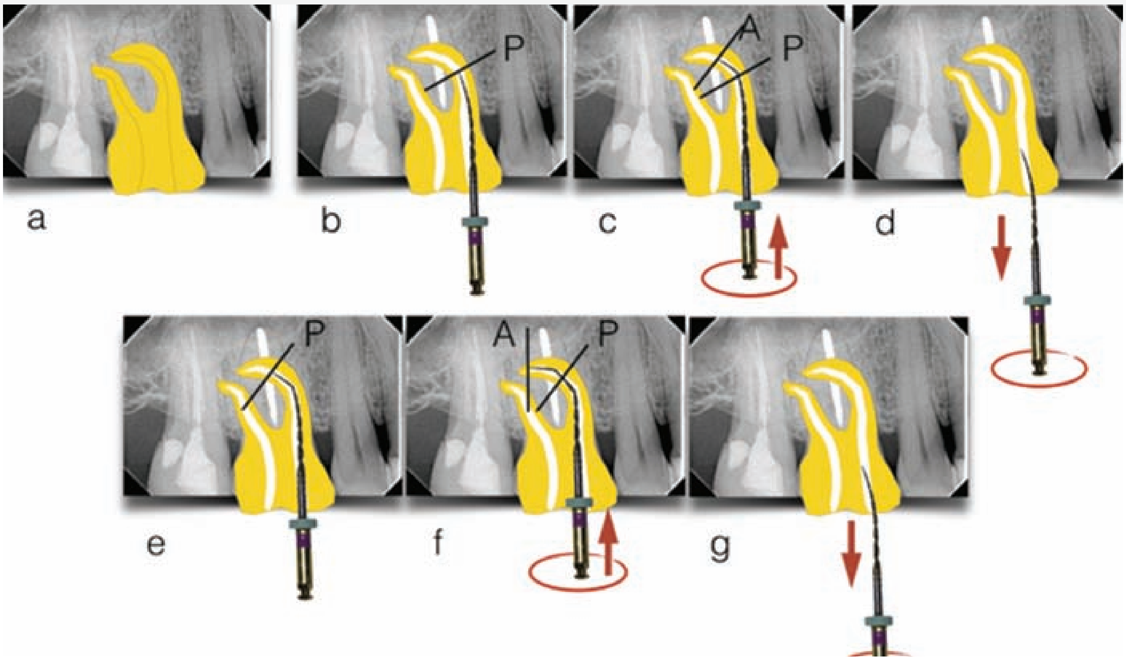

Figure 6: Tactile controlled activation (TCA) technique explained.

to resist advancement around curvatures while in action (McSpadden, 2007).

Keeping in mind the complexity of root canal systems and the need to minimise file engagement during instrumentation, a novel approach was developed and named as the TCA instrumentation technique.

The TCA technique can be defined as the activation of a motionless engine-driven file only after it becomes fully engaged inside a patent canal (Chaniotis, Filippatos, 2015). TCA utilises file activation only after maximum engagement of the flutes is reached and a tactile feedback of the anatomy is felt. Inserting files passively (non-activated) inside the root canals and using controlled memory instruments that can be pre-curved before file insertion is suggested to be advantageous, especially when complicated canal systems are encountered and limited mouth opening hinders canal negotiation and visualisation. TCA technique can be divided into in-stroke and out-stroke components.

After accessing the pulp chamber and locating the canal orifices, technical patency to length is confirmed (Figure 6a). The first file to be used is mounted on the handpiece of an endodontic motor and inserted passively inside the canal until maximum frictional resistance (Figure 6b – point B). The file is activated and pushed apically (in-stroke) until the activated file resists further advancement (Figure 6c – point A) and withdrawn from the canal (Figure 6d). After file withdrawal, the file is inactivated, the flutes are cleaned and checked for any possible deformations. Irrigation and patency confirmation follows. The second time that the same file will be inserted passively inside the same canal it will reach deeper inside the anatomy (Figure 6e – point P). Activating the file again the same way will guide the file even more apically closer to length (Figure 6f – point A). The work to be done by this file is completed when the file can reach working length without having to activate it and is then withdrawn (Figure 6g).

Instrumentation to larger apical preparations is achieved the same way until the desired apical instrumentation width is achieved. TCA technique aims to minimise the time of engagement with an activated file by using file activation only when needed for advancement. With this instrumentation technique, most of the anatomical root canal variations can be enlarged safely to the desired instrumentation size, irrespective of the degree and complexity of canal curvatures, by maintaining a tactile sensation of the anatomy throughout the whole procedure. For dilacerated canals, the controlled memory files can be pre-curved in order to negotiate passively below the fulcrum of the abrupt curvature, activated at the point of maximum engagement and withdrawn from the canal (out-stroke) instead of advancing them deeper.

The next time that the same file will be inserted passively inside the dilacerated canal engagement of the flutes will

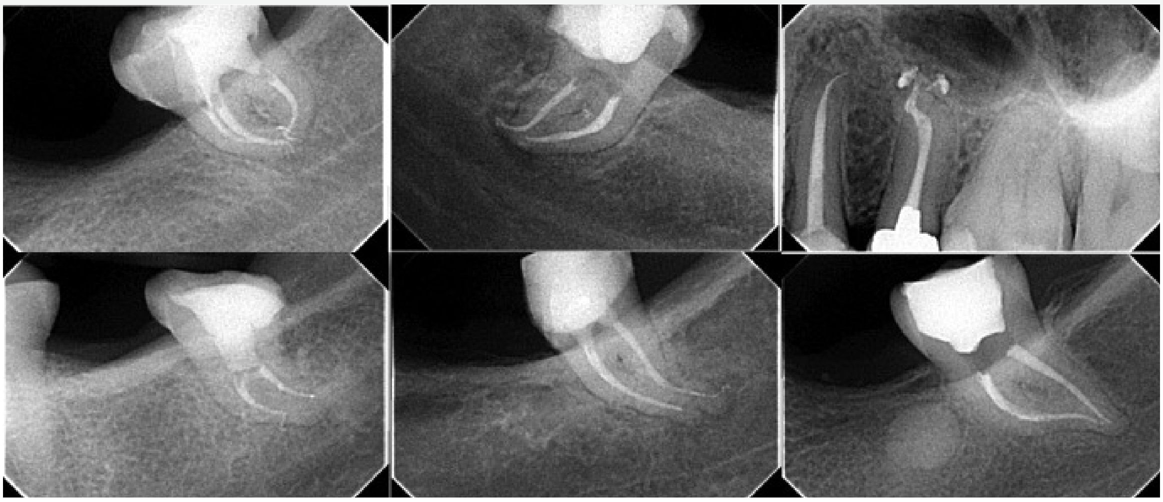

Figure 7: Instrumentation of challenging cases to larger apical preparations with tactile controlled activation (TCA) and controlled memory files.

be felt more apically. The file is activated the same way and withdrawn from the canal. This way, engine-driven files can negotiate the apical third of dilacerated canals safely by maintaining a tactile sensation of the anatomy throughout the whole instrumentation procedure (Chaniotis, Filippatos, 2015).

Challenging cases of extreme canal curvature that were managed with TCA instrumentation technique with controlled memory files can be seen in Figure 7.

Controlled memory file sequencing

The file sequencing during endodontic instrumentation is directly related to the anatomical challenge encountered. In a roentgenographic investigation of frequency and degree of canal curvatures in human permanent teeth, 84% of the root canals were found curved and 17.5% of them presented a second curvature and were classified as S-shaped root canals (Schäfer et al, 2002). From all the curved canals, 75% were found to have a small curvature of less than 27 degrees, 15% a medium curvature ranging from 27 to 35 degrees and 10% a severe curvature of more than 35 degrees.

Usually, patent root canals with a curvature of less than 27o are considered easy and straightforward cases for most instrumentation systems available today and they pose no significant problems to the clinician. The enhanced physical properties of controlled memory files manufactured with the electrical discharge machining procedure makes it possible to shape a canal with the use of a single file in 360o continuous movement. Most of these cases can be shaped quite quickly, effectively and safely by using a single Hyflex EDM file 25 (Coltene) with the TCA technique.

The one EDM Hyflex file has a tip size of 25 with a 0.08 taper. The taper is a constant 0.08 in the apical 4mm of the instruments but reduces progressively up to 0.04 in the coronal portion of the instrument. The file has three different cross-sectional areas over the entire length of the working part (rectangular in the apical part and two different trapezoidal cross sections in the middle and coronal part of the instrument) to increase its fracture resistance and cutting efficiency (Pedulla et al, 2015). Whenever larger apical preparations are required, three finishing Hyflex EDM files of constant taper can be used (40/04, 50/03 and 60/02).

Constricted and obliterated canals, thin and long roots, curved canals of more than 27o and S-shaped canals with smaller than 5mm radius of curvature are considered challenging for all instrumentation systems available nowadays. With controlled memory files, these cases are more effectively, safely and predictably enlarged with the soft, ductile and fatigue resistant Hyflex CM files by following a simple standardised protocol and TCA technique.

After flaring with the 25/08 Hyflex CM flaring file and glide path creation to 10/02 hand file, Hyflex CM files can be used with the TCA technique in a standardised simple protocol of 15/04-20/04-25/04-30/04 and 35/04. This sequence is easy to remember and can work effectively and safely even in the most challenging situations of root canal instrumentation.

The final enlargement will be dictated by the initial anatomy of each root. For glide path creation, the EDM

10/05 glide path file can also be used after flaring and initial canal scouting. In multi-canal teeth, easier canals can be instrumented with a single EDM file 25, and the complicated ones with the aforementioned CM file sequence. In this way, safe and predictable instrumentation to adequate apical preparation size that respects canal anatomy can be achieved.

Conclusions

- Controlled memory files have no shape memory effect, increased flexibility and fatigue resistance. As a result they move passively inside the highly curved or double curved canals guided only by the anatomy and not by the restoring force of other files
- The TCA instrumentation technique minimises the time that the files are under engagement inside challenging canals and results in maintaining a continuous tactile feedback of the anatomy throughout the whole instrumentation procedure
- Although the TCA technique can be used with all instrumentation systems available (rotary or reciprocation), controlled memory systems are the only ones where the files can be pre-bent for easier negotiation of challenging cases (abrupt curvatures, ledges and limited mouth opening patients)
- EDM files with controlled memory characteristics have increased cutting efficiency and fatigue resistance. This makes it feasible to use a single file instrumentation protocol for approximately 75% of human root canals.

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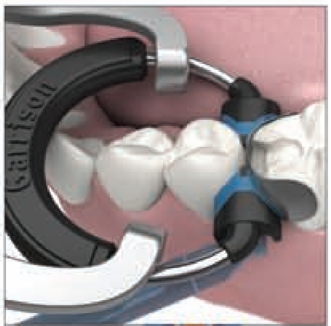

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CASE REPORT

Recurrent aphthous stomatitis A case presentation with 915nm diode laser therapy

Foteini Papanastasopoulou[1]

Recurrent aphthous stomatitis (RAS) is one of the most common oral diseases and it is characterised by round ulcers surrounded by an erythematous halo. The lesions are usually painful due to the exposed nerve endings in the underlying lamina propria and the pain can range from mild to severe, affecting the patient's everyday life. RAS has three clinical presentations: aphthous minor, aphthous major and herpetiform ulcers. The cause of RAS is unknown, although several factors are suspected. These include stress, hormonal changes, genetics, diet, nutritional defi ciencies, immunological and systemic disorders (such as Behçet's syndrome, Reiter's syndrome, and gastrointestinal malabsorption disorders).

The treatment of recurrent aphthous stomatitis is symptomatic. Accurate diagnosis of the cause of the disease and a treatment plan that is tailored individually to each patient can lead to successful management of RAS. The treatment goals are reduction of pain, healing time, number and size of ulcers and prevention of the recurrence of the disease. There are several treatment options for the management of recurrent aphthous stomatitis. Antiseptic mouthwashes containing chlorhexidine decrease the number of ulcers but do not prevent the recurrence of the disease. In addition, chlorhexidine can stain the teeth if it is used frequently. Topical analgesics reduce the pain but cannot be used extensively. Topical and systemic antibiotic treatments are empiric and are used because of a belief that the cause of the disease is an undiscovered infectious agent. Cauterising drugs are used, but they prolong healing time due to their destructive activity. Topical corticosteroids and systemic immunomodulators are commonly used when the immunopathogenesis is the cause of the ulcer. However, both of them have numerous side effects. Dental lasers have also been used for the treatment of RAS.

It was found that laser irradiation accelerates wound healing, promotes pain relief and decreases recurrence of the lesions. There are three factors that accelerate wound healing: the increased production of ATP which results in greater tissue regeneration in the healing process, increased microcirculation which facilitates the cell multiplication and the formation of new vessels. The reason of pain reduction could be attributed to the release of endogenous pain relievers such as endorphins and encephalins, the increased production of serotonin and suppression of bradykinin activity.

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Case report

A 63-year-old female patient presented with painful lesions in her mouth. The patient was diagnosed with recurrent aphthous stomatitis. The ulcers were extremely painful and she had difficulties in eating, speaking and brushing her teeth. The patient had suffered from ulcers for several weeks and was extremely anxious and very sensitive to pain. She had tried to relief the pain by many different topical medications, but to no avail. Also, new lesions developed as the older lesions resolved. The patient had no systemic disorders and was a non-smoker. Eight minor ulcers were found in her mouth (Fig. 1): One in the upper left lip (Fig. 1: lesion a1, Fig. 2), two ulcers in the palate (Fig. 1: lesions a4 and a5, Fig. 3: lesion a4), two ulcers in the right buccal area (Fig. 1: lesions a2 and a3, Fig. 3: lesion a2, Fig. 4: lesion a3), two lesions in the lower lip (Fig. 1: lesions a6 and a7, Fig. 5:lesion a6) and one minor ulcer below the tongue (Fig. 1: lesion a8, Fig. 5). Laser therapy was selected for the treatment of recurrent aphthous stomatitis.

The patient was treated by 915 nm diode laser. A 300 µm fibre was used with power settings of 2 W, cw and in non-contact mode. The tip was moved with circular movements of 1 mm/s in speed from the periphery towards the centre of the lesion. The tip was also moved gradually closer to the lesion from 10 mm to 1 mm distance. The irradiation time of each lesion was 30 s/cm2. Consecutive to each irradiation, the patient was asked if she was still feeling pain. Most lesions were irradiated twice (Fig. 1: lesions a4, a5, a6, a7, a8) and the larger and painful lesions were irradiated thrice (Fig. 1: lesions a1, a2, a3). At the end of the treatment, the patient reported that five ulcers were free of pain (Fig. 1: lesions a4, a5, a6, a7, a8) and three out of eight ulcers were mildly sensitive to the touch (Fig. 1: lesions a1, a2, a3). The patient was send home and instructions were given to avoid hard, acidic and salty foods.

The patient was recalled a week later. She was content and she reported that eating was painless. She felt like the ulcers started healing earlier than the previous attacks. The patient was clinically examined and it was found that five ulcers had completely healed (Fig. 6: lesions a2, a4, a6, a7, a8, Figs. 9 and 10) and three ulcers out of eight were still sensitive to the touch (Fig, 6: lesions a1, a3, a5, Figs. 7 and 8). Additionally, two new painful ulcers were found: one below the tongue (Fig. 6: lesion b2, Fig. 9) and the other on the palate (Fig. 6: lesion b1). The same laser treatment protocol was followed for the three old lesions (Fig. 6: lesions a1, a3,

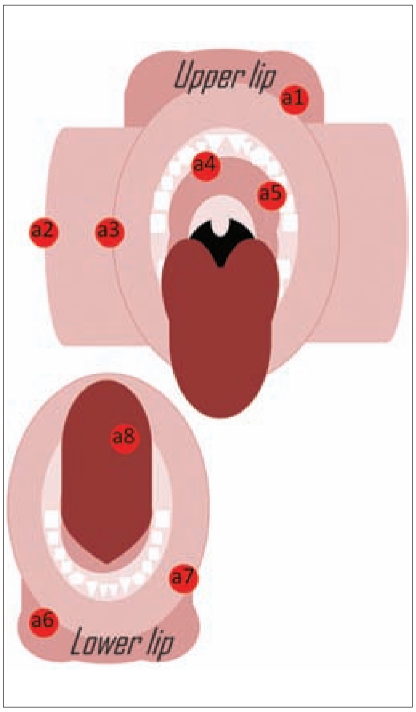


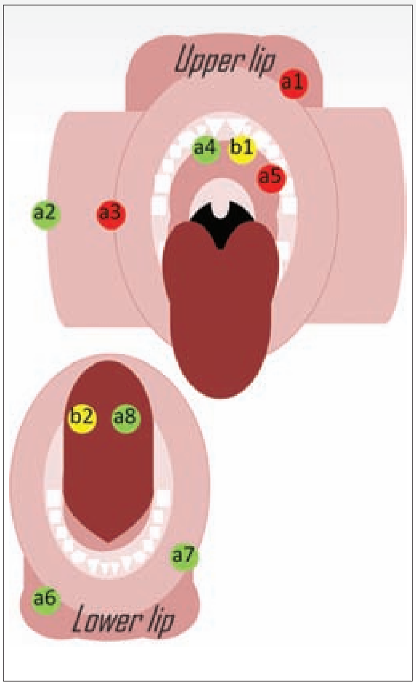
Figure 1: Eight minor ulcers were found (a1–a8).

Figure 2: Ulcer in the upper left lip (a1).

Figure 3: Ulcer in the right buccal area (a2) and ulcer in the palate (a4).

Figure 4: Ulcer in the right buccal area (a3).

Figure 5: Ulcer in the lower lip (a6) and ulcer below the tongue (a8).



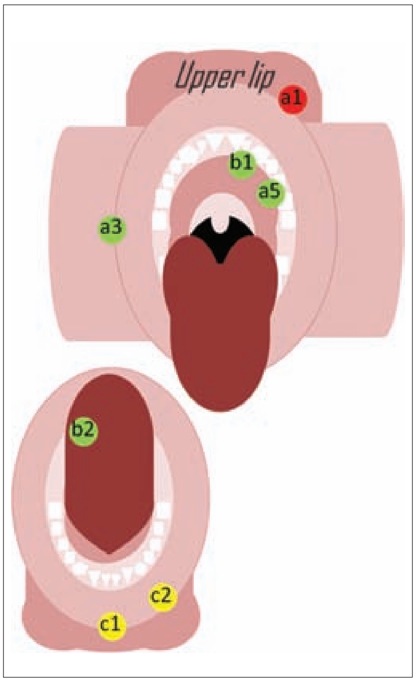
After seven days – Figure 6: Completely healed ulcers (a2, a4, a6, a7, and a8), still painful old lesions (a1, a3, and a5), new painful ulcers (b1, b2).

Figure 7: Still painful old ulcer in the upper left lip (a1).

Figure 8: Still painful old lesion in the right buccal area (a3).

Figure 9: Completely healed ulcer below the tongue, left side (a8) and new painful lesion below the tongue, right side (b2).

Figure 10: Completely healed ulcer in the lower lip (a6).



After three days (ten days after the first irradiation) – Figure 11: Completely healed ulcers (a1, a3, a5, b1, b2), new painful ulcers (c1, c2).

Figure 12: Completely healed ulcer in the upper left lip (a1).

Figure 13: Completely healed ulcer in the right buccal area (a3).).

Figure 14: Completely healed ulcer below the tongue, right side (b2).

Figure 15: New painful ulcers (c1, c2).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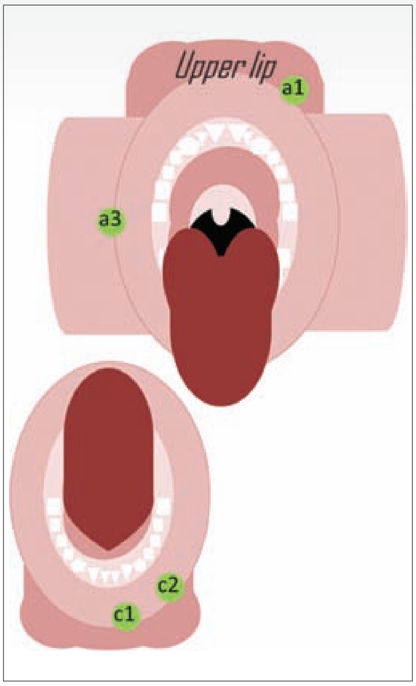

After five days (15 days after the first irradiation) – Figure 16: Completely healed ulcers (a1, a3, c1, c2).

Figure 17: Completely healed ulcer in the upper left lip (a1).

Figure 18: Completely healed ulcer in the right buccal area (a3).

Figure 19: Completely healed ulcers in the lower lip (c1 and c2).

a5) and the two new ones (Fig. 6: lesions b1, b2). The old lesions were irradiated two times and the new lesions three times. Then the patient was recalled three days later. All five lesions were without pain and had completely healed (Fig. 11: lesions a1, a3, a5, b1, b2).

However, two new lesions had developed in the lower lip (Fig. 11: c1, c2, Fig. 15). The two new lesions were irradiated three times each with the same laser protocol. After five days all the lesions had completely healed and no new lesions were detected (Fig. 16: lesions a1, a3, c1, c2, Figs. 17–19). A bi-weekly follow-up showed no recurrence of the disease.

Conclusion

Laser treatment of recurrent aphthous stomatitis is an easy, fast and pain-free procedure. Multiple appointments were required in order to treat the newly- developed lesions. Studies have shown that ulcers treated by laser therapy provide immediate pain relief and fewer recurrences in the future. The main advantage of the laser treatment compared to other treatment options is that it can be used for all the causes of the disease both without having any side effects and without the risk of medication overdose. In conclusion, laser treatment offers advantages for both the clinician and the patient.

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Utilising smile design software and CAD/CAM for creating a mock-up and final restorations

Aki Lindén[1]

Summary

Patient

A 32-year-old woman with hypoplastic pitted amelogenesis imperfecta.

Treatment plan

Patient photos and smile design software were used for treatment planning and creating a digital mock-up. A digital impression was captured with an intraoral scanner. A digital mock-up design was used in CAD software for designing a wax-up. After preparations, a digital impression was taken again; the final veneers were designed with CAD software and created with a milling unit.

Introduction

Treatment planning and smile designing have been performed with traditional techniques for years in aesthetic dentistry. In recent years, various software programmes have emerged to offer useful new tools for digital designing. When compared to traditional techniques, the main advantages of digital designing lie in speed, flexibility and improved communication between the patient and the treatment team.

Figure 1

[1] Aki Lindén, CDT has an extensive history in aesthetic dentistry and fixed prosthetics, as he has worked in his own dental laboratory in Helsinki for over 20 years. Lindén is a recognised Opinion Leader for Ivoclar Vivadent in Finland, for which he regularly serves as an instructor and lecturer. Mr. Lindén is also a member of several aesthetic dentistry societies, such as the Scandinavian Academy of Esthetic Dentistry (SAED), the American Academy of Cosmetic Dentistry (AACD), and the Society for Color and Appearance in Dentistry (SCAD).

Figure 2

Figure 7

Digital smile designing

During the first patient visit, preoperative face photos were taken with a Canon EOS 6D camera (Fig. 1). Two photos were taken of the patient—one face photo of a smile (Fig. 2) and one retractor image (Fig. 3).

The photos were both carefully taken from the same angle using a camera stand. The distal distance between the maxillary central incisors was measured with a calliper for the calibration of the image.

The appropriate shade for the new teeth was also determined (BL3—Fig. 4, the third colour from the left). Next, the patient's smile photo was imported into a smile design software programme. The patient's facial proportions were analysed—including the smile line, central line and papillary line (Fig. 5)

Figure 3

Figure 4

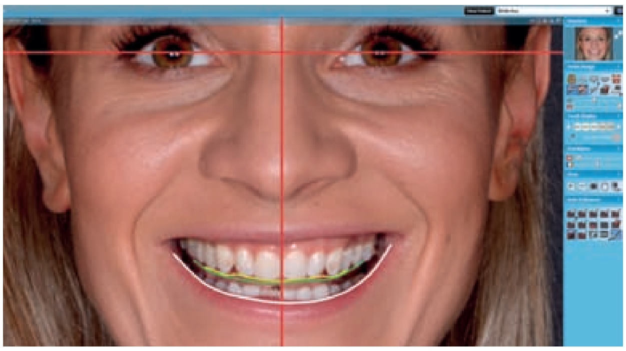


Figure 5

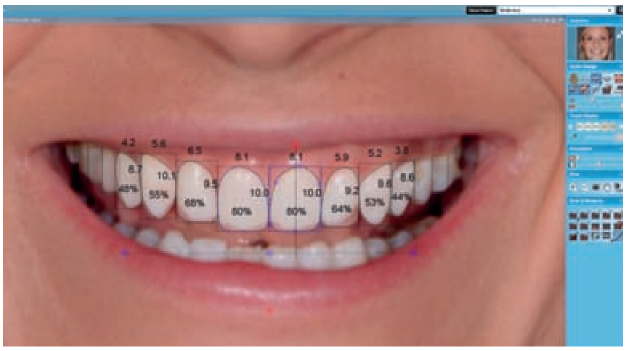


Figure 6


Figure 8

The different treatment possibilities were explained to the patient visually with help of the software's silhouette tool (Fig. 6). The patient was able to take part in the treatment planning process by visually expressing their expectations of the final result (Fig. 7). Ultimately, the decision was made to treat eight anterior maxillary teeth instead of the initially planned six, as the patient's wide smile revealed more teeth than average. The more comprehensive treatment was also better in line with the patient's expectation of the result (Fig. 8).

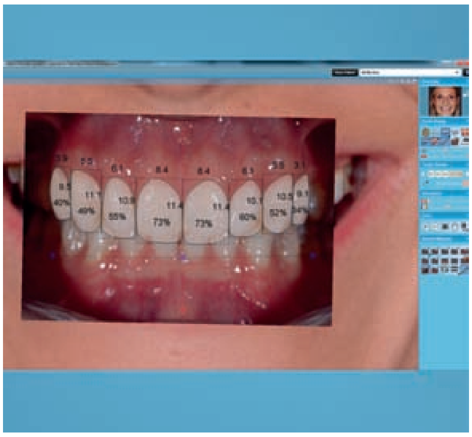
To finalise the design, the patient's retractor image was superimposed on top of the smile image, which enabled viewing and modifying the gingival area (Fig. 9).

Creating wax-up

A digital impression of the patient's pre-op dentition was taken using an intraoral scanner (Figs. 10 & 11). Both the upper and lower arches were scanned and the digital impressions were immediately available for wax-up designing.

The smile design silhouette was exported from the smile design software to the CAD software for wax-up designing (Fig. 12). The silhouette was adjusted on top of the digital impression and used as a guideline for creating veneer designs in the software. The tools in the CAD software were used to design and finalise the digital wax-up (Fig. 13).

Next, the digital wax-up was 3-D printed for mock-up creation. A silicone key was prepared from the 3-D printed model. Using the silicon key and the 3M ESPE Protemp 4 Temporisation Material, a mock-up was created into the patient's mouth (Fig. 14), with its fit and functionality checked. At this point, the patient had the opportunity to experience the design of her new teeth and understand the altered feel and look (Fig. 15).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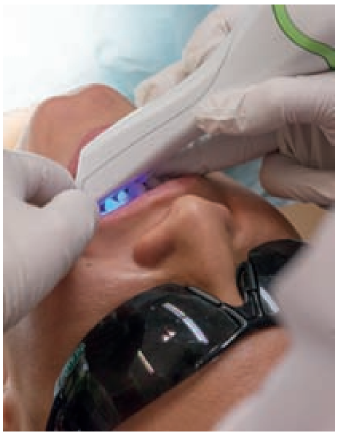
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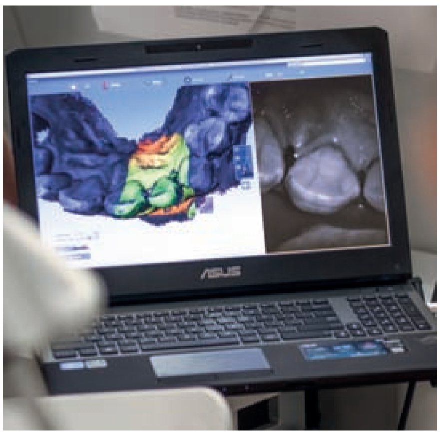

Figure 11

Figure 12

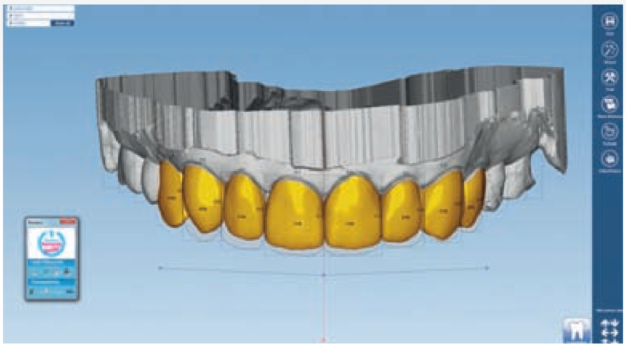
Figure 13


Figure 14


Figure 15


Figure 16


Figure 17

Preparations and temporary veneers

After confirming the proper fit, the patient's teeth were prepared (Figs. 16 & 17) and the preparations were scanned, again using an intraoral scanner. Next, temporary veneers were created with the same silicon key and 3D ESPE Protemp 4 Tempo risation Material. The temporary veneers were tried on the patient and fixed by spot-etching.


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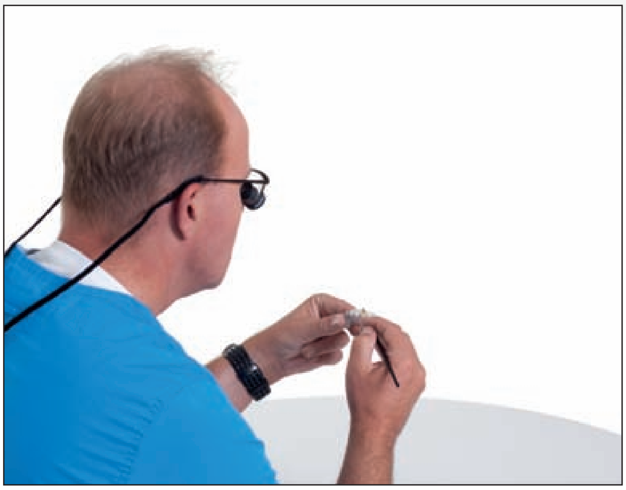

Figure 18

Figure 19

Figure 20

Creating final restorations

Once the temporary veneers had been successfully fitted, the final veneers were created from IPS e.max CAD blocks using a milling unit. The restorations were finished by layering ceramics (e.max Ceram) to the labial and incisal parts for maximum aesthetics (Fig. 18).

To conclude a successful treatment process, the final restorations were cemented. A photo of the end result was also taken (Figs. 19 & 20).

Conclusion

Digital smile designing significantly improves the communication between the patient and the entire treatment team. More predictable results make patients more confident, as they can trust that the outcome will be in accordance with their expectations. Patients are also pleased to be actively involved in their own treatment and that they are able to take part in the design process right from the start. As a result, patient case acceptance is improved.

Digital smile designing provides several benefits compared to the traditional way of smile designing with different wax-ups—it is easier, more comfortable for the patient and more time-efficient.

Acknowledgment: The author would like to thank Dr Katja Narva, DDS, PhD, Specialist in Prosthodontics.
Utilised equipment and software: Planmeca Romexis Smile Design software, Planmeca PlanCAD Premium software, Planmeca PlanScan intraoral scanner, Planmeca PlanMill 50 milling unit.

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CASE REPORT

A-PRF as sole grafting material in sinus lifts

Dadi Hrafnkelsson[1]

Introduction

Reduced residual bone height underneath sinus maxillaris is solved by lifting the Schneiderian membrane from the floor of the sinus using either the osteotome technique or the lateral window approach. By these means, it is possible to place a dental implant to anchor a fixed or removable prosthesis. In these treatments, it is custom to use biomaterials to keep the volume around the dental implant and finally make way for osseointegration of the implant.

The purpose of this case presentation is to describe the author's experience of using A-PRF (Advanced platelet-rich fibrin) as sole grafting material and to show that it is possible to get good bone formation around the dental implant inside the sinus without the use of biomaterials. Two operations were performed under local anaesthesia, venous blood was collected and A-PRF made. Osteotomy was done by means of osteotomes (Summers technique).

There were no perforations to the Schneiderian membrane, A-PRF membranes were placed inside the sinus and the dental implant placed achieving adequate primary stability in both cases. Impressions were taken after twelve weeks. From cone beam computed tomography it is clear that bone formation has taken place inside the sinus underneath the Schneiderian membrane. Both of the two implants were fully osseointegrated and restored successfully.

Figure 1: Three glasses with venous blood placed in the centrifuge.

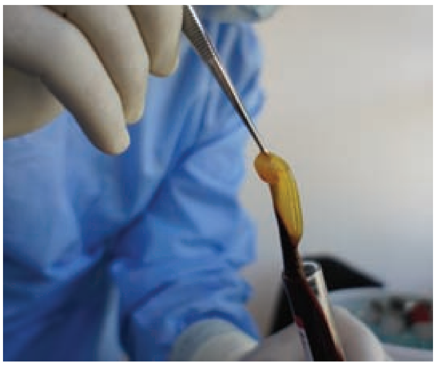

Figure 2: A-PRF clot.

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State of research

In the year 2003 Lundgren et al. published a concise paper[1] showing the spontaneous bone formation in the sinus after removal of a cyst.[1] The space that was once filled with the cyst became filled with bone without any further operations. Lundgren and his colleagues proposed that if space is maintained, bone can form without the use of biomaterials. Lundgren then did a study that was published in 2004, where 19 dental implants were placed with the Summers technique and no biomaterial was used.[2] In this procedure, the implants are used as "tent pegs" that hold the Schneiderian membrane from collapsing to the floor of the sinus; the blood that fills the gap then turns to bone in time. The results were that a lot of extra bone had formed around the implants without the use of biomaterials.

Other authors followed and published similar studies that confirmed Lundgren's results.[3–9] To get a good filling of blood can be a challenge in this procedure because one cannot predict how much blood there will be between the sinus floor and the Schneiderian membrane after the operation. A-PRF can be seen as a good and advanced blood clot that is easy to obtain. In addition, one can control how much the filling will be. In 2009 Mazor and colleagues published a paper where A-PRF was used to fill this space.[10] 25 sinus lifts were performed in 20 patients and 41 dental implants placed. The authors used the same method as Lundgren did earlier, except for filling the space between the sinus floor and the Schneiderian membrane with A-PRF membranes. The results showed an increase in bone height between 7 and 13 mm (mean ± SD: 10.1 ± 0.9 mm).

Mazor and colleagues also took examples for histology six months after the operation that showed a well formed bone full of osteoblasts and osteoclasts in their lacunae. In 2013 Tajima and colleagues published a similar paper where the mean bone height increase was 7.5 mm.[11] It can be seen from Figs. 1–10 below that the bone does not go all the way over the apex of the implants. Therefore, it is helpful to look at a paper published by Palma and colleagues: in an animal study, they discovered that although there was not bone over the apex of the implants, the apex was covered by the Schneiderian membrane.[12] A-PRF has been well introduced in the literature over the last years by Dohan and colleagues.[13–16]

Cases

Two patients were treated in Godt Smil Odense over 16 months. Both of these patients had one thing in common, they did not want any animal products to be used in the treatment and therefore choose to use A-PRF as their sole grafting material. Both patients were in good general health and do not smoke. Venous blood was sampled with a so-called butterfly (Vacuette® Greiner bio-one) and the rule is 10 ml of venous blood for every dental implant, plus 10 ml for each mm of planned bone height. The blood is collected in 10 ml tubes (A-PRF®+) and are centrifuged according to Choukroun's protocol.

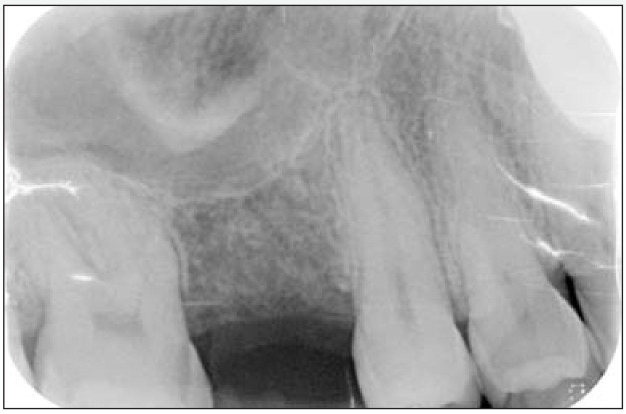

Figure 3: Case 1, pre-operative.

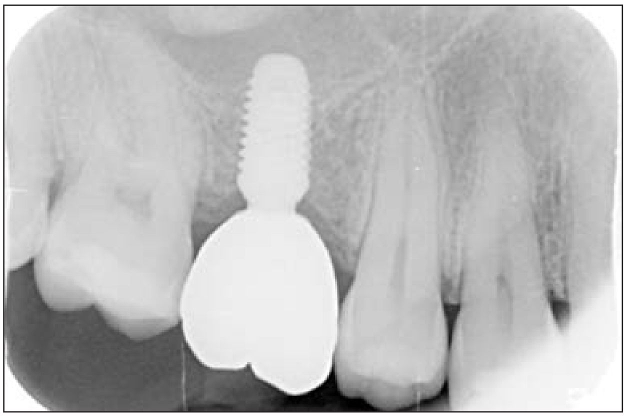

Figure 4: Case 1, immediately after operation.

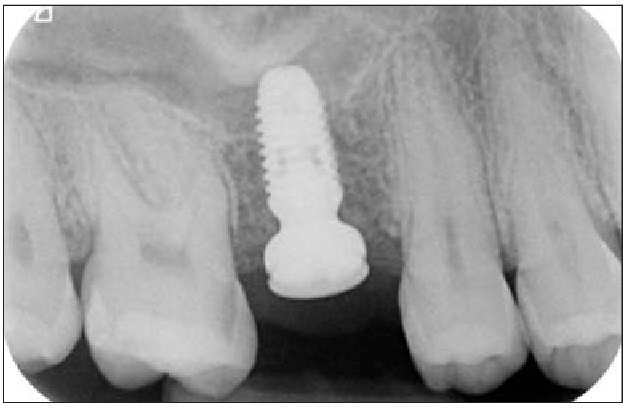

Figure 5: Case 1, 14 weeks after operation.


Figure 6 & 7: Case 1, six months post-op.

Figure 8: Case 2, pre-operative.


Figure 9 & 10: Case 2, six months after operation.

Operation

Premedication is 2,000 mg Imadrax (Amoxicilin), 1,000 mg Pinex (Paracetamol) and 400 mg Ibumetin (Ibuprofen) 60 minutes before treatment. The oral cavity was rinsed with 0,2 % Chlorhexidin for one minute. Local anaesthesia was administered buccally and palatally (Xyloplyin® dental adrenalin 20 mg/ml + 12.5 microgram/ml lidocaine hydrochloride + adrenalin. The mucoperiosteal trapizoid flap was raised and osteotomy was performed using the Summers technique. A-PRF membranes were placed into the sinus underneath the Schneiderian membrane. Valsalva tests were negative for both patients. The dental implant (K3Pro Sure) was inserted and the last A-PRF membrane was placed over the area, underneath the incision line.

Both dental implants had good primary stability. Sutures were Glycolon 6–0 (Resorba). No further bone augmentations were done. Postoperative medication was Imadrax (Amoxicillin), 500 mg 4 times a day for three days, Ibumetin (Ibuprofen, 400 mg) in combination with 1,000 mg Pinex (Paracetamol) as needed. Both patients were instructed to remain on soft diet for the next two days, no physical activity for seven days. Abutment operation was performed after twelve weeks and both dental implants received a screw-retained Prettau® full-ceramic crown.

Discussion

It is not possible to have valuable results from a small case presentation like this, but it is clear that a considerable amount of bone has formed around the implants, both dental implants were stable six months after loading. There was no BOP at control three months after loading. Previous publications on this matter confirm that it is safe to use A-PRF to increase the bone height in sinus maxillaris using the Summers technique when the primary stability of the implant is good.[3, 4, 10, 11, 17] Further research in this area is much needed.

Editorial note: A different documentation of the same cases has been published in The Icelandic Dental Journal. A list of references is available from the author.

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PLANMECA 45

Clear Collection instruments for clear aligner treatments: part 2

S. Jay Bowman[1]

In part 2 of a series, Dr. S. Jay Bowman continues his look at instruments that help increase the utility of aligners and expand the scope of appropriate applications

Contact points to accent aligners

The two accent pliers in the Clear Collection (i.e., The Horizontal and The Vertical) (Figures 1-2) were designed to enhance desired tooth movements by employing "contact points." Although overcorrection is a critical aspect that is integral to aligner treatment planning, there are occasions when the virtual setup does not predictably produce the desired result. In fact, researchers have reported that a percentage of tooth movement prescribed for a setup is simply not translated from plastic into the dental results.[1-4] The flexibility of plastic, the potential errors transmitted from inaccuracies of PVS or scanned "impressions" and creation of models, imprecisions in the vacuum process of fabricating aligners, and the fact that all teeth do not move to the same degree when exposed to forces exerted by the trays can all lead to incomplete correction.

To improve the predictability of desired tooth movement, The Vertical and The Horizontal pliers were designed to produce shallow impressions in the aligner plastic to contact specific surfaces of individual teeth. These indentations are intended to generate an enhanced "contact point" and/ or to create a mechanical couple to move a tooth in a desired direction. These "accents" may help avoid another series of

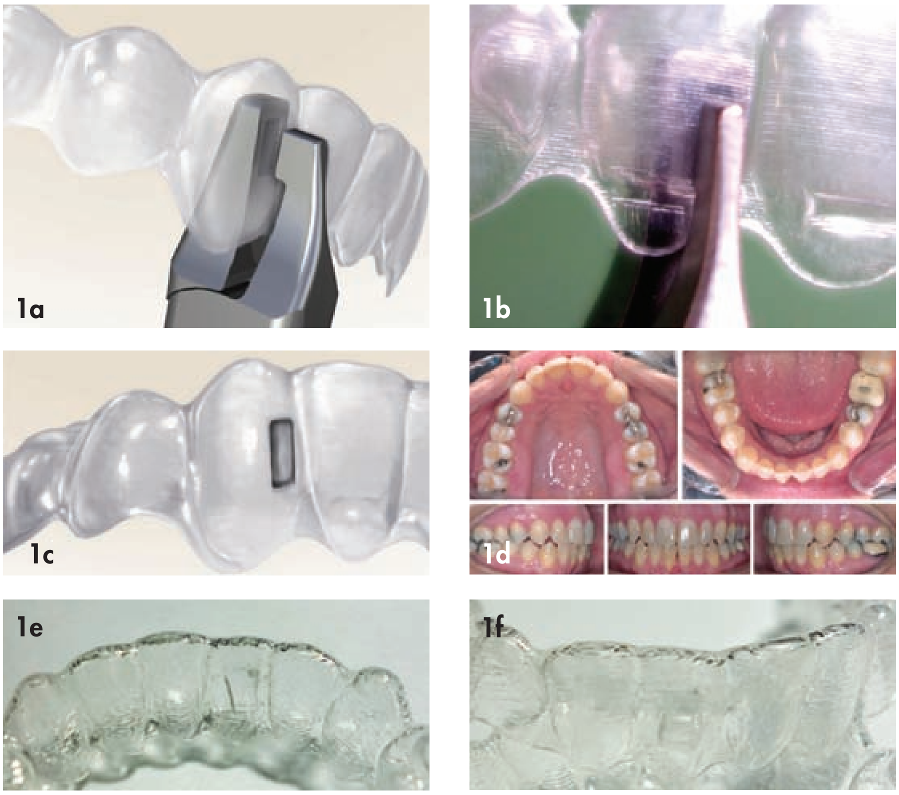

Figure 1a1f: The Vertical pliers are used to accent rotational tooth movement.

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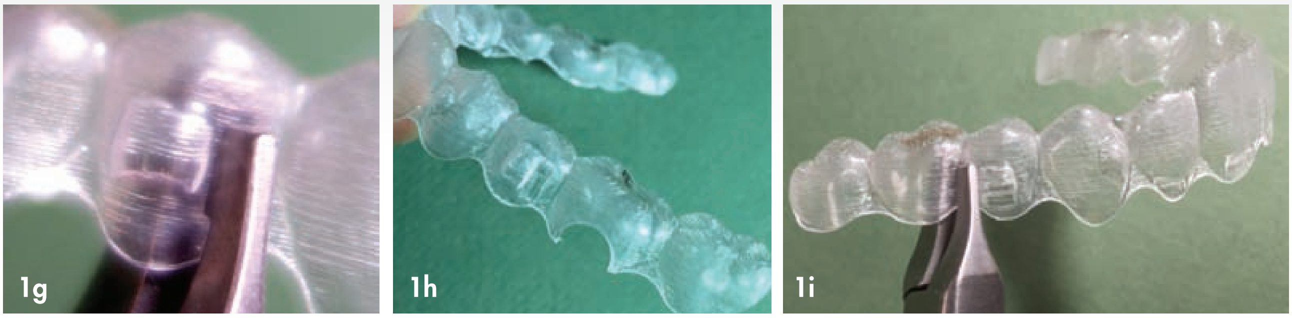


Figures1g-1i: The shallow indentations are produced without heating the pliers, producing "contact points" to assist with rotational couples, including situations with composite "attachments" (1g,1h), enhancing molar distalization (1i), or root paralleling.

"refinement" aligners with their attendant additional scans/impressions and associated virtual setups — potentially reducing treatment delays and the "hassle factor."

The Vertical

The control of rotations is often a challenge with clear aligners. The Vertical (Figure 1) is an instrument designed specifically for enhancing the correction of rotated teeth with clear aligners or even during minor tooth movement when using simple, clear retainers. Rotating upper laterals and cuspids is often problematic,[5,6] especially since aligners do not have a large surface area contact on laterals. Consequently, these incisors can get left behind, resulting in another form of "lag" or loss of tracking. The Vertical is used to produce an indentation at the mesial or distal of a specific tooth in the facial and/or lingual aspects of the aligner plastic. These indentations are made without heating the pliers and at a very shallow depth so as to not compromise the integrity of the plastic (Figure 1). The intent is to add contact points to accent the rotational couples that were prescribed when creating a virtual treatment setup. This certainly contributes to the concept of overcorrection that is key to correcting rotations with aligners.

The Vertical can also be used at the line angles of teeth to accent other types of tooth movement. For example, placing a vertical indent at the mesial of maxillary first molars (in the buccal and/or lingual plastic) will enhance molar distalization (Figure 1). When placed at the distal, the indent will assist molar protraction. Vertical indents at the embrasures of incisors or premolars will assist root paralleling, especially in extraction scenarios.

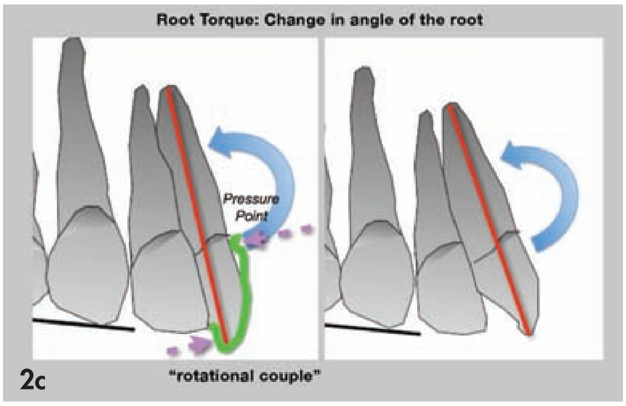
Another option is to use The Vertical to produce a very slight indent at the junction between the incisal or gingival surface of the plastic and a composite aligner attachment. This may enhance the sharpness of the conformation or contact between plastic and attachment to avoid loss of tracking noted as an "escaped attachment." The Vertical can also be used to produce an indent in aligner plastic in the middle onethird of the facial or lingual of a tooth to give a mild nudge for in-and-out or labiolingual discrepancies, including minor tooth movement with clear retainers.

The Horizontal

There are instances where we would like to accentuate root torque for specific teeth during clear aligner treatment. In other instances, there is a need to increase the retentiveness of aligners or clear retainers. The Horizontal (Figure 2) is an instrument designed to accent labial or lingual torque for individual teeth, and it can also be used to simply increase the retentiveness of clear aligners or retainers.

Either labial or lingual root torque can be a challenging aspect of tooth movement for clear aligners. This is typically due to the fact that the plastic is more flexible near the gingival margins, diminishing the required forces. The Horizontal can be used to produce an indentation on either the lingual, buccal or both sides of the aligner, anywhere along the aligner plastic to emphasize torque (Figures 2a-2b). Commonly, these "impressions" in the plastic are positioned at the gingival margin on the facial of an incisor to apply a contact point to emphasize lingual root torque. In contrast, the indent is placed on the lingual to enhance labial root torque.

Another option is to use The Horizontal to produce a very slight indent at the right angle junction between a rectangular aligner composite attachment and the facial surface of a tooth (Figures 2c-2e). This indent may enhance the sharpness of conformation or contact between the plastic and the attachment to reduce the risk of lost tracking during either intrusive or extrusive movements. The Horizontal can also be used to produce a mild force to address labiolingual discrepancies (like The Vertical) — pushing a tooth facially or lingually. Finally, the Horizontal can be utilized to place an indent at the undercut of the crown of a tooth near the gingival margin to enhance the retentiveness of aligners (Figure 2f).



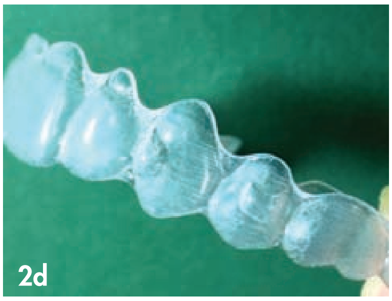
Figures 2a-2c: The Horizontal pliers are specifically designed to add individual root torque.

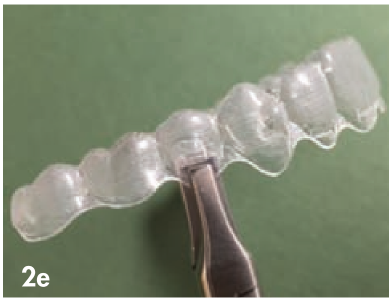
Standardized clinical process

In order to streamline the process of integrating individualized enhancement for a series of aligners, a prescription form is used to note the specific sites where Clear Collection instruments will be applied to each tray (Figure 3). In preparation to address each aligner, the prescription is completed in anticipation of the specific procedures needed for the trays. Notes regarding any mechanics to be employed are added (e.g., Class II elastics, bootstrap elastic, chain for rotation, molar distalization, protraction, intrusion, extrusion, etc.). The prescription accompanies the aligners that are to be dispensed at the patient's next appointment along with the necessary Clear Collection pliers needed. A copy or scan of the prescription is kept for reference in the patient's chart. In this manner, clinical coordination and consistency are communicated clearly.

Clear conclusions

The Clear Collection can assist in the application of adjunctive forces to broaden the variety of malocclusion problems that may benefit from aligner treatments. Enhancing and accentuating chosen biomechanics helps reduce the known limitations of aligners and orthodontists' occasional frustrations. In this manner, the clinician can more efficiently individualize treatment for each patient by altering the aligner trays in a series by adding appropriate forces to affect desired tooth movements. Specifically, The Hole Punch and The Tear Drop instruments facilitate the addition of elastic forces necessary for the correction of a significant number of malocclusions. Much like bending wires with orthodontic pliers, The Vertical and The Horizontal provide an added dimension for individualizing specific tooth movements in "real time" at the clinic chair. The instruments in the Clear Collection help the orthodontist to better customize clear aligner treatments, enhance his/her desired biomechanics, and streamline the addition of adjunctive forces during the course of a series of aligners. For information on the use and applications of the Clear Collection, instructional videos are available on YouTube: https://www.youtube.com/ watch?v=hrs2VfnImLY





Figures 2d-2f: In addition, the Horizontal is used to reduce "lag" by accenting extrusive or intrusive movement by applying contact points immediately adjacent to composite attachments.

Figure 2g: Indents can also be created to increase the retentiveness of aligners or retainers.

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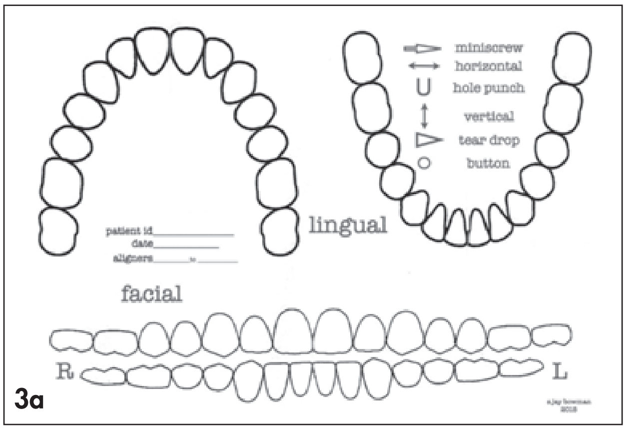

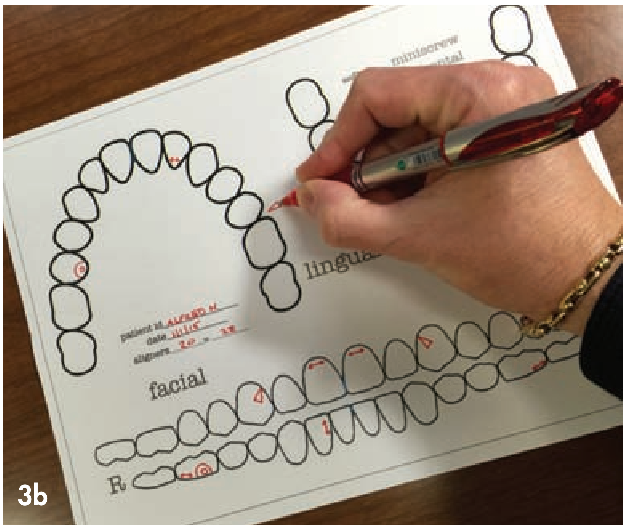

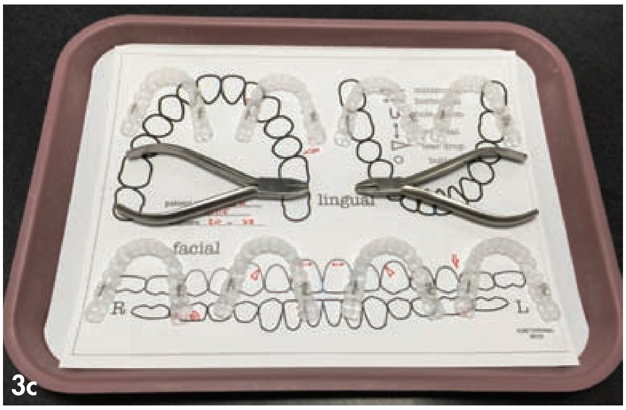

Figures 3a-3b: Clear Collection prescription sheet is prepared for each patient to specify the instruments that will be used for a series of aligners along with the exact sites where they will be employed. Figure 3c: Completed prescription sheet with notations (in red) accompanies the required instruments and the series of aligners to be enhanced. A copy of the Clear Collection prescription sheet is available for download and duplication at: http://www.hu-friedy.com/clear-collection.

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Invisible dentures

The recipe for success in fabricating functionally, phonetically, and esthetically perfect full dentures

Elke-Kerstin Hohmuth,[1] Katja Fuchs,[2] Katrin Bretschneider[3]

Keywords
Esthetics, acrylic molding, acrylic teeth, full dentures, VITAPAN PLUS, VITA LINGOFORM, tooth setup, gingiva contouring

Successful full dentures must meet high demands in regard to function, phonetics, and esthetics. The objective is nothing less than to give an edentulous person their teeth back, with which they can easily chew and swallow, that remain stably in place, and with which they can speak clearly, feel attractive and smile confidently, knowing that the teeth are not recognizable as dentures.

In this article, Elke-Kerstin Hohmuth, a dentist practicing in Mülsen near Zwickau, Germany, master dental technician Katja Fuchs and dental technician Katrin Bretschneider, both dental prothestists at Duo Dental Zahntechnik GmbH in Falkenstein, Germany, explain how they produce a perfect full denture as a team. Patients not only receive functionally and phonetically perfect dentures but can also be sure that they are not recognized as denture wearers, due to the natural appearance of the new prosthesis.

Initial situation

An approximately 75-year-old patient came into the practice with the desire to be able to eat without restriction again. He had not been able to chew hard food with his current dentures for a long time. He was also no longer happy with the appearance of his dentures. The desire to be able to chew without restriction as much as possible and to have a natural appearance motivated him to visit his dentist.

At the first visit, it was already apparent that the occlusal plane considerably deviated from the lip closure line and the midline just as clearly deviated from the middle of the face. (Fig. 1)

An examination of the old dentures showed that the denture bases and denture bearing area no longer matched due to extractions and expansions. (Fig. 2, 3) This incongruence affected the retention of the dentures, the occlusal plane, the occlusal height, and thus the chewing function. Remaking the maxillary and mandibular dentures was unavoidable.

Figure 1: The initial situation. The considerable esthetic flaws of the old dentures are immediately apparent.

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Dentist (Dipl.Stom)
Private practice, Mülsen, Germany.

[2] Katja Fuchs
Master dental technician

[3] Katrin Bretschneider
Dental technician

Figure 2 and 3: Loss of function and cosmetic flaws of the old dentures justified making new dentures.

The prosthetic concept

The setup system "Totalprothetik in Funktion" (Total prosthetics in function or TiF) has proven its worth for many years in the treatment of edentulous patients. In this system, dental technician Karl-Heinz Körholz combines the static and functional philosophies of the dentists Alfred Gysi and Albert Gerber with lingualized occlusion and model analysis according to the dental prothestist Peter Lerch. Building on this, he developed his didactically oriented and practically oriented prosthetic concept, which is the basis of the fabrication in this patient case.

The implementation

The perhaps most important insight gained from many years of experience with the TiF system is the dependency of the consecutive steps that build upon each other. An error that is made along the way can never be corrected at a later stage. For example, if the functional impression does not reproduce all relevant areas for a functional model, then the functional model and thus the denture base will never correctly reflect the conditions of the mouth.

However, experience also shows that the success rate is very high when all individual steps are carried out conscientiously and consistently.

Anatomical models

Good functional impressions are based on precise anatomical models. They include all relevant areas that are necessary for the best possible fit of the base and the tegument of the jaw. For capillary forces to generate a suction effect between the base and the surface of the mucosal tissue during speech and masticatory function as well, the impression trays must be adjusted to the movements of the lip, cheek, and tongue muscles.

The expanse of the impression trays is shown on the models. (Fig. 4) Sufficient clearance is left around the lip and cheek tendons as well as around the tongue tendon. A self-curing tray material (C–Plast/Candulor AG/Wangen, Switzerland) has proven its value in the fabrication of stable bases that are as torsionally resistant as possible.

The impression trays are equipped with a kind of rim that imitates the rows of teeth, supports the cheeks, and simultaneously provides a boundary and space for the tongue during impression-taking. (Fig. 5) Occlusal grooves provide a better grip during impression-taking and also serve as a retainer for securing the face bow with the upper tray.

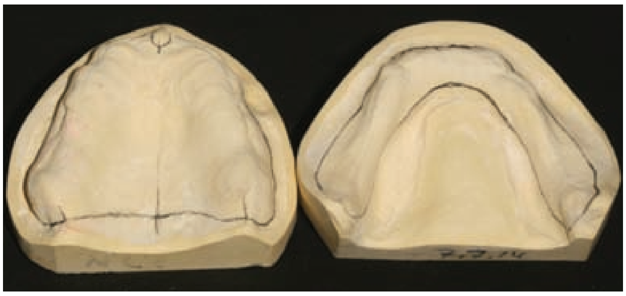

Figure 4: The situation models with reference lines for the expanse of the impression trays and areas for special consideration.

Figure 5: Upper and lower custom trays with acrylic rims.

Functional impressions and face-bow transfer

The individual trays are adjusted in the mouth and corrected on the ligaments. An impression is taken of the functional periphery with Coltex medium (Coltène/Whaledent AG/Altstätten, Switzerland); the fine impression is taken with Impregum (3M/St. Paul, USA). (Fig. 6) Before the upper tray is removed, the face bow is put on, adjusted, and repositionably connected to the tray with bite stops. This makes it possible to mount the upper functional model in the articulator with an anatomically correct cranium/axis relation.

In the laboratory, the boundaries of the functional periphery area are marked on the casting compound before pouring. After pouring with super hard stone type IV, the models are based with a split cast and magnet.

Before demolding, the upper model is secured in the fully adjustable articulator (Artex CR/Amann Girrbach/Koblach, Austria) using the face bow (Artex/Amann Girrbach/Koblach,

Figure 6: The functional impressions after removal from the mouth.

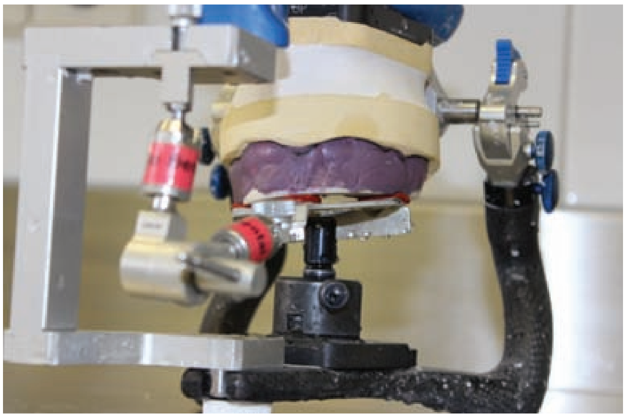

Figure 7: The upper model is mounted in the articulator using the face bow.

Figure 8: The completely based, trimmed, and ground functional models.

Figure 9: The completed registration rims are prepared for an occlusal height that has been raised by 8 mm.

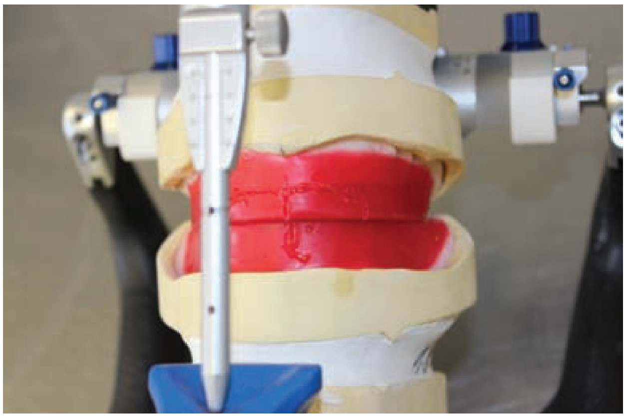

Figure 10: The models have been mounted in the articulator. The markings on the wax rims indicate the midline, smile line, and canine position..


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Austria). (Fig. 7) The functional models are trimmed, and the functional periphery area is ground at a right angle to the edge of the model. (Fig. 8)

Determination of maxillo-mandibular relationship

After the old dentures had been worn for many years, the vertical distance between the upper and lower jaw, in other words, the occlusal height, had decreased considerably. The desired increase in the vertical relation by 8 mm in comparison to the old dentures was a tolerable level for the patient and meant a perceptible and visible improvement over the initial situation.

The fabrication of the bite rim bases took place analogously to the impression trays, however, now on the basis of the functional models. The wax rims were preset to the height of the old dentures plus 8 mm. (Fig. 9)

These registration rims are then used to determine the maxillo-mandibular relationship. This makes it possible to clearly assign the lower model to the upper model in the articulator. Markings on the wax rims provide information on the midline, the width of the nasal base, which correlates with the distance from the tip of one upper canine to the other, to the smile line and to the occlusal plane. (Fig. 10)

Analysis of the functional models

The model analysis is an important part of the fabrication process for functional dentures. This makes it possible to determine former tooth positions as well as statically suitable load areas of both denture bearing areas. The model analysis also provides information for the definitive position of the teeth during setup.

The data determined in the analysis – anatomical model midlines, midlines of the alveolar ridges, progressions of the alveolar ridges, canine points, joint setup areas, dorsal boundaries – are transferred to the margins of the model so that they can still be recognized in covered jaws. (Fig. 11, 12)

In the present case, the alveolar ridges are well developed, and there are no unusual setup conditions, which can occur, for example, in the case of diverging alveolar ridges caused by atrophy.

Shade determination and tooth selection

The patient paid special attention to selecting anterior teeth and their shade. After many years with standard dentures, his desire for a natural appearance was understandable.

At the request of the patient, the tooth shade was not to be oriented to the old dentures but was to be lighter. After consultation, he followed the recommendation of his dentist, who works with the VITA classical A1-D4 tooth shades (VITA Zahnfabrik/Bad Säckingen, Germany) as the gold standard. Light A and B shades were eliminated because they appear too light in this case and do not suit his skin type. The choice fell to the VITA tooth shade C2, which is also light but appears more muted due to the higher amount of gray and also harmonizes well with his facial color.

Master dental technician Katja Fuchs has experienced that patients will often decide spontaneously to choose VITAPAN PLUS anterior teeth (VITA Zahnfabrik/Bad Säckingen, Germany). She attributes this to the fact that people have an instinct for "what looks real and what looks fake." For this reason, now she seldom offers other anterior teeth. "If a patient wishes to have an anterior tooth that is above the standard, that looks natural and is esthetically pleasing, then VITAPAN PLUS is the tooth of choice," notes the experienced dental prosthetist.

An initial examination of the VITAPAN PLUS acrylic teeth

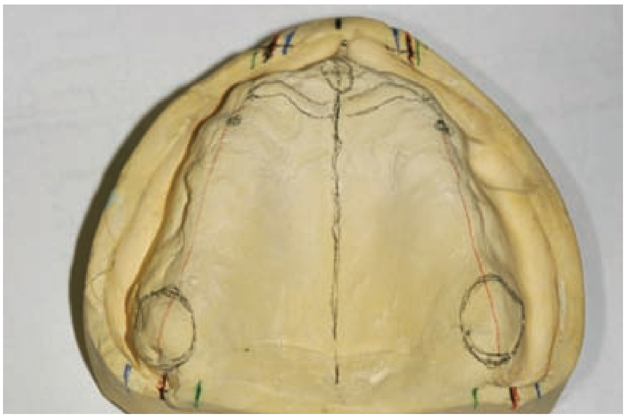

Figure 11 and 12: Markings after the model analysis show former tooth positions and indicate statically suitable load areas of both denture bearing areas.

Figure 13: The anterior teeth are set up according to the information on the upper bite rim.

Figure 14: The upper jaw and lower jaw anterior are completely set up.

already convinced the patient and the dental technician and led to a quick decision for this anterior tooth. Due to his body size, athletic physique, jaw shape, individual space conditions and wishes, a medium-sized, rectangular tooth shape was chosen for this patient: R47 in the upper jaw and L35 in the lower jaw, because its shape matches the width and length.

In the posterior area, the dentist decided on VITA LINGOFORM (VITA Zahnfabrik, Bad Säckingen, Germany) acrylic teeth in the shape 22L. They harmonize very well with VITAPAN PLUS anterior teeth. Their fully anatomically pre-abraded occlusal surfaces allow them to be easily brought into occlusion with very little grinding effort. The flat inclination of the cusps also make them an ideal posterior tooth for longtime denture wearers, whose dentures have often had strongly abraded posterior teeth for many years.

Setup of the teeth

The setup of the anterior teeth of the lower jaw follows the information on the upper jaw bite rim. (Fig. 13) The tooth length, sagittal overbite, and overjet are oriented according to the markings there. The subtle, individual setup ensures the natural appearance of the anterior later on. At the patient's request, pronounced anomalies in position were consciously avoided. (Fig. 14)

The setup of the posterior teeth follows the principle of the lingualized setup method with VITA LINGOFORM acrylic teeth. (Fig. 16, 17)

Gingiva modeling in wax

The careful waxing of naturally looking gingival areas is already a good idea for the try-in. (Fig. 15 to 18) After all, this is the patient's first contact with his or her new dentures.

Figure 15 and 16: The lower wax setup has been carefully waxed and is ready for try-in. The individual setup looks natural together with the detailed gingival modeling.

Figure 17 and 18: In the upper jaw, the VITAPAN PLUS anterior teeth also look very natural with this type of individual setup and gingival (left) and palate design (right).

Figure 19: The good fit, the attractive esthetics, and the smooth phonetics convinced the patient during the wax try-in.

Figure 20: In wax, the appearance has already changed greatly in comparison to the initial situation; the dentures do not look like false teeth.

Figure 21: As a result of the bite elevation, the entire profile of the face seems more harmonious than before.

Try-in

The patient was pleasantly surprised during the try-in; he did not expect that the dentures would fit right away at the first check. (Fig. 19) He tolerated the occlusal height elevated by 8 mm without any problem. A slight occlusal early contact on the left side was quickly corrected.

Cosmetically, he was very pleased; the individual setup of the VITAPAN PLUS anterior teeth looked very natural together with the anatomically molded gingiva. (Fig. 20) He could also speak perfectly right away.

A view from the side shows that the elevation of the bite makes the area between the chin and the nose seem more harmonious; the lips are evenly padded, the notch above the chin is filled in and practically smooth. (Fig. 21) The better support of the upper lip prevents it from being overlapped by the lower lip.

Finishing

To reproduce the gingival areas in acrylic that were anatomically designed in wax, fabricating with conventional plaster investing is not the best approach. Instead, gel duplication and acrylic molding provide a highly precise system for reproducing carefully waxed dentures in acrylic with all the anatomical contours and details, without any loss.

The waxed dentures are invested in flasks (PremEco Line flask) together with the model using a special duplication gel (PremEco Line/Merz Dental/Lütjenburg, Germany).

After the wax has been removed and the teeth have been boiled out, the anterior teeth areas of both jaws are first

Figure 22: Different colored acrylic powders are alternately applied and brought to reaction with monomer, here in the maxillary flask.

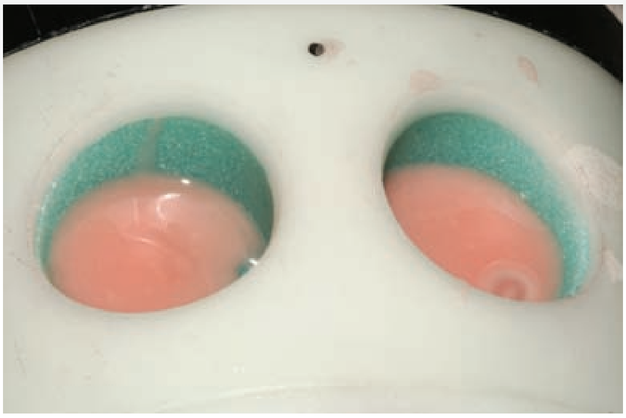

Figure 23: The acrylic is poured into the mold via the funnel (left) until it comes out of the second opening (right) again.

Figure 24 and 25: Directly after devesting, the shaping has been precisely reproduced in acrylic, even without rework.

individualized by the alternate application of colored acrylic powder and monomer (PremEco Line Prothetik-Color-System/ Merz Dental/Lütjenburg, Germany). (Fig. 22)

After the models are repositioned and the flask is closed and screwed tight, the acrylic (FuturaGen cold curing acrylic/Schütz Dental/Rosbach, Germany) is filled via the funnels provided for this purpose. (Fig. 23) The polymerization takes place in a pressure pot for pore-free compression of the acrylic.

Devesting

After devesting, it is immediately apparent that the careful preparatory work has paid off, since only minor reworking is required. (Fig. 24, 25) Surfaces and palatal rugae come out of the flask already molded. Interdental spaces, which are also critical with conventional methods because they are unclean, only require polishing.

The sprues are milled, the occlusion checked, and the malocclusion caused by the contraction of the acrylic is corrected. To reduce the residual monomer content of the bases, the dentures are stored in a water bath for 24 hours. Following this, the denture surfaces are minimally reworked and then polished to a high-gloss finish.

Placement

The natural appearance that was already achieved during the try-in is confirmed when the dentures are placed (Fig. 32 to 35), so that the patient feels good about his new dentures. As a result of the pronounced, natural-looking anatomical features of the VITAPAN PLUS anterior teeth already designed by the manufacturer, no individualization, for example, with the veneering composite VITA VM LC, is necessary anymore, except for discreet, individual tooth positioning. For this reason, high-quality results can be achieved with little effort in a very short time.

Figure 26 to 31: The completely polished dentures. All details molded in wax are preserved and support the natural appearance of the VITAPAN PLUS anterior teeth. The pronounced corporeality of the individual teeth is clearly apparent..

Figure 32: The new dentures support a harmonious overall impression – with an adjusted occlusal plane, alignment of the middle of the face and the middle of the dentures and a natural tooth position.

Figure 33: In comparison to the previous dentures, the improvement can be seen in the profile: The lower jaw no longer slides forward, the facial features are relaxed, and the head posture is also straighter than before.

Figure 34 and 35: The "new teeth" surpassed the expectations of the patient and fully satisified him from a functional, phonetic, and cosmetic point of view.

Successful teamwork

The important steps in the process of fabricating complete dentures were shown using a case from clinical practice as an example. Crucial to the success of this type of denture are the perfect interaction of high-quality and naturally looking prefabricated teeth - such as the VITAPAN PLUS anterior teeth and the VITA LINGOFORM posterior teeth - a logical, comprehensible and easy-to-implement methodology that combines the individual steps with each other, and the common goal of all involved parties to achieve a high-quality, individual result that suits the patient's style, especially in the case of a full denture. Since all fabrication steps are interdependent and build upon each other, the responsible actions of each individual in the team – that is, the dental technicians and the dentist – are an important aspect for the success of full dentures that are functionally and phonetically perfect and serve as an "invisible third set of teeth" that are not recognizable as dentures. In addition, the high degree of patient satisfaction has a strong motivational effect on the joint effort that goes far beyond the case that was just resolved.

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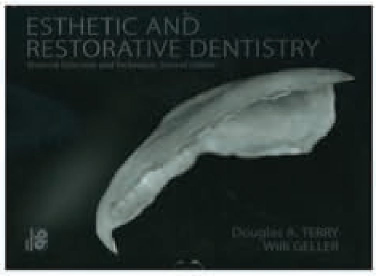

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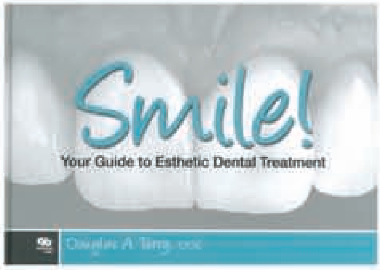

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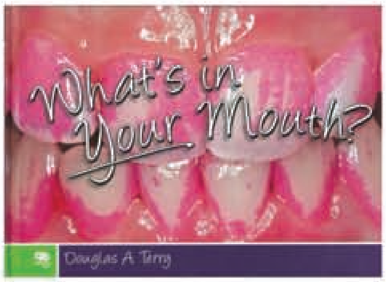

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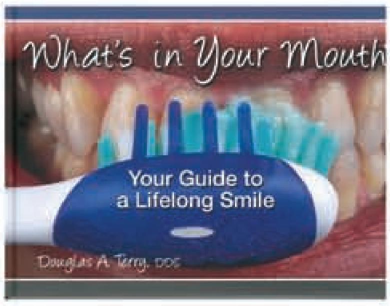

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New technologies – to improve root canal disinfection

Gianluca Plotino,[1] Nicola M. Grande,[2] Gianluca Gambarini[3]

Introduction

The major causative role of micro-organisms in the pathogenesis of pulp and periapical diseases has clearly been demonstrated.[1] The main aim of endodontic therapy is to disinfect the entire root canal system, which requires the elimination of micro-organisms and microbial components and the prevention of its reinfection during and after treatment. This goal is pursued through chemomechanical debridement, for which mechanical systems are used with irrigating solutions.

Standard endodontic irrigation protocol

Sodium hypochlorite

Sodium hypochlorite (NaOCl) is the main endodontic irrigant used, owing to its antibacterial properties and its ability to dissolve organic tissue.[2] NaOCl is used during the instrumentation phase to increase its time of action within the canal as much as possible without it being chemically altered by the presence of other substances.[3] The effectiveness of this irrigant has been shown to depend on its concentration, temperature, pH solution and storage conditions.[3] Heated solutions (45–60 °C) and higher concentrations (5–6 %) have greater tissue-dissolving properties.[2] However, the greater the concentration, the more severe the potential reaction if some of the irrigant is inadvertently forced into the periapical tissue.[4] In order to reduce this risk, the use of specially designed endodontic needles and an injection technique without pressure is recommended.[5]

EDTA

The main disadvantage of NaOCl is its inability to remove the smear layer. For this reason, combination of NaOCl with EDTA (ethylenediaminetetraacetic) is recommended.[2] EDTA has the ability to decompose the inorganic component of intracanal debris and is generally used in a percentage equal to 17 %. EDTA appears to reduce the antibacterial and solvent activity of NaOCl; thus, these two liquids should not be present in the canal at same time.6 For this reason, during mechanical preparation, abundant and frequent rinsing with NaOCl is performed, while the EDTA is used for 2 min at the end of the preparation phase to remove the inorganic debris and the smear layer from the canal walls completely.

Ultrasonic activation of NaOCl

The use of ultrasound during and at the end of the root canal preparation phase is an indispensable step in improving endodontic disinfection. The range of frequencies used in the ultrasonic unit is between 25 and 40 kHz.[7] The effectiveness of ultrasound in irrigation is determined by its ability to produce cavitation and acoustic streaming. Cavitation is minimized and limited to the tip of the instrument used, while the effect of acoustic streaming is more significant.[7]

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Figure 1: Ultrasonic activation with a passive file

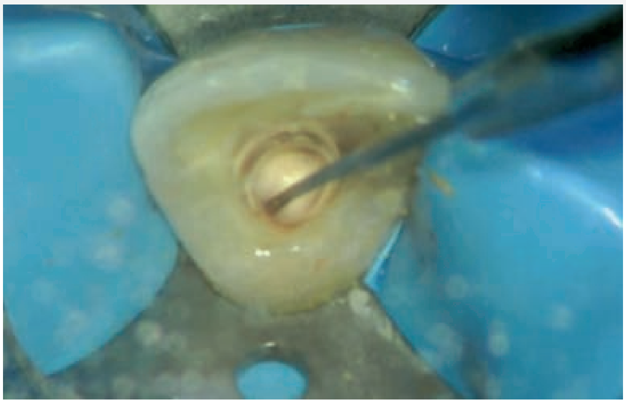

Figure 2: and an active file

Ultrasound creates bubbles of positive and negative pressure in the molecules of the liquid with which it comes into contact. The bubbles become unstable, collapse and cause an implosion similar to a vacuum decompression. Exploding and imploding they release impact energy that is responsible for the detergent effect. It has been demonstrated that ultrasonic activation of NaOCl dramatically enhances its effectiveness in cleaning the root canal space, as ultrasonic activation greatly increases the flow of liquid and improves both the solvent and antibacterial capacities and the removal effect of organic and inorganic debris from the root canal walls.[7]

Ultrasonic activation of NaOCl of 30–60 s for each canal, with three cycles of 10–20 s (always using new irrigant), appears to be sufficient time to obtain clean canals at the end of the preparation phase (Figs. 1 & 2).[7] Ultrasound appears to be less effective in enhancing the activity of EDTA, although it may contribute to better removal of the smear layer.[7] The accumulation of debris produced by mechanical instrumentation in inaccessible areas is preventable by using ultrasonic activation of NaOCl even during the preparation phase.[8] The use of a system of ultrasonic continuous irrigation might therefore be advantageous. It involves the use of a needle activated by ultrasound. With this method, the irrigant is released into the canal and is activated by the action of the ultrasonic needle simultaneously.[9]

Chlorhexidine

A final flush with 2 % chlorhexidine (CHX) after the use of NaOCl (to dissolve the organic component) and EDTA (to eliminate the smear layer) has been proposed to ensure good results in cases of persistent infection, owing to its broad spectrum of action and its property of substantivity.[5, 10] However, the use of CHX is hindered by the interaction between NaOCl and CHX, which tends to create products that may discolor the tooth and precipitates that may be potentially mutagenic. For this reason, CHX should not be used in conjunction with or immediately after NaOCl.[11] This interaction can be prevented or minimized by an intermediate wash with absolute alcohol, saline or distilled water.[12]

Activation systems

Mechanical instrumentation alone can reduce the number of micro-organisms present within the root canal system even without the use of irrigants and intracanal dressings,[13] but it is not able to ensure an effective and complete cleaning.[14] Irrigating solutions without the aid of mechanical preparation are not able to reduce the intracanal bacterial infection significantly.[15] For these reasons, today research is oriented toward the study of systems that can improve root canal disinfection through mechanical activation of endodontic irrigants, and in particular NaOCl. Multiple agitation techniques and systems for irrigants have been used over time,[16] demonstrating more or less positive results.[17]

Manual agitation techniques

The simplest technique of mechanical activation of irrigants is manual agitation, which can be performed with different systems. The easiest way to achieve this effect is to move vertically an endodontic file that is passive in the canal. The use of the file facilitates the penetration of the irrigant, leads to a more effective delivery of irrigant to the untouched canal surfaces and reduces the presence of air bubbles in the canal space,[18] but does not improve the final cleaning.[17] Another similar technique moves vertically a gutta-percha cone to working length with the canal filled with irrigant. Even this method, however, has not been found to improve the intracanal cleaning.[9, 17] For this purpose, in each case, wellfitting gutta-percha cones (increased taper) were more effective than cones with the standard taper (0.02).[9] The use of endodontic brushes and of particular needles for endodontic irrigation with bristles on their surface is another technique suggested in order to move the irrigant more effectively within the canals. These systems have been shown to be valid in the removal of the smear layer from root canal walls and thus they can be recommended during irrigation with EDTA to improve their efficacy at the end of the preparation.

Machine-assisted agitation systems

The evolution of manual systems led to the introduction of instruments that can be rotated in handpieces at low speed inside the canal filled with irrigant. They are rotary brushes too large to be brought close to the working length; thus, they can be used effectively only in the coronal and middle thirds of the canal. Other similar instruments are files in plastic with a smooth surface and increased taper or with a surface with lateral plastic extensions, that have dimensions appropriate to achieve the working length if used after the canal preparation. Studies on these systems have shown conflicting results. In general, the results are better than with hand irrigation with a syringe, but lower than that of other more effective systems.[16]

Continuous irrigation during instrumentation

Recently, a new system for root canal preparation has been introduced to the market. This system uses a particular instrument with an abrasive surface that enlarges the canal via friction in a vibrating motion and allows irrigant to flow through the file itself. This system has shown excellent results in terms of respecting the anatomy and cleaning of difficult root canal anatomies, such as difficult isthmuses, oval canals or C-shaped canals.[19] The low cutting efficiency of this system in some cases may limit its use in root canal preparation, but makes it an excellent additional technique to enhance the cleaning and disinfection of the root canal system at the end of the preparation.[20] The concept of continuous irrigation was developed in the past with the use of mechanical instruments for sonic and ultrasonic preparation that could concurrently clean through the continuous release of irrigant. These techniques were then abandoned for various reasons related to the poor quality of the preparation itself.

Sonic activation

Sonic activation has been shown to be an effective method for disinfecting the root canals. The recent systems use smooth plastic tips of different sizes activated at a sonic frequency by a handpiece. The system seems to be able to clean the main canal effectively, to remove the smear layer and to promote the filling of a greater number of lateral canals.[17] Another recently introduced technique uses a syringe with sonic vibration that allows the delivery and activation of the irrigant in the root canal simultaneously. Sonic activation differs from ultrasonic activation in that it operates at a lower frequency (1–6 kHz), and for this reason it is generally found to be less effective in removing debris than are ultrasonic systems.[17, 21, 22]

Apical negative-pressure irrigation

As the irrigant must be in direct contact with the micro-organisms and canal walls to be effective, the accessibility of the irrigant to the whole root canal system, in particular in the apical third, is essential. In order to deliver the irrigant into the root canal for the entire length and to obtain a good flow

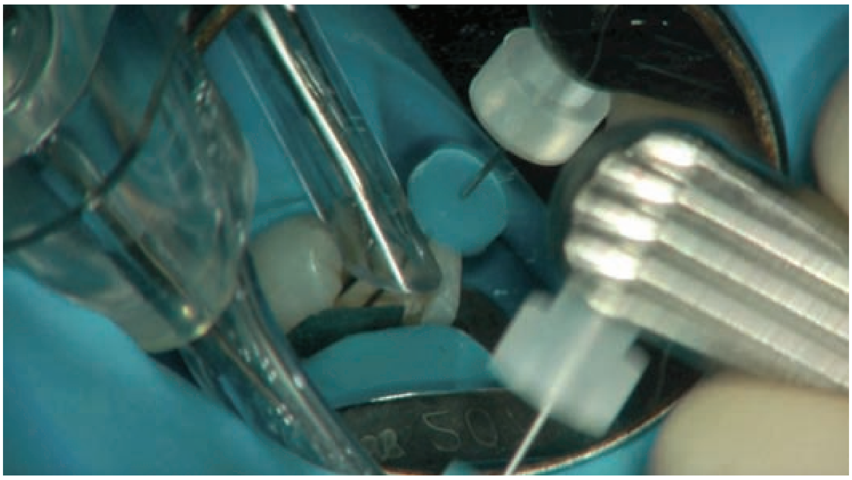

Figure 3: Apical negative-pressure irrigation system used to enhance debridement.

of fluid, apical negative-pressure systems have been introduced that release and remove the irrigant simultaneously.

These systems consist of a macro-cannula for the coronal and middle portions and a microcannula for the apical portion, and the cannulas are connected to a syringe for irrigation and the aspiration system integrated with the dental unit (Fig. 3). During irrigation, a tip connected with a syringe delivers the irrigant to the pulp chamber without the risk of overflow, while the cannula placed in the canal pulls irrigant into the canal, through the aspiration system to which it is connected, and evacuates it through the suction holes. This system is intended to ensure a constant and continuous flow of new irrigant into the apical third safely and with a lower risk of extrusion.[23] Most of the studies on this technique have shown that it is very effective at ensuring a greater volume of irrigant in the apical third[24] and excellent removal of debris from this area[25] and inaccessible areas,[26] with results in the majority of cases similar to those of ultrasonic activation techniques.[27–29] From a clinical perspective, apical negative-pressure systems can be effectively integrated with ultrasonic irrigation techniques because they act by different mechanisms. They can operate in synergy with the objective to obtain cleaner canals, especially in the apical third and the most inaccessible areas.

Laser activation

The interaction between the laser and the irrigant in the root canal is a new area of interest in the field of endodontic disinfection. This concept is the base of laser-activated irrigation (LAI) and photon-initiated photoacoustic streaming (PIPS) technology.[30] The mechanism of this interaction has been attributed to the effective absorption of the laser light by NaOCl. This leads to the vaporization of the irrigant and to the formation of vapor bubbles, which expand and implode with secondary cavitation effects. The PIPS technique is based on the power of the Er:YAG laser to create photoacoustic shock waves within the irrigant introduced into the canal. When it is activated in a limited volume of liquid, the high absorption of the laser in NaOCl combined with the high peak power derived from the short pulse duration employed (50 μs) determines a photomechanical phenomenon.[30] A study showed that there was no difference in bacterial reduction achieved by NaOCl activated by laser compared with only NaOCl.[31] Another study investigated the capability of LAI to remove a bacterial biofilm created in vitro on the canal walls.[32] This study found that it did not completely remove the biofilm from the apical third of the root canal and infected dentinal tubules. However, the finding that laser activation generated a higher number of samples with negative bacterial cultures and a lower number of bacteria in the apical third was a promising result regarding the effectiveness of the technique, and has been confirmed by a more recent study.[33]

Additional disinfection systems

In addition to the above-mentioned systems that were able to activate the endodontic irrigants and to improve their cleaning capability, endodontic research is oriented toward the identification of alternative solutions that could further refine disinfection and assist in the destruction of biofilms and the elimination of micro-organisms. For this purpose, different substances and technologies have been investigated over time with different results.

Photoactivated disinfection

A new method recently introduced in endodontics is photoactivated disinfection. This technique is based on the principle that the photosensitizing molecules (photosensitizer, PS) have the ability to bind to the membranes of the bacteria. The PS is activated with a specific wavelength and produces free oxygen, which causes the rupture of the bacterial cell wall on which the PS is associated, determining a bactericidal action.[34] Extensive laboratory studies have shown that the two components do not produce any effect on bacteria or on normal tissue when used independently of each other; it is only the combination of PS and light that exert the effect on the bacteria.[34]

An endodontic system called light-activated disinfection (LAD) has been developed based on a combination of a PS and a special light source. The PS attacks the membranes of micro-organisms and binds to their surface, absorbs energy from light and then releases this energy in the form of oxygen, which is transformed into highly reactive forms that effectively destroy microorganisms. LAD is effective not only against bacteria, but also against other micro-organisms, including viruses, fungi and protozoa. The PSs have far less affinity for the cells of the body; therefore, toxicity tests carried out did not report adverse effects of this treatment. Clinically, after root canal preparation, the PS is introduced into the canal to working length with an endodontic needle and is left *in situ* for 60 s to allow the solution to come into contact with the bacteria and spread through any structures, such as biofilms. The specific endodontic tip is then inserted into the root canal up to the depth that can be reached and irradiation is performed for 30 s in each canal (Fig. 4). This technique has proven to be effective in laboratory studies at eliminating high concentrations of bacteria present in artificially infected root canals.[35] Care should be taken to

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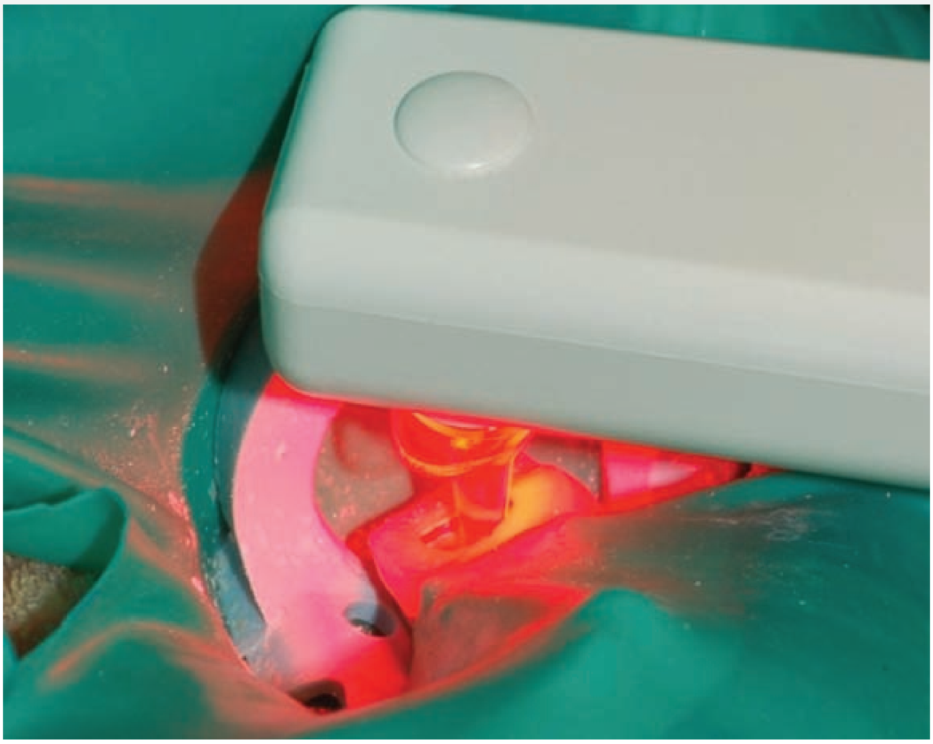

Figure 4: Disinfection activated by light to enhance root canal cleaning.

ensure maximum penetration of the PS, since it is important that it come into direct contact with the bacteria, otherwise the effect of photosensitivity will not occur. In addition, LAD appears to be effective not only against the bacteria in suspension, but also against biofilm.[5] Research is now directed toward evaluating the possibility of increasing the antibiofilm effectiveness of LAD, combining the benefits of photodynamic therapy with those of bioactive glasses and nanoparticles, which will be described later. Currently LAD is not considered as an alternative, but rather as a possible supplement to standard protocols of root canal disinfection already in use.[5]

Laser

One of the main disadvantages of the current endodontic irrigants is that their bactericidal effect is limited primarily to the main root canal. In the endodontic field, several types of lasers have been used to improve root canal disinfection: the diode laser, carbon dioxide laser, Er:YAG laser and Nd:YAG laser. The bactericidal action of the laser depends on the characteristics of its wavelength and energy, and in many cases is due to thermal effects. The thermal effect induced by the laser produces an alteration of the bacterial cell wall that leads to changes in osmotic gradients up to cell death. Some studies have concluded that laser irradiation is not an alternative, but rather a possible supplement to existing protocols to disinfect root canals.[36] The laser energy emitted from the tip of the optical fiber is directed along the canal and not necessarily laterally toward the walls. In order to overcome this limitation, a new delivery system of the laser was developed. The system consists of a tube that allows the emission of the radiation laterally instead, directed through a single opening at its terminal end. The objective of this modification was to improve the antimicrobial effect of the laser in order to penetrate and destroy microbes in the root canal walls and in the dentinal tubules. However, complete elimination of the biofilm and bacteria has not yet been possible, and the effect of the laser has been found to be less relevant than that of the classical solutions of NaOCl.[37] In conclusion, strong evidence is not currently available to support the application of high-power lasers for direct disinfection of root canals.[38]

Ozone

Ozone is an unstable and energetic form of oxygen that rapidly dissociates in water and releases a reactive form of oxygen that can oxidize cells. It has been suggested that ozone may have antimicrobial efficacy without inducing the development of drug resistance and for this reason it was also used in endodontics. However, the results of the available studies on its effectiveness against endodontic patho gens are inconsistent,[39] especially against biofilms. The antibacterial effectiveness of ozone was found not comparable and less than that of NaOCl.[39]

Alternative antibacterial systems

Nanoparticles

Nanoparticles are microscopic particles between 1 and 100 nm in size that have antibacterial properties and a tendency to induce much lower drug resistance compared with traditional antibiotics. For example, nanoparticles of magnesium oxide, calcium oxide or zinc oxide are bacteriostatic and bactericidal. They generate active oxygen species that are responsible for their antibacterial effect through electrostatic interaction between positively charged nanoparticles and negatively charged bacterial cells, resulting in accumulation of a large number of nanoparticles on a bacterial cell membrane and a subsequent increase in its permeability associated with the loss of its functions. Nanoparticles synthesized from powders of silver, copper oxide or zinc oxide are currently used for their antimicrobial activity. In addition, nanoparticles can alter the chemical and physical properties of dentin and reduce the strength of adhesion of bacteria to the dentin itself, thus limiting recolonization and bacterial biofilm formation. In any case, the possible success of the application of nanoparticles in endodontics will depend essentially on the manner in which they can be delivered in the most complex root canal anatomy.

Bioactive glass

Recently, bioactive glass or bioactive glass-ceramics have been a subject of considerable interest for endodontic disinfection owing to their antibacterial properties, but conflicting results have been obtained.[5]

Natural plant extracts

A current trend is the use of natural plant extracts, taking advantage of the antibacterial activity of polyphenolic molecules generally used for storing food. These compounds have been found to have poor antibacterial efficacy, but several demonstrate significant ability to reduce the formation of biofilms, although the mechanism by which this occurs is not clear.[5]

Noninstrumentation techniques

The first trial of a method of cleaning without canal preparation was the noninstrumentation technique conceived by Lussi et al.[40] This technique did not provide for the enlargement of the root canals because there was no mechanical instrumentation of the root canal walls. In fact, root canal cleaning was exclusively obtained with the use of NaOCl at low concentration, introduced and removed from the canal using a vacuum pump and an electric piston that created fields of alternating pressure inside the canal. These caused the implosion of the produced bubbles and hydrodynamic turbulence that facilitated the penetration of NaOCl into the root canal ramifications. At the end of this procedure, the canals were filled with a cement conveyed by the same vacuum pump. This system did not prove to be of substantial effectiveness and was never marketed.

Recently, a method has been developed for cleaning the entire root canal system through the use of a broad spectrum of sound waves transmitted within an irrigating solution to remove pulp tissue, debris and micro-organisms quickly. One study showed that this technique was able to dissolve the tissue tested at a rate significantly higher than that of conventional irrigation.[4] More research is needed to determine whether this approach is effective in the root canal system with minimally invasive or no canal preparation.

Conclusion

According to current knowledge, endodontic pathology is an infection mediated by bacteria and in particular by biofilm. From a biological perspective, endodontic therapy must then be directed toward the elimination of micro-organisms and the prevention of possible reinfection. Unfortunately, the root canal system, with its anatomical complexity, represents a challenging environment for the effective removal of bacteria and biofilm adherent to the canal walls. Chemomechanical preparation involves mechanical instrumentation and antibacterial irrigation, and it is the most important phase of the disinfection of the endodontic space. The technological advances of instruments have brought significant improvements in the ability to shape the root canals, with fewer procedural complications. In the management of the infected root canal system, various antimicrobial agents have been employed. Furthermore, some clinical measures, such as an increase in apical preparation and a more effective system of irrigant delivery and activation of irrigant, can promote and make more predictable the reduction of intracanal bacteria, especially in complex anatomical and noninstrumented portions of the root canal system.

Editorial note: A list of references is available from the publisher.

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Is oral bisphosphonate therapy a risk factor for implant failure?

Johan Hartshorne[1]

A critical appraisal of a systematic review: Ata-Ali J, Ata-Ali F, Peñarrocha-Oltra D, Galindo-Moreno P. What is the impact of bisphosphonate therapy upon dental implant survival? A systematic review and meta-analysis Clinical Oral Implants Research 2014 doi: 10.1111/clr.12526
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(Origin of research –Valencia University Medical and Dental School, Valencia, Spain and Department of Oral Surgery and Implant Dentistry, University of Granada, Granada, Spain)

Summary
Systematic review conclusion: The present study suggests that dental implant placement in patients receiving bisphosphonates (BP's) does not reduce the dental implant success rate. However, such patients are not without complications, and risk evaluation therefore must be established on an individual basis, as one of the most serious though infrequent complications of BP therapy is osteonecrosis of the jaw.

Critical appraisal conclusion: This meta-analysis indicates that exposure to oral BP's for less than 3 years may not be a risk factor for implant failure. However, the studies included in the review are mostly retrospective studies, with several limitations including bias, small sample sizes and variability amongst subjects, interventions and outcome measurement. Therefore, the clinical significance and implications of the results of this review should be interpreted with caution due to the low level of the evidence and lack of controlling and analyzing important confounding factors such as patient's age, smoking habits, poor oral hygiene, periodontal disease, dental trauma, diabetes, and obesity, that is known to influence the incidence of bisphosphonate related osteonecrosis of the jaws (BRONJ) and implant failures.

Implications for clinical practice: It is prudent to apply appropriate clinical judgment in all patients who are on oral BP therapy when implant placement or any other dento-alveolar surgical procedure is contemplated. A preventive approach aimed at optimizing oral health and mitigating factors such as smoking, periodontal disease, diabetes, history of cancer and cortico-steroid use that increase the risk of BRONJ or implant failure should be followed in patients using oral BP's. Patients treated with oral BP's must be given a full disclosure of risk of BRONJ and the possibility of implant loss over the long-term. It is also essential for patients receiving dental implants that are on oral BP therapy to comply with a regular recall schedule. Placing implants in patients receiving IV therapy is contraindicated at this stage of time.

Clinical question
What is the impact of bisphosphonate therapy upon dental implant survival?

Review methods
Methodology
This study followed the *Preferred Reporting Items for Systematic Reviews and Meta-analysis* (PRISMA) guidelines.[1] Two reviewers independently assessed the

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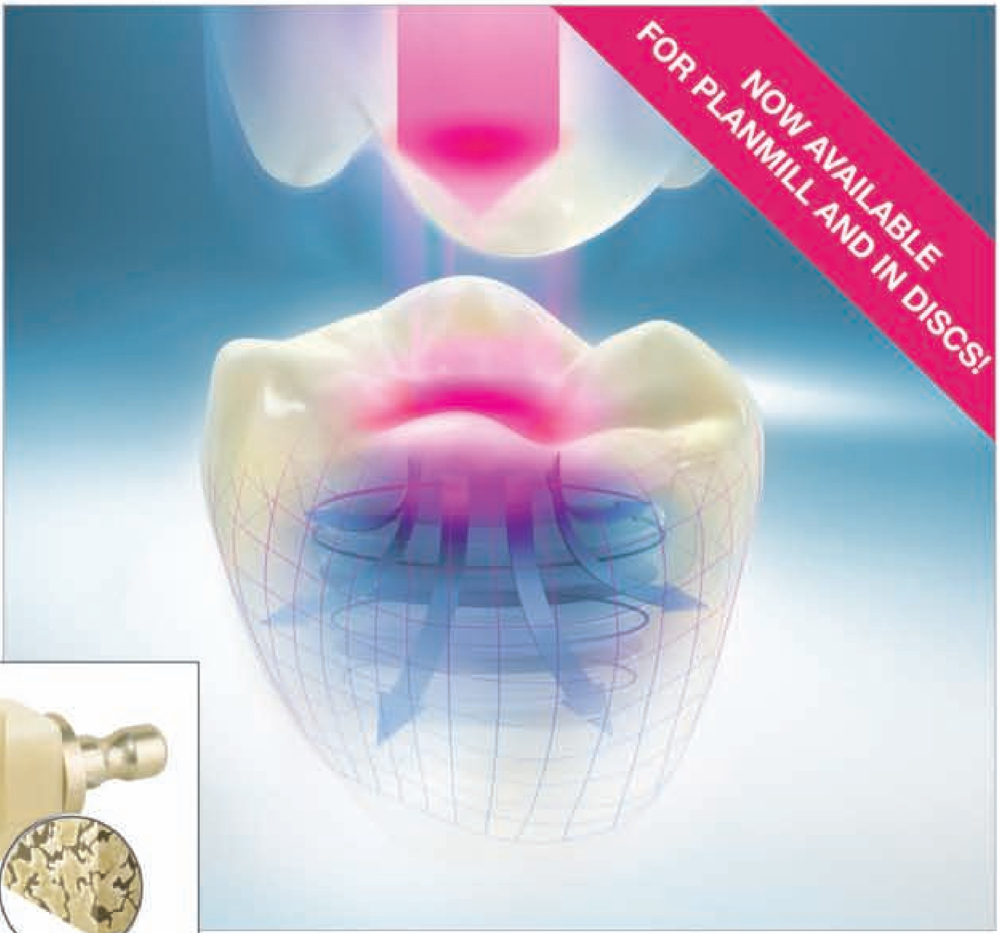

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