BioRace NiTi system: biologically desirable apical sizes – safely and efficiently

Dr Martin Trope and **Dr Gilberto Debelian** explore the BioRace NiTi system, designed to achieve an apical preparation that will consistently disinfect the canal to levels required for a high level of success

CPD Aims and objectives

This clinical article aims to present an analysis of the BioRace NiTi system, including a look at the design of the system to achieve a high level of success.

Expected outcomes

Correctly answering the questions on page XX, worth one hour of verifiable CPD, will demonstrate you understand that the BioRace NiTi system was designed with an appropriate irrigation protocol to achieve an apical preparation that will consistently disinfect the canal to levels required for a high level of success.

Bacteria and Prognosis
Success by Culturing Results

	Presence of Bacteria	No Bacteria
Zeldkow & Ingle (1963)	83%	93%
Oliet & Sorin (1969)	80%	91%
Bystrom et al (1987)		95%
Sjögren et al (1997)	68%	94%
Molander et al (2007)	44%	80%

Figure 1: Outcome studies related to culturable microbes. When the threshold is high (positive culture) the success rate is considerably lower than when microbes cannot be cultured from the canal (negative culture)

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Endodontics is the prevention or elimination of apical periodontitis. Apical periodontitis is caused by microbes in a necrotic root canal space (Kakehashi, Stanley, Fitzgerald, 1965; Bergenholtz, 1974; Sundqvist, 1976).

If the canal is vital, apical periodontitis of endodontic origin is not possible (Fabricius et al, 1982; Moller, 1966). Vital pulp therapy is considered prevention of apical periodontitis while the disinfection steps when treating a necrotic infected pulp is considered elimination of apical periodontitis.

The biological requirements for successful root canal treatment are well established. If the canal is filled when the canal is free of microbes (vital tooth) or when the microbes are below a certain threshold (infected tooth), an extremely high success rate of preventing (vital tooth) or eliminating (necrotic tooth) apical periodontitis can be expected. Root canal treatment comprises two phases:

1. The microbial control phase

The aim of this step is to avoid (vital) or eliminate (necrotic/infected) as many microbes as possible before moving to the next step .

2. Root filling phase

The 'clean' canal is sealed so that an environment is in place to heal a previous apical periodontitis or maintain a healthy periodontium apically over the long term.

Median diameter of Mandibular canals 1 mm from radiographic apex	
Central incisor	**0.37 mm**
Lateral incisor	**0.37 mm**
Canine	**0.33 mm**
Premolar	**0.35 mm**
MB (molar)	**0.40 mm**
ML (molar)	**0.38 mm**
D (molar)	**0.46 mm**

Figure 2a: Median diameters of mandibular measured 1mm from the apex

Median diameter of Maxillary canals 1 mm from radiographic apex	
Central incisor	**0.34 mm**
Lateral incisor	**0.45 mm**
Canine	**0.31 mm**
Premolar	**0.37 mm**
$MB_{1\&2}$ (molar)	**0.19 mm**
DB (molar)	**0.22 mm**
P (molar)	**0.33 mm**

Figure 2b: Median diameters of maxillary canals measured 1mm from the apex

As mentioned, the microbial control phase of root treatment is aimed at leaving as few microbes as possible in the canal before filling. It is irrefutable that less microbes at the time of filling results in more success of the treatment (Zeldow, Ingle, 1963; Engström, Lundberg, 1965; Byström et al, 1987; Sjögren et al, 1997; Waltimo, et al, 2005; Molander et al, 2007).

In fact, even in a necrotic tooth, if a technique is used that ensures that microbes cannot be cultured before filling the canal, an extremely high success (>90%) equal to a vital tooth should be expected (Zeldow, Ingle, 1963; Engström, Lundberg, 1965; Byström et al, 1987; Sjögren et al, 1997; Waltimo, et al, 2005; Molander et al, 2007) (Figure 1).

The BioRaCe system is designed with an appropriate irrigation protocol to achieve an apical preparation that will consistently disinfect the canal to levels required for a high level of success.

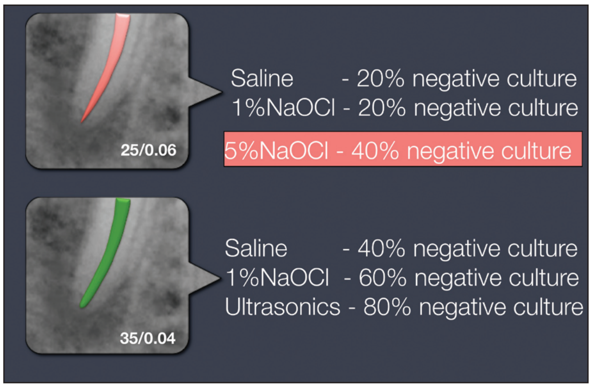

Figure 3: Culture results when the canal is instrumented to 25/0.06 (upper bracket) and instrumented to 35/0.04 with different strengths of NaOCl and ultrasonics. The increased effectiveness of the 35/0.04 group can be explained by the fact that by going from 25/0.06 to 35/0.04 increases the volume in the apical third region by 70%

What is the appropriate apical preparation?

Anatomic considerations:

Mechanical instrumentation is a critical step in the prevention/disinfection of the root canal. Studies have shown that, even when no biologically active irrigating solution is used, as the canal is instrumented to larger diameters, so the number of remaining microbes is significantly reduced (Dalton et al, 1998; Mickel et al, 2007; Bartha et al, 2006; Weiger et al, 2006).

If one studies the literature, it is obvious that the natural sizes of the apical third of almost all root canals are surprisingly large (Green, 1955; Green, 1956; Kuttler, 1955; Wu et al, 2000) (Figures 2a and 2b).

Studies have been performed as to how large a canal should be instrumented in order to adequately clean (and thus disinfect) most root canals (Card et al, 2002; Baugh, Wallace, 2005; Weiger et al, 2006).

As is appreciated, these sizes are considerably larger than what is achieved by using the traditional step-back shape of instrumentation. However, as can now be appreciated when comparing the apical sizes of #25, #30 of the step-back shape to the natural sizes of the canal, the step-back shape has little chance of removing canal microbes and relies almost entirely on irrigating solutions and intra-canal medications for disinfection and thus success of treatment. Conclusive evidence exists showing that the step-back sizes are insufficient to clean most canals (Dalton et al, 1998; Shuping et al, 2000; McGurkin-Smith et al, 2005). The importance of physically 'scraping' the walls of the canals has been highlighted recently with the appreciation of the role of biofilm on the internal aspect of all infected canals (Chavez de Paz, 2007). Biofilm is 1,000 times more difficult to remove than floating planktonic microbes and it stands to reason that physical contact with them would be the most effective method for their removal.

Influence of irrigation

An additional problem of using minimal apical instrumentation sizes and irrigating solutions is that the effectiveness of these solutions is nullified when the apical third of the canal is instrumented to smaller sizes. Studies have shown that the medicaments cannot reach the apical third of the canal unless minimal sizes larger than those provided by the step-back shape (Shuping et al, 2000). This is logical when one appreciates when one instruments the apical 3mm to a #35 (0.04 taper) compared to a #25 (0.06), the volume increase

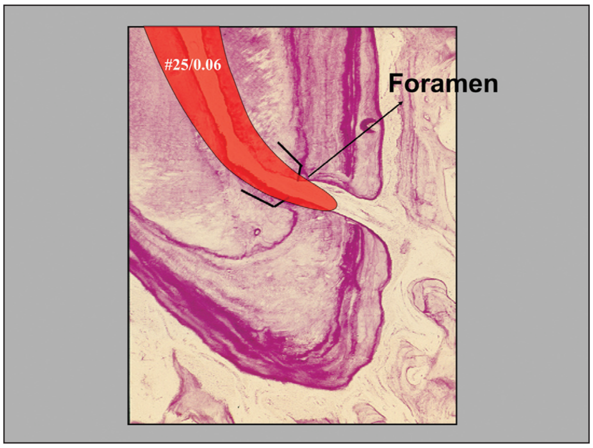

Figure 4: When the canal is obturated to #25/0.06 it is difficult to stop the master point at the dento-cemental junction

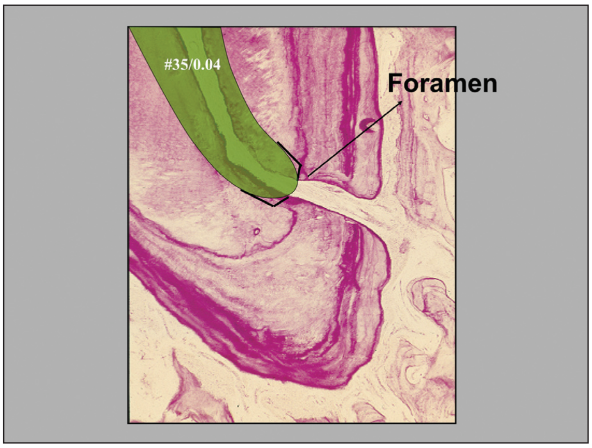

Figure 5: When the canal is instrumented to #35/04 an apical stop is created, providing a matrix against which the master point is pushed and resisting the movement of the point past the dento-cemental juntion

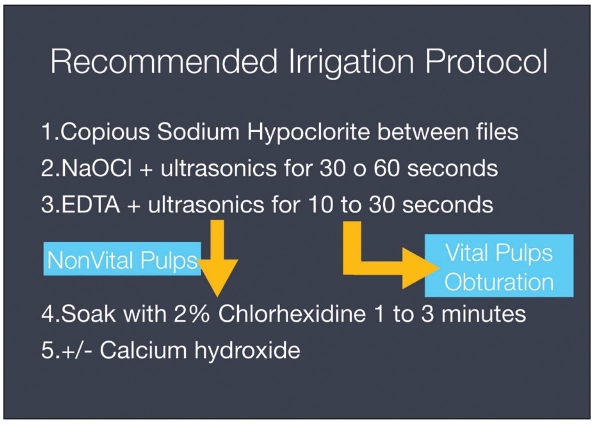

Figure 6: Recommended irrigation protocol that, when combined with apical sizes shown in Figure 7, will result in canals with consistently low microbial counts and high prognosis. For vital teeth the canal can be filled after the EDTA step. For infected teeth the chlorhexidine and or calcium hydroxide steps should be included

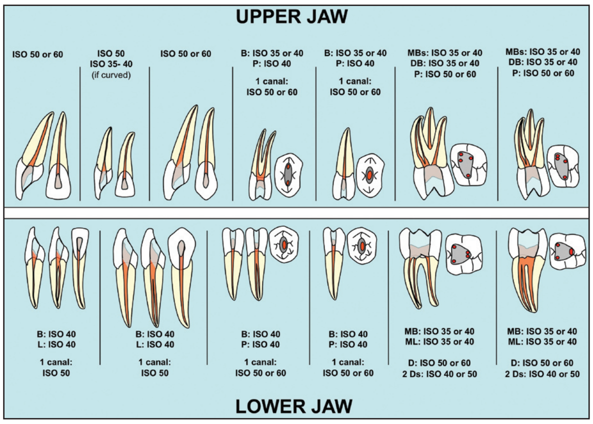

Figure 7: Recommended sizes that, in conjunction with the irrigation protocol (Figure 6) recommended in this paper, will result in a consistent low threshold of microbes before filling the root canal. For multi-rooted teeth, mesials of lower molars, buccals of upper molars sizes #35 or #40 0.04 are recommended. For single rooted teeth, palatal roots of upper molars and distal roots of lower molars sizes #50/0.04 or #60/0.02 are recommended

in this area is 70%. This 70% increase in volume will result in more biofilm disruption and allow more irrigant into the area to remove any remaining microbes in the area. Recent studies have shown the ultrasonic agitation of the irrigant results in an even better killing of the microbes (Carver et al, 2007). The increased volume provided by larger apical sizes will further enhance the added effectiveness of the ultrasonic irrigation method (Figure 3).

Obturation

Since the natural sizes of most canals are larger than the #25 that is used with the step-back shape, root filling requires a technique that uses friction along the canal walls to fill to a point short of the dento-cemental junction (Figure 4).

The technical difficulty of this obturation technique results in many cases where the master cone is pushed through the foramen, resulting in a lowering of the success rate. When adequate sizes are used, in order to create a 'box' just short of the dento-cemental junction, it is possible to push on the master cone, allowing lateral movement of the filling material and sealer thus keeping the fill short of the foramen and forcing material into the dentinal tubules and accessory canals. Therefore, the advantages of larger apical sizes are:

- Physical disruption of the biofilm
- Increased volume so as to increase the effectiveness of the irrigant
- Easier and more effective root filling.

Figure 6 shows the irrigation protocol proposed while Figure 7 shows the suggested apical sizes that, with the irrigation protocol, will result in a consistent low microbial count after this phase of treatment and thus a consistently high probability of success.

The BioRace system

This system is designed to achieve the 'biological sizes' described in the chart (Figure 7) in an efficient and safe

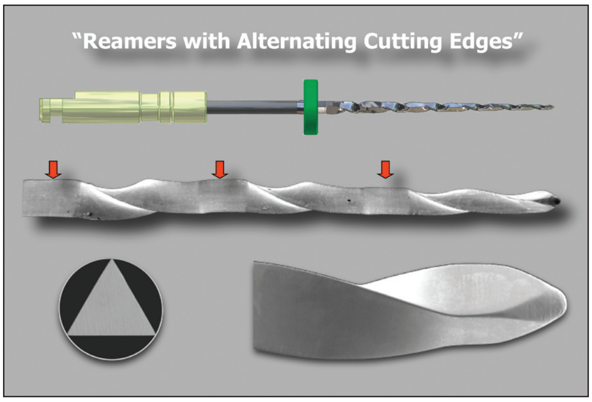

Figure 8: Physical characteristics of Race files: alternate cutting edges, non-cutting tips, triangular cutting edges and electrochemical surface treatment

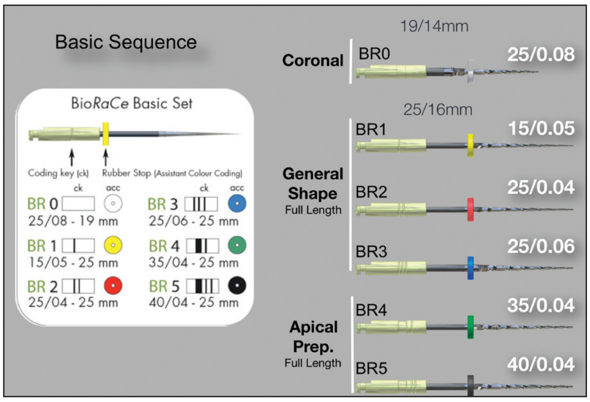

Figure 9: BioRace basic set

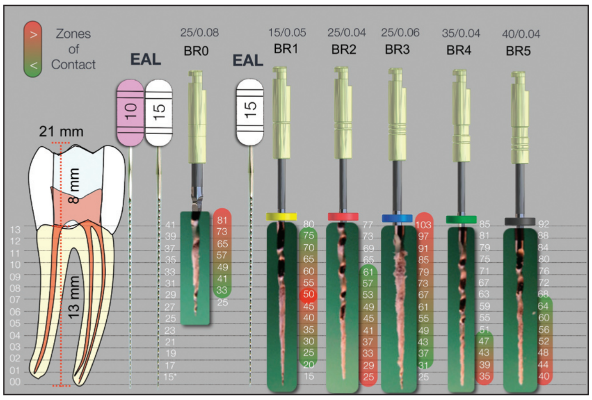

Figure 10: Zones of contact on the dentinal walls. The green zones shows where dentin is removed in small amounts and the red zones is where the dentin is removed in greater amount. The areas where the red/green zones are not marked are the areas where the instrument does not enlarge the canal

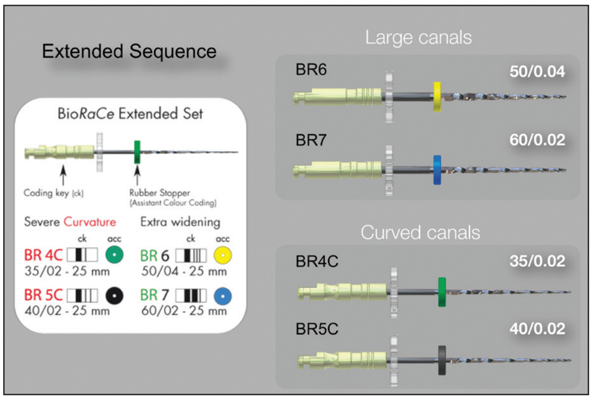

Figure 11: BioRace extended set

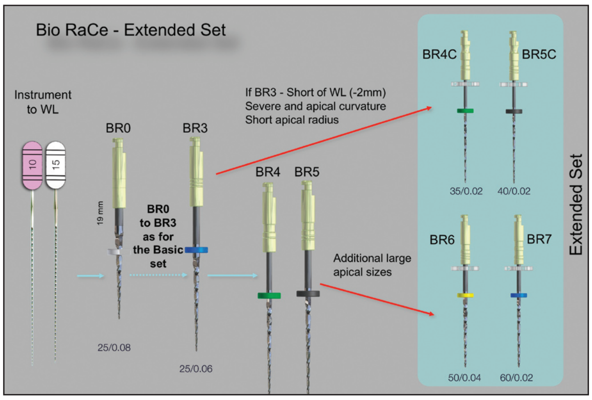

Figure 12: The entire clinical protocol for the BioRace system

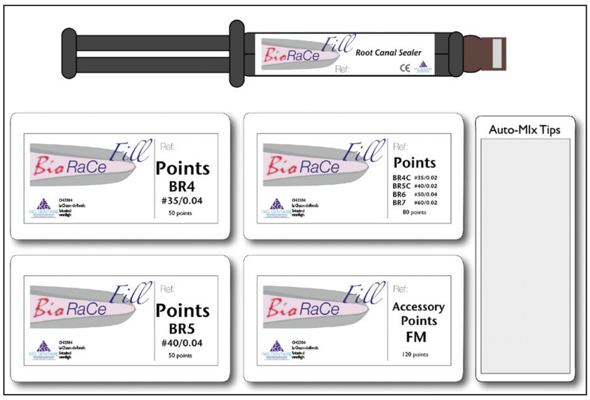

Figure 13: BioRace Fill system

manner.

BioRace instruments possess the same physical characteristics of the well-known NiTi rotary Race instruments with:

- Alternating cutting edges
- Non-cutting safety tips
- Sharp cutting edges (triangular section) without radial lands
- Electro-chemical surface treatment (Figure 8).

BioRace differs from standard Race instruments in regard to instrument tapers, sizes, sequence and handle codes. The unique aspect of this sequence is that the recommended

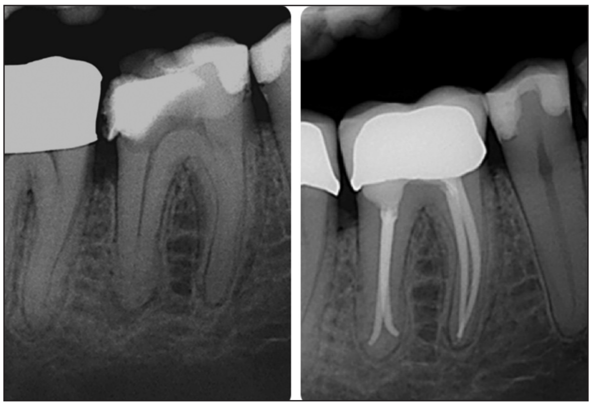

Figure 14

Figure 15

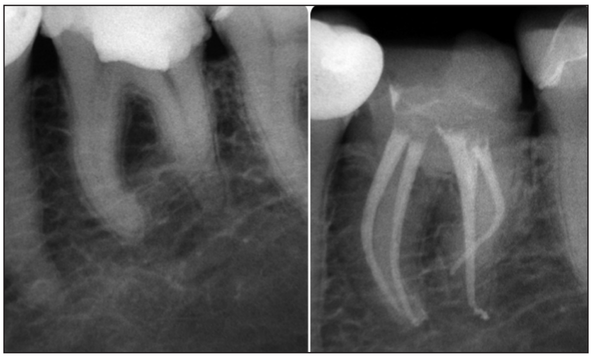

Figure 16

Figure 17

apical sizes of most of the teeth can be achieved with five to seven instruments (depending of the root canal anatomy – see Figure 7).

As with all Race instruments, the files are used with four gentle continually moving apical strokes at 500-600rpm. If the desired length is not achieved with these four strokes, the file is removed from the canal, wiped clean and another four strokes are used. This can be repeated until the desired length is attained, although it is unusual to use more than two four stroke attempts to get to length.

BioRace sets and instruments

The majority of cases can be completed with the BioRace basic set. This set comprises six instruments and will achieve a size #40/0.04 taper.

After the working length is confirmed and a glide path achieved with a #15 file, the BR0 (25/0.08) is used as an orifice opener. As can be seen by the contact zone chart, most of the 'work' done with this instrument is in the coronal 4mm of the canal.

It is prudent to reconfirm the glide path with a #15 file after the use of the BR0 instrument.

The BR0 is followed by the BR1 (15/0.05) used to the working length. The 'work' with this instrument will be in the next 4-5mm, continuing a controlled crown-down instrumentation of the canal with minimal stress on the instrument.

The use of the BR2 (25/0.04) to working length continues the controlled crown-down shaping of the canal by working the final 4-5mm of the canal. Again, since only 4-5mm of the file is in contact, the stress to the file is minimized.

The BR3 (25/0.06) contacts the coronal two thirds of the canal that will allow the apical cleaning files that follow to work with minimal stress.

The apical cleaning BR4 (35/0.04) and BR5 (40/0.04) files are then used as needed by the size requirements of each specific canal.

An extended set is also available (Figure 11), which includes four additional files. The BR6 (50/0.04) and BR7 (60/0.02) can be used for those canals that require sizes larger than 40/0.04 (Figure 7). In addition, the BR4C (35/0.02) and BR5C (40/0.02) can be used for those canals where the BR3 has difficulty getting to length, indicating a severe curvature of the canal. In these cases the more flexible 0.02 tapered files are recommended.

The unique aspect of this sequence is that the areas of contact of each file are such as to minimize stress on the files so that they can be safely used at full working length (Figure 10).

Figure 12 summarizes the entire clinical protocol for the BioRace system:

• Step 1: Achieve a clear glide path to the selected working length with a #15 file

• Step 2: Use BRO, BR1 and BR3 as described above

• Step 3: If BR3 reaches the working length easily (in a maximum of two four strokes), in a 'small' canal continue to BR4 or BR5. In a 'big' canal continue to BR6 or BR7

• Step 4: If the BR3 does not reach working length as described in step three, use BR4C or BR5C.

Bio Fill

The BioRace Fill system (Figure 13) comprises Resilon points and self etch sealer used with a passive lateral condensation technique. The points match with the BR4, BR5, BR6, BR7, BR4C and BR5C. Accessory points are also available in the system. Of course, a thermoplastic filling technique is possible with this file system as with any other system.

Another advantage of this system is the ease and simplicity of filling the canal once the canal instrumentation is completed with the BioRace files. Essentially, only three choices of points will be used 99% of the time. In addition, based on the way the canals are prepared, only minimal use of accessory points will be necessary.

As can be seen from the minimal instrumentation chart, sizes #35, 40 and 50 are the sizes that are most often required. These sizes correspond to BR4, 5 or 6. Also, when BR4 is used, 5mm of the canal fits snugly in the canal, leaving 3-5mm for additional points. These can usually be filled with two to three points placed in a passive fashion. For the BR5 and BR6, the length of snug fit of the primary point is at least 7mm. Therefore, the need for additional points for these sizes is even less than the BR5 points.

When a #60/0.02 file has been used for the final instrumentation size, a BR7 point can still be used but 1mm of the apical point must be removed with the use of a sizing gauge.

Thus, with this system, there is a need to stock only three sized points with one or two types of accessory points.

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