The goal of this article is to describe and suggest functional, esthetic materials and clinical techniques as viable alternatives to traditional post/cores, and to describe a protocol and a philosophy, for post-endodontic restorations presenting in various degrees of severity. Posts are traditionally indicated for retention where remaining coronal tooth structure is less than 50% and/or the core strength is compromised by an endodontic access opening.

BACKGROUND
Fouchard first described cast post/crowns in the 1700s, and the technique utilized the best technology available at the time. Today, custom cast posts have been abandoned in most parts of the world, and replaced by either prefabricated metal posts or fiber-reinforced composite posts. There is wide, evidence-based support for the shift from the metallic to the use of biocompatible organic posts:

- All fiber posts have a Modulus of Elasticity compatible with that of dentin (~20 GPa), allowing the post, composite core and the tooth to flex together (slightly), in function. This dissipates stress and reduces the likelihood of damage to the root.1-4

- Organic posts cannot fall prey to galvanic or corrosion activity.

Corrosion with base metals predisposes to a high percentage of failures with cast posts,5 which fail twice as often (clinically) as prefabricated metal posts.6

- Most fiber posts are esthetically invisible under esthetic restorations, and also avert the phenomenon of Dark Root show-through7,8 (Fig. 1).

- Should re-treatment ever become necessary, and unless there is a metallic internal component for purposes of radiographic tracking, fiber posts areatraumatically removed in a matter of a few minutes,9-12 whereas cemented metal posts may further limit or complicate endodontic treatment.13

Virtually all fiber posts share these characteristics, but they are far from being the same. They vary remarkably from one another in terms of composition, and quality control which is generally dependent on the manufacturer. The differences in their raw materials and manufacturing process profoundly affects the posts’ mechanical behavior14,15 and, ergo, clinical performance and optical properties. SEM photographs (Figs. 2-4), show significant differences in the size of fiber, orientation, and quantity of fibers in only four representative post brands. More importantly, a connection between composition, microstructure, and consistency (quality) can be correlated with their mechanical and clinical behavior. This means, for example, that posts with voids or bubbles in the matrix will have inferior structure, and therefore will be weaker and less resistant to load stress.14

Superiority in fracture strength is related to the percentage of and type of fibers, and to the critical interface between the fibers and their matrix.16 Moreover, and perhaps more importantly, the microstructure also affects the cyclic fatigue resistance and radiopacity of fiber posts.

The radiograph (Fig. 5) compares an assortment of fiber posts, and Figures 6-8 demonstrate these same disparities in (the same) extracted tooth. It is obvious that the quartz fiber Macro-Lock(tm) Illusion® X-RO® (RTD St Egreve France / Clinical Research Dental, London, Ontario) is the most radiopaque in this sample (Fig. 7).

Quartz fibers developed for dentistry with a high Silica content and specific radiopacifiers, are some of the most radiopaque fibers being used17,18 and these posts demonstrate better fatigue resistance than to posts made of...
simpler glass fibers\textsuperscript{15} and to that of metal posts.\textsuperscript{19}

Cyclic Fatigue is generally considered as the most relevant method for predicting behavior in an oral environment,\textsuperscript{18} and permit the fair prediction of yielding and, theoretically, the long-term behavior of the restoration.\textsuperscript{20,21}

While it was once hoped that rigid metal posts might reinforce endodontically-treated teeth, Sorensen, et al subsequently concluded otherwise. However, today some in vitro evidence suggests that Quartz fiber posts with bonded composite cores, and with varying amounts of remaining tooth structure can, actually provide some re-strengthening of endodontically-weakened teeth restored with MODs, laminates or crowns.\textsuperscript{22-26} SEM (Fig. 9) represents the adaptation that is possible with a fiber post to create a “monobloc” effect.

We now have meaningful clinical observations of Carbon\textsuperscript{27-30} or glass and Quartz fiber\textsuperscript{31-34} posts. Quartz fiber posts demonstrate remarkable performance at 7-11 years.\textsuperscript{35} Furthermore, the differences in failure rates (particularly catastrophic failure rates) between fiber posts and cast posts is profound at only four years of service.\textsuperscript{36}

Use of single fiber posts in typically “round,” conservative root treatments has been described in many articles, lectures and textbooks. Unlike metal posts, there appears to be no difference between clinical performance of tapered and parallel fiber posts.\textsuperscript{37,38} Yet it is obvious that parallel posts can necessitate removal of additional dentin and will, by design, contribute internal angles- natural stresspoints. So, the tapered
apical/parallel body shape is pref-
erable, if only for the sake of
dentin conservation. In Figures
10 and 11 it is obvious from these
radiographs that more tooth struc-
ture would need to be sacrificed to
allow the parallel posts to seat all
the way, weakening the remaining
root structure.

So, what is the “new technol-
ogy” approach in the case of a
flared, ovoid or figure-eight canal?

Round posts can only provide
good adaptation in the apical end
of the post space, since most post
spaces present some degree of flar-
ing or divergence. When the root
canal is oval or an ellipse, then a
parallel-sided post will not be ef-
fective unless the canal is consid-
erably enlarged, requiring even
more dentin sacrifice. For this rea-
son, many posts are unfortunately
cemented to surfaces covered by
gutta percha. The resulting lack of
retention is a direct result of pre-
paring a round canal space with a
or rotary instrument in a canal
which is never round. There are
now two fiber posts designed with
a round apical section, and an oval
coronal section (PeerlessPost™ —
Sybron Endo & Ellipson™ —
RTD, St Egreve, France/Clinical
Research Dental.)

The MONOBLOC philosophy
must be expandable, with tech-
niques and products to accommo-
date the wide, flared canal, while
also considering the other existing
variables, such as C-Factor and
S-Factor stress, polymerization
shrinkage and even microleakage.

Many fiber posts present in par-
allel sizes that resemble their me-
tallic predecessors, but a tapered
preparation is the least invasive.
As the diameter of metal posts in-
creases, so does the stress transfer
to the tooth, and so, logically, does
the predisposition to root splits,
but this is not the case with fiber
post. So, the clinician is free to
select as large as fiber post as
possible to increase surface area
for bonding, girth for strength,
and taper for adaptation, without
the fear of predisposing to root
fracture.

Some tapered Quartz fiber
posts are available as large as
2.3mm at the coronal extreme
(DT Light-Post, RTD St Egreve,
France/ Bisco Canada, Rich-
mond, BC and Macro-Lock Post,
RTD, St Egreve, France/Clinical
Research Dental, London, ON).
These sizes exceed the diameters
available in most brands, and
are capable of fitting most root
canal treatments without further
instrumentation, eliminating the

![Figure 10](image1.png) — Parallel sided fiber post of 1.5 mm does not seat in same tooth without more apical removal of dentin structurally weakening the tooth.

![Figure 11](image2.png) — 1.5 mm parallel post with lateral serrations and core bulk again requires more apical dentin removal to seat to same length as the tapered Macro-Lock Illusion X-R0.

![Figure 12](image3.png) — A conservative non flared canal is ideal to accept a single, tapered fiber post.

![Figure 13A](image4.png) — The gutta percha is removed with a small starter drill and the post space is created with the appropriate size taper drill.

![Figure 13B](image5.png) — The Macro-Lock Post is tried-in and then cut to the desired length with a disc or diamond bur.

![Figure 13C](image6.png) — Ultra-Etch (Ultradent) is injected from the bottom of the post space up to the cavo surface margin by using a 20 or 22 guage needle (Endo-Eze Tips Ultradent/Clinical Research Dental) to avoid air entrapment. Rinse and remove excess water.
need for custom-cast posts.

This article offers a protocol and a decision tree addressing the many variations in root treatment forms that confront the clinician. The authors propose to categorize these into three treatment categories.

THE “SIMPLE” CANAL
In cases with slender (Fig. 12), conservative shape (less than 25% larger than the fiber post), a single fiber post can be inserted and covered with a composite core build-up, always observing a ‘bottom-up” approach.

The clinical monoblock treatment of the simple canal case is shown in Figures 13A-13G.

Today there are several approaches to the cementation of fiber posts. Traditional in-vitro bonding tests support the use of a 4th or 5th generation adhesive system (i.e. All-Bond 2, or One-Step, Bisco Dental, and SealBond Ultima, RTD/Clinical Research Dental, respectively) in conjunction with dual-cure or chemical-cure resin cement, as being superior to self-etching or self-adhesive cement formulas. The clinician must have knowledge of the compatibility between the adhesive and the resin cement as many incompatibilities exist. Meticulous isolation, good access, vision and technique are imperative, and are much easier in the laboratory than at chair-side.
Some clinicians and researchers have reported good results using self-adhesive or self-etching cements, and resin-reinforced glass ionomer cements, particularly when using macro-retentive Quartz fiber posts (Macro-Lock). However, some of the comparative in-vitro studies show these to be inferior to the “etch and rinse” technique.

There are large tapered and DOUBLE-tapered fiber posts available, and with these, nearly ideal adaptation is possible with minimum cement thickness, thus minimizing S-Factor stresses (minimizing the amount of cement around the post).

Canals that present a more divergent flare shape or a figure-eight shape are more challenging and will be addressed now.

**Unique Botox Training**

*by Dentists for Dentists & the Dental Team*

**Monthly Courses in Vancouver and the US**

“*I’ve been involved with about seven different speakers on this subject and Warren definitely has the best presentation and information!*” - Mike Malone, Past President AADC

**Day 1**

**Introduction to Botox**
- Facial anatomy • Botox Therapy • Facial Aesthetics
- Clinical Photography • Marketing, Integration & Sales

**Day 2**

**Botox Hands-on Session**
- Comprehensive Didactic
- Intensive anatomy/injection points
- Live Demonstration • Extensive Hands-on

**Now is the time to attend the most Comprehensive 2 Day Botox course in the world!**
- Complete Team Member Training (Incl. Marketing & Billing) • Follow-up Botox Study Club • All Materials Provided to Facilitate Simple Integration into the Dental Practice (Consent & TX Forms, Marketing Materials)

604.681.0066 • info@ptifa.com • www.PTIFA.com twitter.com/ptifa • ptifa.blogspot.com

**2012 course locations include:**
- Vancouver BC, Madison WI, Chicago IL, Salem NH, New Orleans LA, Columbia SC, Columbus OH

**FIGURE 13F**—The dual cure resin cement is injected from the bottom up using a 20 or 22 gauge needle in a Skini Syringe (Ultradent/Clinical Research Dental) or a lentulo spiral. (Note: the lentulo may accelerate the setting of the cement.) THE POST IS NOW SEATED AND LIGHT CURED.

**FIGURE 13G**—After injecting and shaping the core material, the composite resin is light cured, and trimmed with a diamond bur.

**THE ANATOMICAL POST & CORE**

The C-Factor and S-Factor (stress associated with polymerization shrinkage) are at their highest with post cementation, because of the high number of involved surfaces and no unbounded surfaces. Polymerization shrinkage stress is higher with resins containing higher percentage filler than those with low percentage filler. The objective is to compensate for these stresses by using materials that actually capi-
talize on them. Techniques have also been described for adapting (whittling) prefabricated fiber posts to fit ribbon-like, oval or ovoid canal spaces.51,52 The volume of cement is minimized, however, no information is offered regarding how this adaptation affects the mechanical properties of the fiber post.

In the mildly flared space (25%-50% greater than that of the largest fiber post Fig. 14), a composite “Core Build-down” followed by the Core Build-UP, is indicated.

In this clinical case (Figs 15A-15K), the composite is light cured IN THE FLARED SPACE through and around the light-conductive fiber post. The clinician must look for and mitigate undercuts, or it will NOT be possible to remove the post. Orientation, by marking the labial with a pencil, is recommended. The post is removed from the canal, creating a custom-fitted core build-down.

With this anatomical post, any composite shrinkage takes place in free space, not between the tooth and the restoration, neutralizing the S-Factor effect. The cement thickness will be minimal and uniform.48 If the air-inhibited layer on the build-down is not intact, the excess cement and remaining tooth structure can be refreshed before the bonding agent and core build-up composite are applied.

The composite can also be further augmented, sculpted and cured extra-orally, then re-cemented. This direct-indirect technique has shown encouraging results.53-55

THE ACCESSORY POST TECHNIQUE

Finally, in the case of a wide flare (Fig. 16), where the coronal circumference is more than 50% greater than that of the largest fiber post available, or ribbon shaped, ovoid, or triangular, a different clinical protocol is suggested by the authors.

The Accessory Post technique, where the “Master” fiber post is selected for its fit at the apical end of the space — and it is accessorized by one or more slender, tapered Accessory Posts (eg Fibercone™, RTD St. Egreve, France/Clinical Research Dental). It is reminiscent of the familiar placement rationale for gutta percha cones.

In the demonstrative clinical case study (Figs. 17A-17G), a cast post and core has failed, leaving a widely flared coronal aspect. As in the previous two techniques, the apical extension of the canal is prepared to fit a prefabricated fiber post, but the large amount of resin cement in the coronal section needs to be minimized; to decrease the shrinkage factor, and
any bulk of cement and core material will need reinforcement.

RTD translucent Quartz fiber posts (DT Light-Post, and Macro-Lock Post) have been shown to have limited but relatively superior transmission of the polymerization light energy down into the post-restorative space, which contributes to the efficiency of this and the Anatomical Post techniques. Opaque posts and poorly transmissive posts would be clinically inappropriate.

In addition, the flexural and compressive strength of the factory-made composite (99.9% cross-linked) are higher than any composite light-cured at chair-side. In fact, the cross-linked networks during polymerization and degree of conversion for most direct resin materials offer only 45% to 70%.59

Published research confirms the benefits of the Accessory Post technique:

- Minimized shrinkage in flared canals and, therefore, minimizing or eliminating gap formation.60
- Reduced need for drilling in order to adapt posts to root cavity (minimizes dentin removal).
- Reduced thickness of cement, and increased fracture resistance.60

Fiber posts, in combination with composite resin or with accessory fiber posts, are recommended by the authors as THE alternative to cast post and core in flared roots, because of the lower risk of catastrophic failures and better stress distribution.62 It is the tactic of choice for reinforcing structurally weakened roots, and the function and prognosis of the restored root is improved, compared to the use of one single, inadequately fitting post.63,64

SUMMARY
With the high price of dental gold, the lack of clinical expediency and the inherent disadvantages of base metals, there is no remaining reason to provide custom cast posts. In the vast majority of the published research, fiber posts are also superior to and offer many advantages over metallic and ceramic prefabricated posts. Because of the advances in adhesive dentistry, there are many cases that will NOT require a retentive post. However, in cases where less than 50% of coronal tooth structure remains, there are now esthetic, non-corrosive, fracture resistant radiopaque fiber posts that save time and money without compromise. Their most compelling advantage, regardless

www.oralhealthgroup.com

FIGURE 15—After refreshing and etching the margins, more bonding resin is placed on the dentin, air-dried and light-cured.
FIGURE 15J—The light cure or dual-cure build-up composite is placed, sculpted and then light cured.
FIGURE 15K—The core is finished with a coarse diamond bur to length and depth requirements for the ceramic crown.

FIGURE 15F—After a thorough rinsing of the prepared canal space and the custom fiber post and core, the core is reseated in the canal and the labial aspect marked with a pencil.
FIGURE 15G—The canal is etched, rinsed from the bottom up, and a bonding agent is agitated into the dentin, air-dried and light cured.
FIGURE 15H—The dual-cure resin cement is injected into the canal from the bottom up, and the anatomic post is re-seated into the canal with the pencil mark for orientation.
of the geometry or amount of residual tooth structure, is the protection from root fracture that low modulus restoration provides.

In selecting the materials (posts, resins) for these techniques, the dentist is advised not to cut corners, to seek the strongest and most radiopaque posts available in their market, and to fully understand the bonding protocols and materials that ensure success. 

The authors wish to thank Dentistry Today for allowing the authors to use some of the photographs and materials from a previously published article entitled Fiber Post Techniques for Anatomical Root Variations Dentistry Today May 2011.

Dr. Leendert (Len) Boksman, DDS, BSc, FADI, FICD, has a consultancy position as the Director of Clinical Affairs for Clinical Research Dental and Clinician’s Choice, is an Adjunct Clinical Professor at the Schulich School of Medicine and Dentistry, and has a private practice in London, Ontario, Canada. He can be reached at lboksman@clinicalresearchdental.ca

Dr. Alejandro Bertoldi Hepburn works as a Regular Professor at the Oral Rehabilitation Post Grade Career in the University del Desarrollo Dental School (Concepcion, Chile). He is post graduated at the Educational Career of the University of Buenos Aires (UBA) and has his private practice in Buenos Aires, Argentina. His book “Rehabilitacion posendodontica. Base racional y consideraciones esteticas” is in a final printing phase. He is consultant to several manufacturers and can be reached at hepburn@speedy.com.ar.

Research Dental and Clinician’s Choice, is an Adjunct Clinical Professor at the Schulich School of Medicine and Dentistry, and has a private practice in London, Ontario, Canada. He can be reached at lboksman@clinicalresearchdental.ca
Dr. Enrique Kogan works as a Professor of Restorative Dentistry Universidad Tecnológica de Mexico, visiting professor Nova Southeastern University College of Dental Medicine, Fort Lauderdale, Florida and has a private practice in Mexico City. He is a consultant to several manufacturers, and is the designer and patent owner of the PeerlessPost (Sybron-Endo), and can be reached at ekoganf@gmail.com.

Dr Manfred Friedman maintains a private practice limited to Endodontics in London, Ontario and is Assistant Adjunct Professor in the Div. Restorative Dentistry University of Western Ontario London Canada. He has no financial interest in any of the products mentioned in this article. He can be reached via e-mail at ndofriedman@rogers.com.

Dr Waldemar DiRijk is professor of Restorative Dentistry and Chief of the Biomaterials Unit at the School of Dental Medicine East Carolina University, and can be reached at derijkw@ecu.edu. He has no financial interest in any of the products mentioned in this article.

A complete list of references is available upon request (Refs 44-54).

REFERENCES
Implanting smiles since the 1980s. 
Sometimes aging yourself is a good thing.

When it comes to creating a perfect smile, you need the experience to know what works and the talent to make it happen. Luckily we have one of the first implantology specialists in Canada leading our team.

We also work with all the major implant companies, collaborate with you to determine treatment options, and are even there for the insertion. It’s going the extra mile that helps us exceed the expectations of both doctors and patients alike.

For over 25 years our full-service lab has utilized the newest, most innovative technology to earn a reputation for advanced implant experience, high-end aesthetics, talented technicians and quality results.

So the next time you have an implantology case, let us give you the confidence of knowing your patient’s smile is in more than good hands. It’s in the best.

Follow us on Twitter: @dentalartstudio
Find us on Facebook: facebook.com/GordanaDentalArtStudio

www.gordanadentalarts.com
416.785.6690  1.800.460.0211

www.oralhealthgroup.com  November 2011