DENTO CLIC
GLASS FIBER

Glass-fiber posts for the reconstruction of endodontically treated teeth

# WHITE PAPER


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# Endodontic treatment

Endodontically treated teeth commonly present great coronal loss due to caries, fractures or access methods of the endodontic treatment (Marchionatti et *al.*, 2016) [1]

The aim of endodontic posts is to reinforce the treated tooth, through the repartition of the mechanical forces that are distributed inside the oral cavity.

However, the first primary aim of the post is to act like an anchoring to retain a core that in turn will support the final restoration.

The favourable outcome depends on the quality of the treatment and the clinical environment of the patient, but also on the quality of the post used.

Ideal characteristics for the post material include mechanical properties like modulus of elasticity, compressive strength, flexural strength, translucency and radiopacity.

It should be esthetically invisible and bond efficiently to the dentin via the cements. Those properties should be the closest possible to dentin in order not to form a heterogeneous system inside the restored tooth.

The physical properties of Dentoclic Glassfiber posts, similar to dentin, provide excellent mechanical results preventing fracture and failure by minimizing the propagation and intensity of stresses over the root.

# Endodontic Posts

## Metallic

Metallic posts, derived from diverse alloys present high mechanical resistance properties. They possess high density and hardness values, making them very resistant and long-lasting.

Metallic posts are very rigid and possess a high elasticity modulus, blocking the diffusion of the forces into the whole material and concentrating them on the radicular part.
Those properties enhance the risk of fracture at the root site of the restoration.
Moreover, electro-chemical corrosion can occur, inducing the corrosion of the post that may weaken the root even more. This “battery” effect usually occur between two alloys via an electrolyte (saliva) and induces a galvanic reaction, corroding the most electronegative material. [2]

Finally, the metallic opaque posts can lead to un-aesthetic results. Vichi *et al.* (2000) have shown that if the ceramic thickness is less than 1,5mm, the underlying restoration material is visible and the advantage of an all-ceramic crown is lost. [3]

## Fiberglass posts

For the last two decades, fiberglass posts have represented a good alternative to the disadvantages of metallic posts.

Fiberglass posts are mainly composed of parallel E-glass fibers distributed into a resin-composite matrix.

Their elasticity modulus is much closer to that of dentin, allowing a good distribution of mechanical strains through all of the material.

They are also more aesthetically suitable due to their white and translucent shades.

# Mechanical behaviours of posts

## Elasticity

Elasticity is the ability of a body to resist to a distorting influence and to return to its original size and shape when that influence or force is removed. This property is represented by the elastic modulus (Young Modulus).

A material with a high elastic modulus will be stiff and will require high load values in order to be elastically deformed.

On the contrary, a material with a low elastic modulus will be flexible and will react to lower load forces.

Now, all dental material present different modulus of elasticity, depending on their composition.

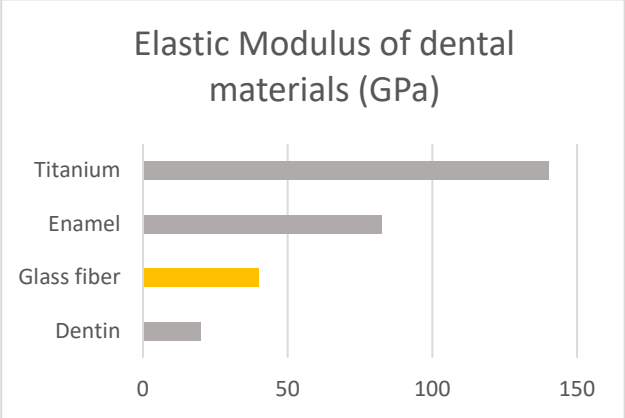



Fig1: Modulus of elasticity of different dental materials

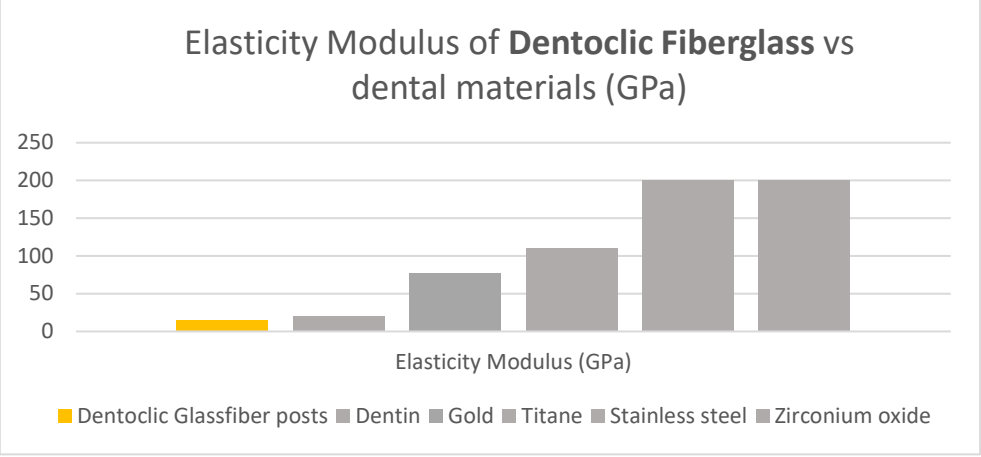



Fig2: Modulus of elasticity of DENTOCLIC and different dental materials

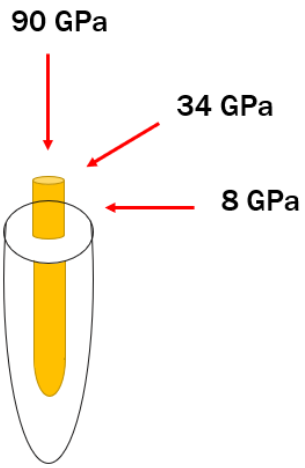



Fig3: Representation of the anisotropic behaviour of glassfiber posts

Moreover, fiberglass posts present an anisotropic behaviour, meaning that the mechanical properties of the post are directionally dependent.

In this sense, the elastic modulus of fiberglass posts depends on the direction of the applied stress. It varies from 90 GPa to 8 GPa depending on the angle of strain. [2]

On the other hand, metallic posts present an isotropic behaviour, meaning that they possess the same mechanical properties whatever the direction of the applied stress.
In this sense, the elastic modulus of metallic posts does not change with the angle of the strains.

## Stresses

Kumar and Rao (2015) have shown that the mechanical stresses values occurring on the restored tooth are dependent on the material used.

Metallic posts will induce higher values of mechanical stresses compared to restoration coupled with fiberglass posts. [4]

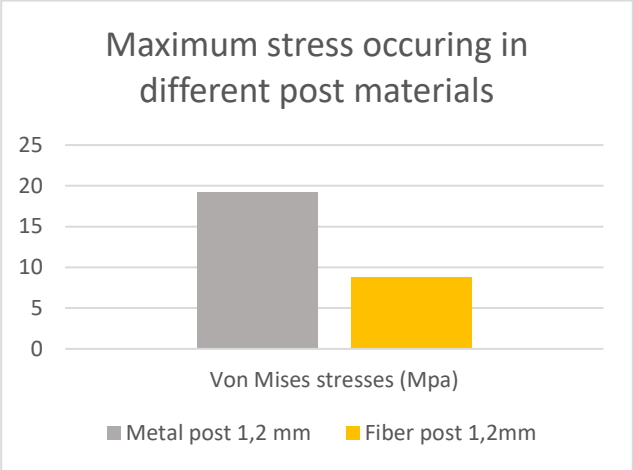



Fig4: Maximum stress values depending on dental post material

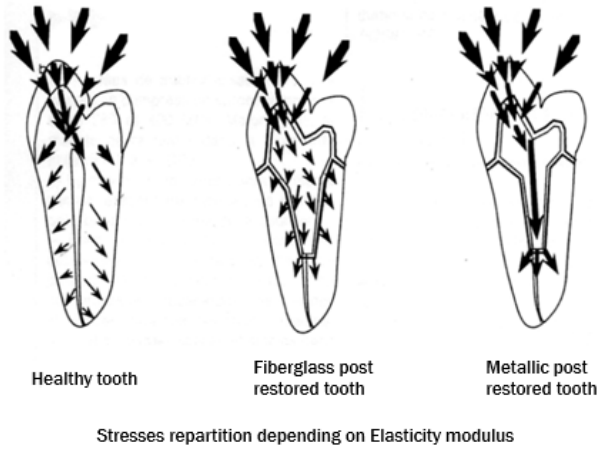



Fig5: Stress diffusion patterns in physiological conditions and different dental restorations

Plus, the forces diffusion pattern of stresses will also diverge depending on the material used in the restoration. [5]

When in a normal environment, stresses are equally diffused through the tooth.

When using a very rigid metallic post, the stresses will concentrate at the apical end of the material, towards the root of the tooth. When using a fiberglass post, the forces will diffuse through the material, mimicking the natural reaction.

## Failure modes

The different materials used for the restoration create mechanical heterogeneity: dentin, post, cement and core material all have different mechanical properties.

This causes different behaviours at the occlusal site and those multiple interfaces create fragility zones, sources of crown decementation and fractures.

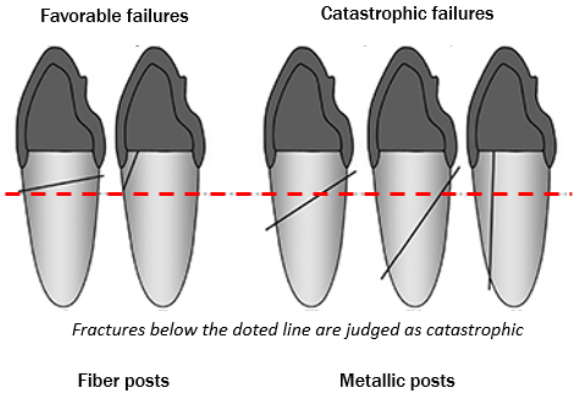



Fig6: Fracture modes of endodontically treated teeth depending on dental post material

Oblique root fractures are apparent in restoration with metallic posts, with fracture lines more apical on the labial than palatal surface. Those fractures represent catastrophic failures and cannot be retreated. The tooth has to be extracted.

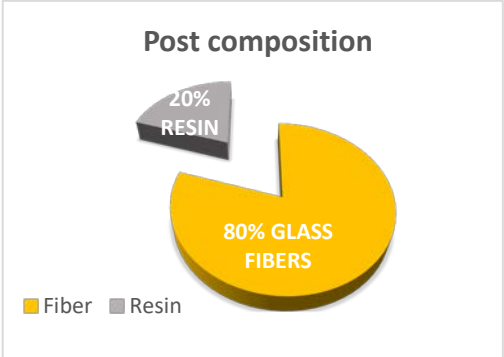
Fiberglass posts restorations show different fracture modes, where posts bend at the apical end, and fractures take place at the core/root interface. Those fractures represent favourable failures and are retreatable without having to extract the remaining tooth.

Plus, Akkayan and Gulmez (2002) have shown that in 100% of cases, a fracture restored with a metallic post is catastrophic against 20% for restoration with fiberglass posts. [5]

Finally, the most frequent mode of failure of restoration with fiberglass posts is mostly caused by debonding and not fracture, which is favourable to retreatment. (Kulkarni *et al.*, 2016) [6]

# DENTOCLIC Fiberglass – Technical specifications

Dentoclic Fiberglass is a metal free system of fiberglass endodontic posts.
The posts are tapered post with double taper, for an optimized fit inside the canal.
They are used as support of crown restoration on endodontically treated teeth.




## Material Composition

Dentoclic Fiberglass posts are made of 80% unidirectional parallel oriented glass fibers embedded in 20% of pigmented composite epoxy-resin. [7]

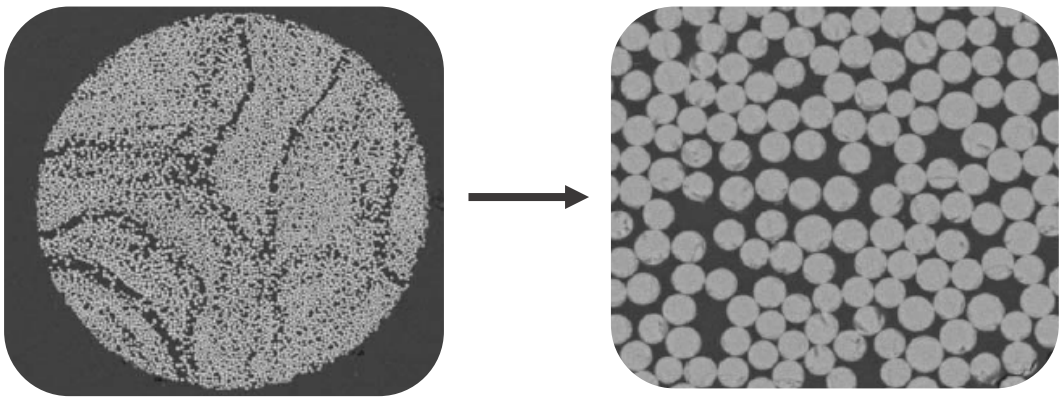


Fig7: Microscopic observation of a Dentoclic Fiberglass cross section (SEM x50 /x500)

This high concentration of E-glass fibers gives the product outstanding mechanical performances while maintaining the advantages of flexibility of fiber posts systems.

Regarding the matrix, the resin provides excellent resistance to compression, which ensures the posts excellent resistance to fracture under normal physiological conditions. [7]

Longitudinal

Cross section

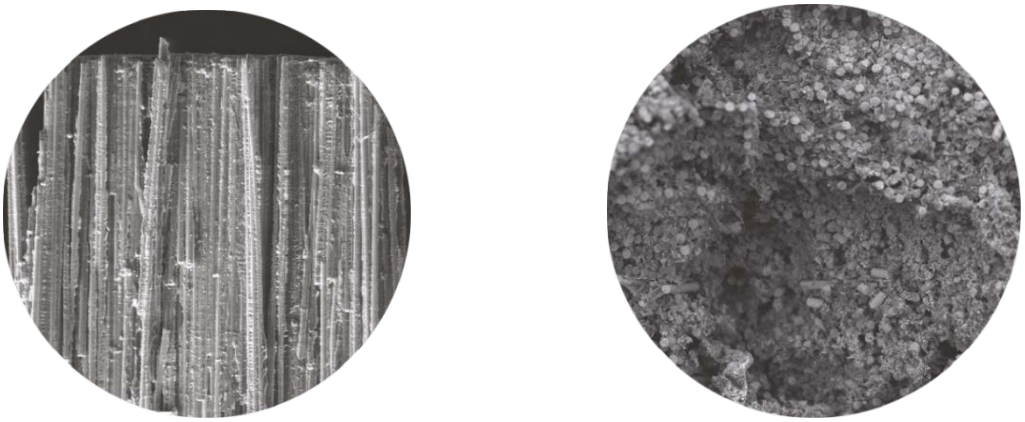


Fig8: Microscopic observation of the structural disposition of the Dentoclic glass fibers inside the posts (SEM x100)

Dentoclic Glassfiber posts contain E-glass fibers, providing flexural strength and elasticity to the post.
Those fibers consists of SiO2, CaO, B2O, Al2O and a few other oxides of alkali metals in the amorphous phase.

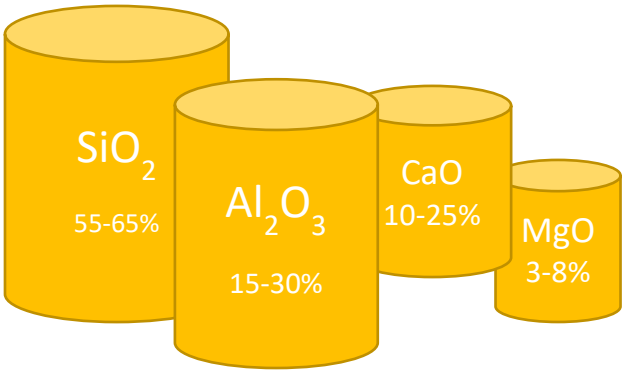



Fig9: Composition of E-Glass fibers

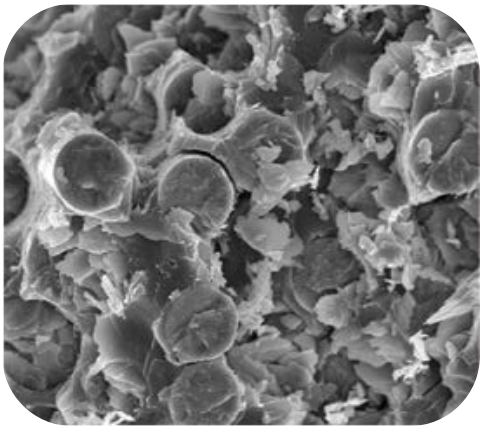


Fig10: Microscopic observation of the E-glass fibers (SEM x1200)

Araujo *et al*. (2015) have shown that endodontically treated teeth restored with Dentoclic Fiberglass posts presented higher resistance to fracture compared with other endodontic treatments. [8]

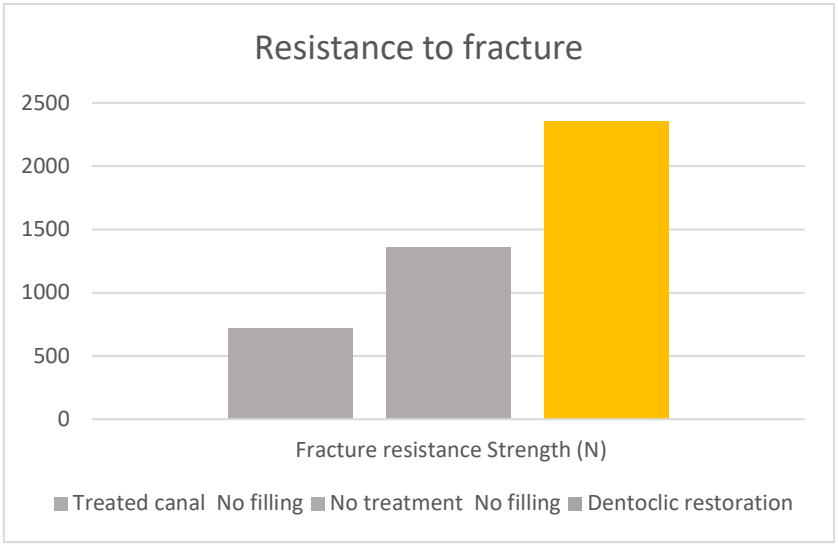
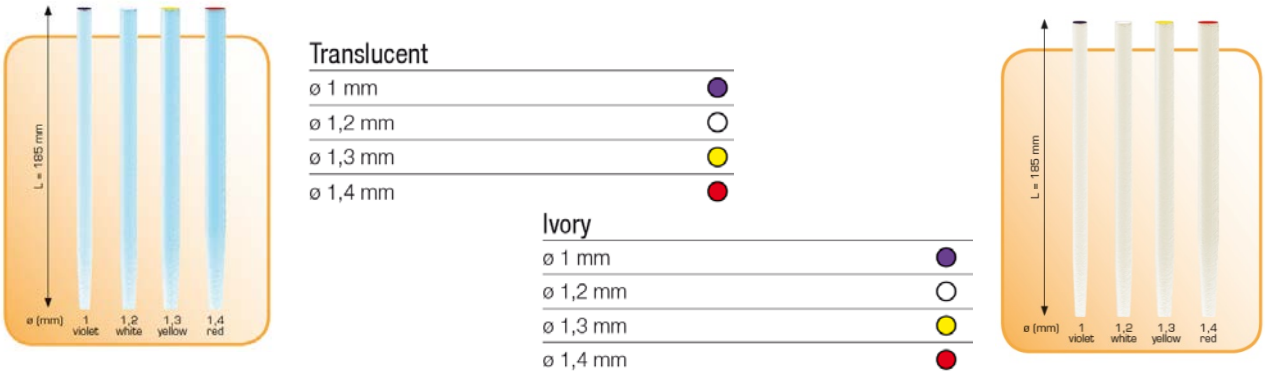



Fig11: Fracture resistance values of teeth restored with Dentoclic Fiberglass post compared with other treatments

## Posts range




The Dentoclic Fiberglass posts system is composed of translucent and ivory posts of several diameters.

## Easy post removal

Due to their composition and structural conformation, Dentoclic Fiberglass posts do not present high resistance to removal post treatments.

The longitudinal arranged fibers help to steer the drill into the canal, facilitating the post removal when retreatment is needed.

# Product performances vs competitors

## Elasticity vs other fiberglass posts

Dentoclic Fiberglass posts present great elasticity properties, facilitating the diffusion of the forces along the post during mastication and other strains induced on the teeth. This allows a safe and stable restoration. [9]

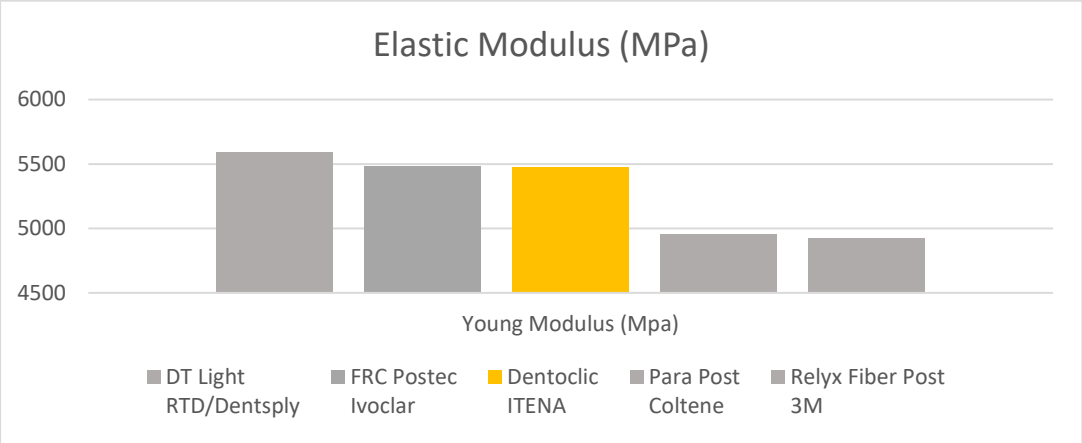



Fig12: Elastic Modulus of Dentoclic Fiberglass posts compared with other products

## Translucency

Translucency is the property of a substance that partially allows light to pass through it. In dental posts, translucency is important for aesthetics of the final restoration, but also because it permits light to diffuse throughout the material.

This allows polymerization on all of the post surface, including root areas that are deep and often unreachable for the light curing systems.

Dentoclic Fiberglass posts possess the highest values of translucency, ensuring a perfect bond with all dental cements. [7]

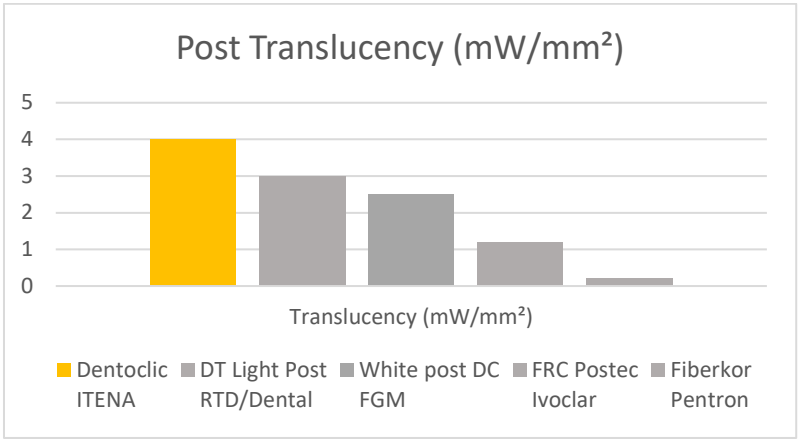



Fig14: Translucency of Dentoclic Fiberglass posts compared with other products

Fig13: Observation of light diffusion through Dentoclic Fiberglass post

## Radiopacity

Radiopacity of an aesthetic fiberglass post is important to the extent that it allows the post to be clearly identified on an x-ray when surrounded by tooth, bone tissue and core material.

Dentoclic Fiberglass posts possess high values of radiopacity, making them easily visible on radiographs. [10]

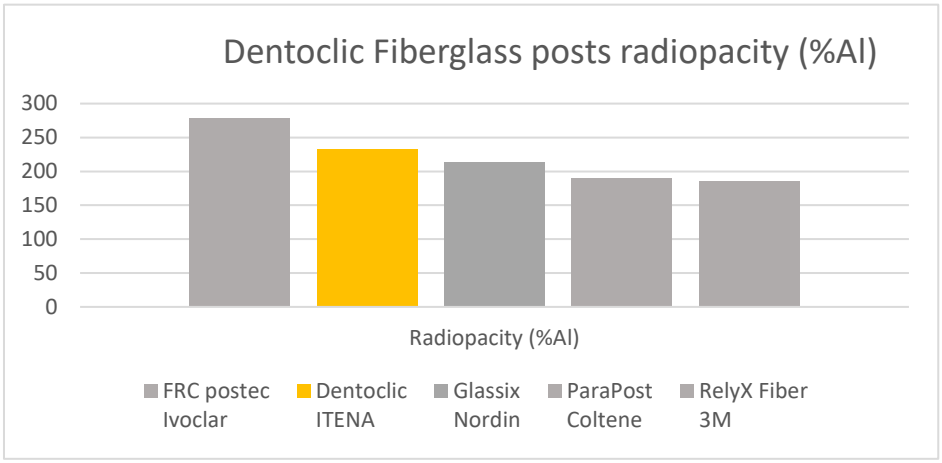



Fig16: Radiopacity of Dentoclic Fiberglass posts compared with other products

Fig15: Visualisation of Dentoclic Fiberglass post on X-rays

## Glassfibers composition and quality

Novais *et al.* (2016) have shown the correlation between the structural composition of glassfiber posts and the associated mechanical performances. It was concluded that the flexural strength is directly correlated with the fiber/matrix ratio.

Dentoclic Fiberglass posts possess the highest Fiber / Matrix ratio on the market, with 80%/20% respectively. [9]

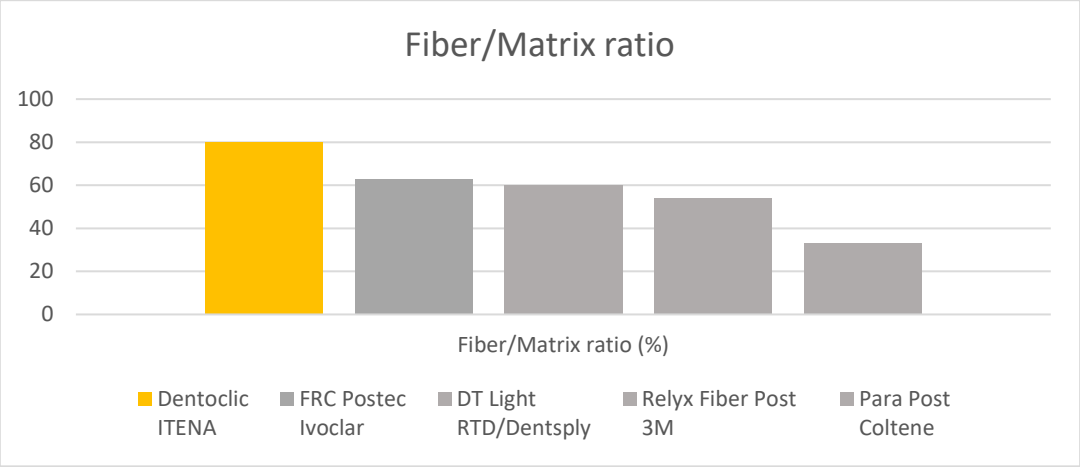



Fig17: Fiber /Matrix distribution of Dentoclic Fiberglass posts compared with other products

It was also shown that the number of glass fibers per mm² inside each dental post is directly correlated to the mechanical performances of the material.

Dentoclic Fiberglass posts possess the highest number of glass fibers inside their posts with approximately 8000 glass fibers per mm². [9]

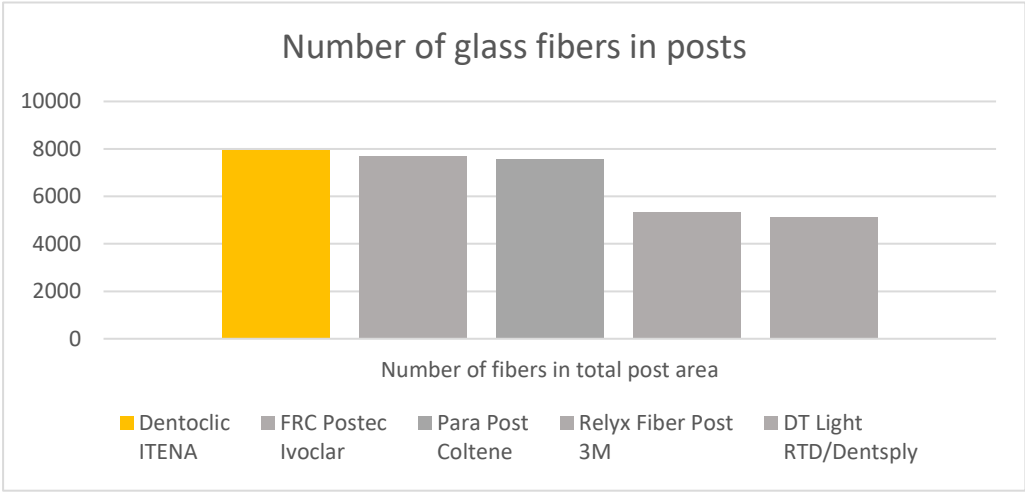



Fig18: Number of glass fibers in Dentoclic Fiberglass posts compared with other products

Structural defects such as bubbles and discontinuities along the interface between the matrix and the fibers influence the flexural strength of fiberglass posts.

Dentoclic Fiberglass posts do not present irregularities such as bubbles or cracks inside their posts. [9]

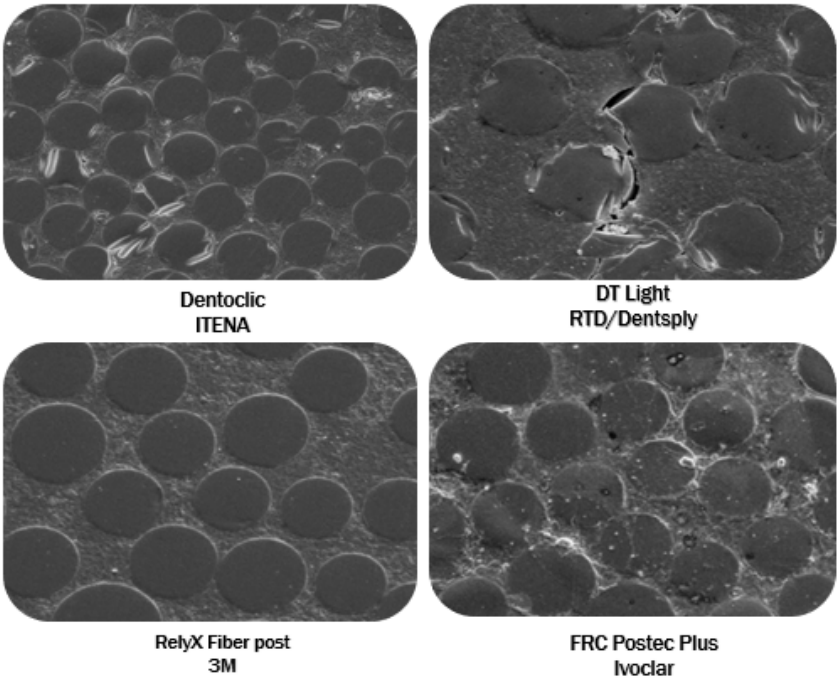



Fig19: Microscopic observation Dentoclic Fiberglass posts homogeneity compared with other products (SEMx1000)

## Mechanical resistance

The flexural strength represents the maximum resistance of a material before fracture occurs. This property is clinically important, especially during mastication process, when different stress-inducing forces occur.

The Flexural Strength value of Dentoclic Fiberglass posts is increased due to the numerous longitudinal glass fibers and their homogeneous arrangement. [9]

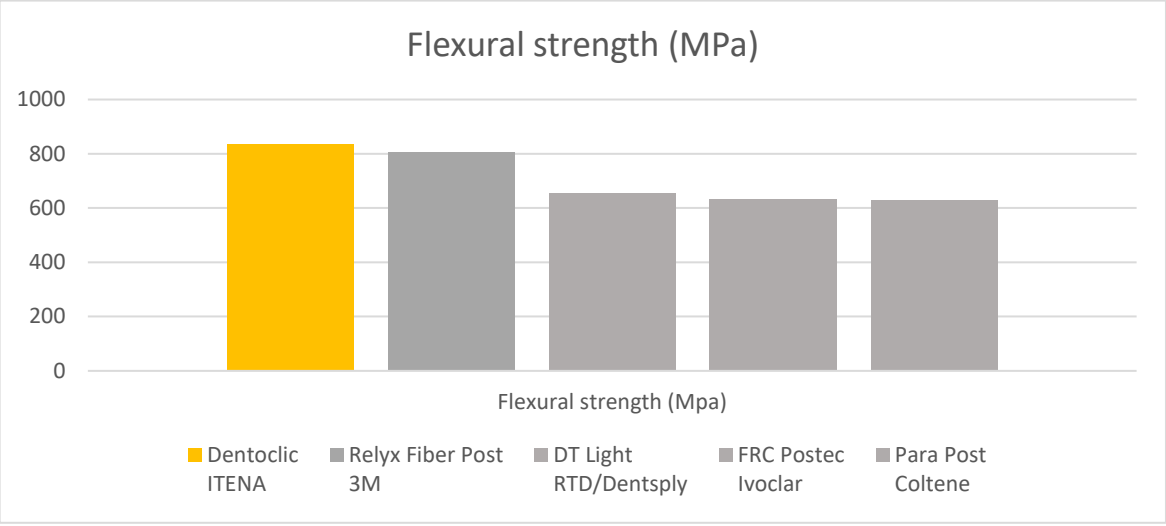



Fig20: Flexural Strength of Dentoclic Fiberglass posts compared with other products (3-point bending test)

## Scientific literature

[1]: Clinical performance and failure modes of pulpless teeth restored with posts: a systematic review - Marchionatti *et al.* Brazilian Oral Research - 2016.

[2]: Thesis – Les reconstitutions corono-radiculaire – University of Nantes - 2006

[3]: Influence of ceramic and cement thickness on the masking of various types of opaque posts - Vichi *et al.* – The journal of Prosthetic dentistry - 2000

[4]: Three-dimensional finite element analysis of stress distribution in a tooth restored with metal and fiber posts of varying diameters: An *in-vitro* study – Kumar and Rao – Journal of conservative Dentistry - 2015

[5]: Resistance to fracture of endodontically treated teeth restored with different post systems – Akkayan and Gülmez – The journal of prosthetic Dentistry - 2002

[6]: Evaluation of the Mode of Failure of Glass Fiber Posts: An In Vitro Study – Kulkarni *et al.* – International Journal of Scientific Study – 2016

[7]: Internal documentation

[8]: Fracture resistance of simulated immature teeth after different intra-radicular treatments – Araujo *et al.* – Brazilian Dental Journal - 2015

[9]: Correlation between the mechanical properties and structural characteristisc of different fiber posts systems – Novais *et al.* – Brazilian Dental Journal - 2016

[10]: Experimental and clinical report on overfibers endodontic fiber posts – Univertsity of Bologna - 2015