SCIENTIFIC INFORMATION

Rebilda Post - Loading behaviour

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The long-term success of a post-endodontic treatment with a post build-up is closely linked to the behaviour of the post under loading. To what extent different post materials react to loading was analysed in a finite element analysis at the University of Campinas (Brazil). [1]

Endodontic posts are manufactured from many different materials today. Examples are titanium, zirconium oxide, dimethacrylate- and epoxy-resin-based quartz- and carbon fibre-reinforced posts. The material itself has a considerable effect on the long-term success, according to several studies. A study by Ferrari et al. examined the failure rate of metal- and glass fibre-reinforced posts in the first 4 years. Metal posts had a failure rate of 16% and the failure rate was only 5% with glass fibre posts. [2] The different elasticity behaviour of the two materials is a reason for this difference.

Influence of the elasticity modulus on the distribution of forces

A comparison between endodontic posts made from zirconium oxide ceramic and glass fibre was conducted in this study. In a finite element analysis, 3-D models of both posts were created and then subjected to simulated chewing load. All parameters up to the E modulus were equally set for the calculation. A significant difference between the two materials could already be seen in their E modulus: An E modulus of 205 GPa was allocated for zirconium oxide ceramics, the E modulus for the glass fibre post was chosen depending on the axes (E_x = 37 GPa, E_y and E_z = 9.5 GPa), since these posts are not isotropic by the arrangement of the glass fibres.

Table 1: Overview of the elasticity modulus

Component	E modulus [GPa]
Dentine	15
Enamel	80
Periodontium	0.05
Bone marrow	13.8
Bone	0.345
Core build-up composite	12.5
Adhesive	4.5
Gutta-percha	0.1
Luting cement (low E modulus)	7
Luting cement (high E modulus)	18.6
Zirconium oxide ceramic	205

The parameters used for the calculation are summarised in Table 1.

In addition to the effect of the E modulus of the endodontic posts, the effect of the E modulus of the luting material as well as the layer thickness of the cement were analysed. In this aspect, the study came to the conclusion that these two parameters do not have a significant effect on the load distribution.

A completely different situation for the two posts was determined. The spatial distribution of the stress under chewing load is displayed in different colours in Figure 1.

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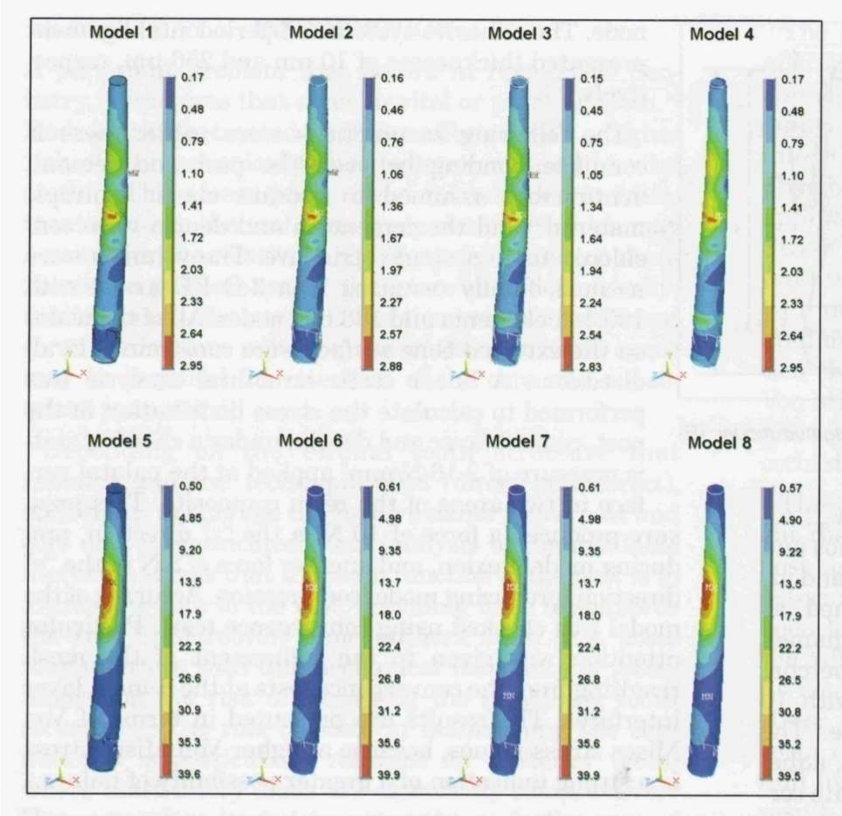

Figure 1: Qualitative analysis of the stress distribution [MPa] (Von Mises Stress)

The models of the glass fibre posts are represented in the top row. Models 1-4 merely differ in the E modulus and layer thickness of the luting cement. A homogeneous distribution of the load can be seen in all of the models.

The respective analogous situation with the use of zirconium oxide posts is shown in the bottom row. Loading peaks are clearly recognisable in the middle to apical area here (red colouring).

This powerful, local loading can lead to two very unpleasant situations. On the one hand, these forces can lead to root fractures, which always results in extracting the affected tooth; on the other hand, this stress can lead to a fracture of the endodontic post without a simultaneous fracture of the root. This scenario is also extremely unfavourable, since zirconium oxide posts, in contrast to glass fibre posts, cannot be revised. It is impossible to remove the fragment in the apical region - the result here can also be a extraction.

The work presented here clarifies the major effect of the E modulus on the long-term success of post-endodontic treatment. The Rebilda Post has a orthogonal E modulus of 24 GPa. In comparison to the E modulus of 37 GPa used in the calculation, it is thus closer to the elasticity behaviour of natural tooth substance.

An E modulus of 15 was set for dentine in this study; values between 18 and 24 GPa are found in the literature. The Rebilda Post thus imitates the loading behaviour of dentine and provides an ideal distribution of forces. In the study, this is summarised with the following words:

The use of a glass fibre post in combination with a luting material with a E modulus lower than dentine is preferable in these types of restorations. The reason is the lower concentration of stress in the post and in the cement, which reduces the risk of a fracture as well as the risk of failure of the adhesive bond.

Conclusion: Glass-fibre reinforced endodontic posts are preferable to posts made from zirconium oxide ceramic, since they clearly exhibit a more favourable loading behaviour. The Rebilda Post is consistent with the findings of this study: It provides ideal distribution of loads with an E modulus of 24 GPa and thus minimises the risk of root and/or post fractures.

[1] A. O. Spazzin, D. Galafassi, A. D. de Meira-Junior, R. Braz, C. A. Garbin, *Oper. Dent.* **2009**, *34*, 223-229.
[2] M. Ferrari, A. Vichi, F. García-Godoy, A*m. J. Dent.* **2000**, *13* (Spec No), 15B-18B.