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Evaluation of modern post and core systems by testing the mechanical fatigue resistance

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Introduction

Prosthetic treatment failures related to the mechanical deficiencies of post and core systems still represent a problem of clinical significance and justify the researches orientated through the increasing of their performances and clinical longevity. The fatigue resistance tests represent an essential research instrument because they simulate the repetitive cyclic pattern of the occlusal forces and replace the clinical tests that are time consuming and thus contribute to decrease of clinical evaluation costs and time.

Objectives

The aim of the present study was to evaluate the fatigue resistance of the teeth restored with different posts (carbon fiber post, zirconium post, titanium post) when subjected to a cyclic loading test.

Material and Methods

We used forty human maxillary incisors having similar dimensions and without cracks, decay or abrasion. After anatomic crowns were removed, the teeth were endodontically treated and reconstructed with carbon fiber, ceramic and titanium posts. In the control group, no posts were used. The crown build-up was made with composite resin and covered with metal crowns. After that, teeth were mounted in acrylic resin blocks with a simulated periodontal ligament (fig. 1). The samples were divided into three experimental groups and one control group:

- group C - teeth restored with prefabricated carbon fibre reinforced posts;
- group Z - teeth restored with prefabricated zirconium posts;
- group T - teeth restored with prefabricated titanium posts;
- group M (control) - endodontically treated teeth with no posts.

Each test specimen was intermittently loaded to a maximum level of 25 daN at an angle of 45 degrees to the long axis of the tooth, at a frequency of 1.3 Hz until failure (fig. 2 and 3).



Fig. 1: The prepared sample

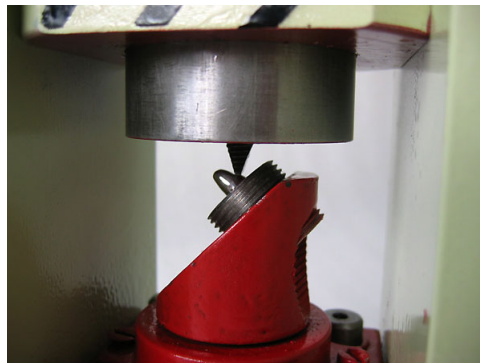


Fig. 2: The sample mounted in the testing device

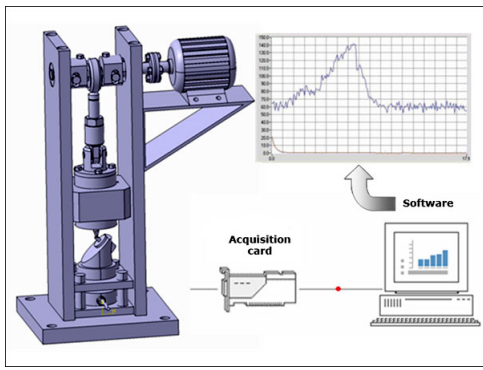


Fig. 3: The testing device and the data acquisition system

Results

The testing device was stopped after 400 000 cyclic loads if no failure had occurred. Root fractures, post fractures and post and crown decementation were considered causes of failure. The results obtained after 400.000 impacts are shown in the Table 1. Only one fracture was observed in the control group (teeth with no post) and three in carbon fiber group, while in zirconium and titanium groups were recorded six fractures in each group (fig. 4-7). The survival rates of the groups were statistically compared with a Kaplan-Meier analysis (fig. 8).



Fig. 4: The fracture recorded in the control group (M)



Fig. 5: The modes of failure recorded in group Z



Fig. 6: Fractures recorded in group C



Fig. 7: Fractures recorded in group T

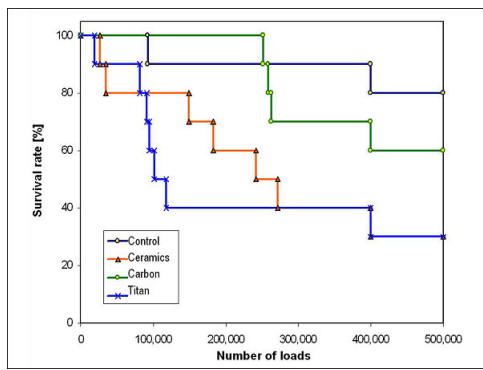


Fig. 8: Kaplan Meier curves of the experimental groups

The survival rates recorded in the experimental groups (C, Z and T) were lower than that of the control group. The differences between the experimental groups were significant, the teeth reconstructed with posts reinforced with carbon fibers had a higher survival rates than the teeth reconstructed with titanium and zirconium posts.

M (control)	Z (zirconia)	C (carbon)	T (titanium)
92.794	26.171	251.123	18.763
400.000	28.419	258.434	81.109
> 400.000	149.762	262.257	90.981
> 400.000	182.143	> 400.000	95.012
> 400.000	241.112	> 400.000	101.448
> 400.000	272.018	> 400.000	117.674
> 400.000	> 400.000	> 400.000	> 400.000
> 400.000	> 400.000	> 400.000	> 400.000
> 400.000	> 400.000	> 400.000	> 400.000
> 400.000	> 400.000	> 400.000	> 400.000

Tab. 1: The results after 400.000 cyclic loads

Conclusions

Teeth reconstructed with fibre reinforced posts exhibit a higher fatigue resistance than teeth reconstructed with rigid posts (titanium or zirconium posts).

Fiber posts reduce the risk of root fracture and are the best choice in reconstruction of endodontically treated teeth. Knowing the advantages and disadvantages of different type of post, the dentist will be able to avoid a post that predispose to irreparable tooth fractures.

Literature

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This Poster was submitted by Assoc. Prof. Dr. Anca Mihaela Vitalariu.

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EVALUATION OF MODERN POST AND CORE SYSTEMS BY TESTING THE MECHANICAL FATIGUE RESISTANCE

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The aim of the present study was to evaluate the fatigue resistance of the teeth restored with different posts (carbon fibre post, zirconium post, titanium post) when subjected to a cyclic loading test. The fatigue resistance tests represent an essential research instrument because they simulate the repetitive cyclic pattern of the occlusal forces and replace the clinical tests that are time consuming and thus contribute to decrease of clinical evaluation costs and time.

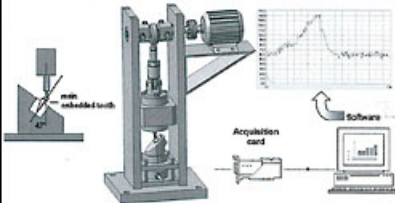
Material and method



We used forty human maxillary incisors having similar dimensions and without cracks, decay or abrasion. The teeth were endodontically treated and mounted in acrylic resin blocks with a simulated periodontal ligament. The samples were divided into three experimental groups and one control group:

- group C** – teeth restored with prefabricated carbon fibre reinforced posts;
- group Z** – teeth restored with prefabricated zirconium posts
- group T** – teeth restored with prefabricated titanium posts
- group M** (control) – endodontically treated teeth with no posts

Each test specimen was intermittently loaded to a maximum level of 25 daN at an angulation of 45 degrees to the long axis of the tooth, at a frequency of 1.3 Hz until failure.



The testing device and the data acquisition system

Experimental results

The testing device was stopped after 400 000 cyclic loads if no failure had occurred. Root fractures, post fractures and post and crown decementation were considered causes of failure.

The results obtained after 400.000 impacts are shown in the Table. Only one fracture was observed in the control group (teeth with no post) and three in carbon fibre group, while in zirconium and titanium groups were recorded six fractures in each group.

The survival rates recorded in the experimental groups (C, Z and T) were lower than that of the control group. The differences between the experimental groups were significant, the teeth reconstructed with posts reinforced with carbon fibres had a higher survival rates than the teeth reconstructed with titanium and zirconium posts.

The results after 400.000 cyclic loads

Microhard	Zirconium	Carbon	Titanium
93.784	26.117	231.125	18.765
> 400.000	28.415	258.424	81.100
> 400.000	149.783	262.237	99.581
> 400.000	192.143	> 400.000	93.015
> 400.000	241.112	> 400.000	101.448
> 400.000	277.311	> 400.000	117.674
> 400.000	> 400.000	> 400.000	> 400.000
> 400.000	> 400.000	> 400.000	> 400.000
> 400.000	> 400.000	> 400.000	> 400.000
> 400.000	> 400.000	> 400.000	> 400.000
> 400.000	> 400.000	> 400.000	> 400.000

Legend: ✖ fracture; ◉ intact; ⚠ crack

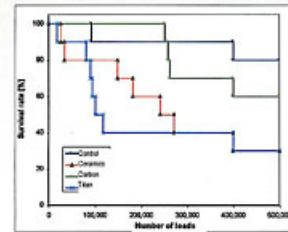


Conclusion

The survival rates of the groups were statistically compared with a Kaplan-Meier analysis.

Teeth reconstructed with fibre reinforced posts exhibit a higher fatigue resistance than teeth reconstructed with rigid posts (titanium or zirconium posts).

Fibre posts reduce the risk of root fracture and are the best choice in reconstruction of endodontically treated teeth. Knowing the advantages and disadvantages of different type of post, the dentist will be able to avoid a post that predispose to irreparable tooth fractures.



Kaplan Meier curves of the experimental groups