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COMPARATIVE EVALUATION OF ZIRCONIA MATERIAL USED FOR FIXED PARTIAL PROSTHESIS PLACED ON VITAL & NON-VITAL ABUTMENTS ON THE PERIODONTAL STATUS – A TWO YEAR RETROSPECTIVE FOLLOW-UP

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ABSTRACT

Objective:

A sound periodontium is critical for the long term success of fixed prostheses. These prostheses are often prepared on vital teeth and non-vital as abutments. Endodontically treated teeth (non vital abutments) have often been looked upon with doubt as suitable abutments. Metal free ceramics have become highly popular choice in fixed prosthodontics. The present study aimed to assess the long term clinical and radiographic effects and tissue responses when zirconia was used in FPD placed on vital and non-vital abutment teeth on the periodontal parameters.

Methodology:

Following ethical committee approval, the study group comprised of 30 abutment teeth; 14 vital and 16 non vital, in 14systemically healthy patients (5 males and 6 females) aged between 18 – 45 years who had received 3 unit fixed prosthesis fabricated using Zirconia and having equigingival margins. The following parameters were assessed at the time of bridge placement and 2 year follow up – CAL, Probing depth, Distance between CEJ/ cervical crown margin and alveolar crest of the abutment teeth (radiograph).

Results: Statistical analysis carried out by SPSSV22 software revealed no significant changes in clinical parameters and radiographic bone levels ($P<0.05$) from the time of bridge placement till the 2 year follow up in the zirconia prostheses placed on vital abutments. However, significant changes were observed in prostheses placed on non-vital abutments ($p<0.05$). Additonally, significant differences were observed between vital and non vital abutments at various time intervals only with regard to CAL. ($p<0.05$).

Conclusion:

There seemed to be favorable responses of the periodontal tissues to zirconia used on the abutments of FPDs with not much difference between vital and non-vital abutments in the long term follow-up.

Keywords: vital abutments, non-vital abutments, periodontal status, bone loss, zirconia, FPD

INTRODUCTION

Ceramics used in medical fields have evolved rapidly over the last 20 years. Dental glass ceramics in particular, have been developed because they have advantageous physicochemical and cosmetic properties **[1]**. Ceramics therefore may replace metallic materials in the oral cavity, maintaining the same high quality level in dental rehabilitation **[2]**. Introduced to dental markets over a decade ago, all-ceramic systems covered a wide range of indications, from thin veneers used in single-tooth restorations to crowns and wide-span bridges (FPD) **[3]**.

Fixed prosthesis (FPD) is one of the most popular treatment options available today where the dental implant is relatively or totally contraindicated **[4]**. Selection of a suitable abutment for fixed prosthesis is critical as FPDs transmit forces through the abutments to the periodontium. Successful selection of abutments for fixed partial

dentures requires sensitive diagnostic ability and a thorough knowledge and understanding of anatomy, ceramics, the chemistry and physics of dental materials, metallurgy, Periodontics, phonetics, physiology, radiology and the mechanics of oral function **[5]** which is crucial in the development of treatment plan with predictable prognosis. It is paramount to focus on the qualities of FPDs and crowns in order to reduce the periodontal inflammation and ensure long term prognosis of the prosthesis as periodontal health governs FPD survival to a large extent. The abutments used for FPDs may be vital or non-vital and the choice of abutment and long term stability largely depends on sound periodontium **[6]**. Post-cementation hypersensitivity in abutments is a common complaint among patients receiving fixed prosthesis with vital abutments. Post- cementation sensitivity rates varied widely in clinical studies ranging from a low of 3% to a high of 34 % **[7]**. As abutments, many clinicians are of the opinion that endodontically treated teeth do not serve as well as vital teeth **[8]**. However some researchers believe that with appropriate preparation designs, endodontically treated teeth can serve well as abutments for crowns. Wegner *et al* **[9]** concluded that the endodontically treated teeth restored with endodontic posts and crowns had a good survival rate (92.7%) when observed for a 5 year period. In some fixed partial denture designs, such as long span cases, the use of endodontically treated teeth may be contraindicated.

On the other hand, evidence has also revealed that the survival of the vital pulp in teeth restored with a single-unit metal ceramic crown (CMC) was significantly higher than those serving as an abutment of a fixed-fixed bridge. However, it has also been observed that maxillary anterior teeth used as bridge abutments had a higher rate of pulpal necrosis than any other tooth types **[10]**.

In this regard, the type of material used may also play an important role in determining the long term periodontal health. Studies have forced clinicians and researchers to focus on the qualities of materials used for FPDs and crowns in order to reduce the periodontal inflammation and ensure longevity of the prosthesis **[11-14]**. Metal ceramic systems combine both the exceptional esthetic properties of ceramics and the extraordinary mechanical properties of metals. Some metals used as restorative materials in dentistry may constitute a problem for some patients. The drawbacks, as well as the search for more esthetic materials by patients and dentists, have stimulated research and

development of metal-free ceramic systems **[15]**. The all-ceramic system helps maintain esthetics, as demonstrated by the widespread current use of this system **[16]**. Ceramic abutments, fabricated from yttrium stabilized-zirconium oxide (ZrO2), have been developed for their color, which is similar to that of teeth, high loading strength, tissue tolerability, and intrasulcular design enhancement **[17]**. Transformation toughening of ZrO_2 results in extremely high component stability and extraordinary bending and tensile strength, as well as fracture and chemical resistance **[18, 19]**. These properties allow ZrO2 to self-repair micro-crack initiation by stopping crack propagation.

Most research and meta-analyses of published literature have focused on the prostheses' mechanical complications, for example chipping, and have placed periodontal complications in the background **[20-23]**. Only a few works have investigated gingival and periodontal health around crowns and FDPs exclusively **[12, 24-27]**.

Thus, the aim of the present cross sectional study was to assess the effect of Zirconia used in FPD on the periodontal status of vital and non-vital abutment teeth over a 2year period.

MATERIALS AND METHODS

Following approval from the institutional Ethical Committee at ISNC, Jeddah, nearly 200 patients treated with 3 unit FPDs in the period between January 2017 and December 2018 were screened. Of these, 30 abutment teeth (14 non vital and 16 vital) in 14 patients were selected for the study based on the following inclusion criteria:

(1) Adults who were systemically healthy, non-smokers, and who had 3 unit FPDs using IPS empress for atleast two years and

(2) Abutment teeth that had equigingival margins with plaque and gingivalindices less than 10%.

Informed consents were obtained from the enrolled subjects after explaining the nature of the study and possible risks involved.

Clinical and radiographic measurements were made on the abutment teeth at baseline, following placement of bridge and at 1 and 2 year follow up visits with a UNC 15 periodontal probe as follows:

1. Probing depth (facial and lingual)
2. Clinical attachment level (CAL) (facial and lingual)

   A total of 6 measurements, 3 each on the facial and lingual surfaces and an average of these was used as a final value.

The following measurements were made on the radiographs on the abutment teeth using grids.

1. Distance from CEJ to alveolar crest. (baseline)
2. Distance from cervical margin of crown to alveolar crest. (FPD placement and follow up)

Care was taken to ensure that the radiographic techniques and the radiographs were standardized to maintain homogeneity in measurements.

The linear distances in two dimensions were measured using the following mathematical formula:

$$\frac{\text{Actual distance between two points (grid)}}{\text{Measured distance between two points (grid)}} = \frac{\text{Actual distance between two points (anatomic)}}{\text{Measured distance between two points (anatomic)}}$$

The distance measured was between 2 points – cementoenamel junction/ crown margin to alveolar crest.

The patients were given appropriate oral hygiene instructions to ensure maintenance of low plaque scores throughout the duration of the study.

RESULTS

Statistical analysis was carried out using SPSSV22 software. Since the data was normal, paired 't' tests were used to assess the differences in the means of the clinical parameters of each material at the different time intervals.

Zirconia on Vital Abutment: (Table 1 A & B)

The vital abutment teeth receiving Zirconia crowns revealed no significant changes in clinical and radiographic parameters from time of placement to post 2 year follow up period ($P>0.05$).

Zirconia on Non-Vital Abutment: (Table 2 A & B)

On the contrary, the non-vital abutment teeth receiving zirconia crowns revealed a statistically significant reduction in probing depth, CAL and radiographic bone levels from time of placement to post 2 year follow up period ($P<0.005$).

Zirconia–Vital v/s Non-Vital: (Table 3)

Comparison of the clinical parameters between the vital and non-vital abutments revealed significant differences in CAL at the end of 6 months,1 and 2 years ($p<0.05$) with non- vital abutments showing greater reduction than vital abutments. However, no significant differences were found in probing depths and radiographic bone levels. ($p>0.05$).

VITAL ABUTMENTS

Table 1 A: Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PD P3	1.4786	14	.48386	.12932
	PD P4	1.3500	14	.35464	.09478
Pair 2	CAL P3	.8571	14	.38772	.10362
	CAL P4	.6929	14	.64625	.17272
Pair 3	RBL P3	1.5214	14	.64829	.17326
	RBL P4	1.7000	14	.56569	.15119

PD –probing depth; CAL – clinical attachment level; RBL – radiographic bone level; P-3 at the time of bridge cementation; P-4 at the end of 2years

Table 1B

		Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
PD	baseline- 2 years	.12857	.40274	.10764	1.194	13	.254
CAL	baseline – 2 years	.16429	.49708	.13285	1.237	13	.238
RBL	baseline – 2 years	-.17857	.31666	.08463	-2.110	13	.055

NON VITAL ABUTMENTS

Table 2 A: Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PD P3	1.5625	16	.65511	.16378
	PD P4	1.3750	16	.42817	.10704
Pair 2	CAL P3	1.6875	16	.68007	.17002
	CAL P4	1.2500	16	.75277	.18819
Pair 3	RBL P3	1.1875	16	.35940	.08985
	RBL P4	1.4688	16	.61830	.15457

P-3 at the time of bridge cementation; P-4 at the end of 2years

Table 2B

		Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
PD	baseline- 2 years	.18750	.35940	.08985	2.087	15	.054
CAL	baseline – 2 years	.43750	.47871	.11968	3.656	15	.002
RBL	baseline – 2 years	-.28125	.31458	.07864	-3.576	15	.003

Table 3: Parametric test – Independent t-test vital v/s non vital. Abutment

	t	df	Sig. (2-tailed)	Mean Difference
PDbaseline	1.398	28	.173	.3807
PDphase 6 months	1.691	28	.102	.2954
PDphase 1 year	-.404	28	.689	-.0861
PDphase 2 years	-.129	28	.899	-.0186
CALbaseline	1.390	28	.176	.3807
CAL 6 months	-3.107	28	.004*	-.4725
CAL 1 year	-4.042	28	.000*	-.8304
CAL 2 years	-2.170	28	.039*	-.5593
RBLbaseline	1.733	28	.094	.2800
RBL 1 year	1.783	28	.085	.3361
RBL 2 years	1.072	28	.293	.2334

DISCUSSION

There is a growing popularity of the newer esthetically and biologically compatible materials used in fixed partial dentures today. Although PFM (porcelain fused to metal) has been a popular choice for a long time, newer esthetic materials such as IPS empress (E-max) and zirconia are gradually replacing it. IPS empress is especially used in the anterior esthetic zone and is a popular choice. A literature review on the longevity and clinical performance of IPS –Empress restorations suggested that these crowns were not recommended for the posterior region **[28]**. In fact, Holland *et al* **[29]** reported that IPS Empress 2 may be used to fabricate 3 unit bridges upto second premolar. Whether this has any bearing on the periodontal status is unclear. Studies of IPS e.Max CAD have been limited inscope, partially due to the limited time the material has been available on the market. Several studies have shown promising short-term and medium-term survivability forsingle unit crowns and initial results for implementation for inlays and onlays is also promising. To date there is insufficient long-term survival data available. Over the last few decades the field of dental ceramics has evolved rapidly, both in material properties and manufacturing techniques. Among these advancements is the introduction of glass-ceramics, which are both highly esthetic and possess exceptional mechanical properties.

In order to be a viable and superior treatment choice, ceramic restorations must be cosmetically and functionally appropriate. Biocompatibility and chemical durability are highly important properties in dental materials. Zirconia ceramics have been reported not to have potential toxic or genotoxic effects [**30-32]** and to present satisfactory soft tissue responses **[33]**. Ceramic materials have the lowest plaque-retaining capacity, and a normal crown contour guarantees satisfactory periodontal health and esthetics **[34]**. ZrO2 is considered to be a highly biocompatible material, and has already been used in medical applications such as artificial hip joints. Moreover, this biomaterial was recently reported to be one of the most robust and durable all-ceramic systems tested to date **[18]**.

Vital teeth as abutments pose a few disadvantages like development of periapical pathology [**35]**. In addition, sensitivity to hot or cold stimulation may be an occasional, but unwanted consequence of a newly cemented crown or fixed partial denture. Because of sectioning of dentinal tubules, a certain degree of pulpal trauma is inevitable during

tooth preparation. Completely avoiding sensitivity is impossible **[7]**.

On the other hand, the integrity of the tooth might be important for endodontically-treated teeth, since a treated tooth might become dry and weak when compared to vital teeth **[36]**. Backer *et al* (2007) concluded that endodontically treated abutments resulted in more FDP failures than vital abutments **[37]**.

It was the intention of the current study to determine the periodontal integrity of the treated teeth as evidence has indicated that in subjects with fixed partial dentures, the abutment teeth are more prone to periodontal inflammation than the non-abutment teeth **[7]**. Additionally, the individual's age, duration of insertion of fixed partial dentures and location of the crown margins affect the periodontal health of the abutments. Studies have also suggested that the type of restorative material used in the prosthesis may affect the periodontal status of teeth [**38, 39]**.

This study was designed to assess the periodontal status of a group of Saudi adult patients following the insertion of FPDs with Zirconia material on both vital and non-vital abutments. Such an evaluation of the oral health status of the patients is essential to establish effective maintenance programs. It was decided to include only bridges in which the crown margins were equigingival. Only 3 unit bridges were included in order to standardize the occlusal load on the abutments and keep it uniform. Bridges with multiple units would have further led to variations in clinical and radiographic parameters owing to variations in the load bearing capacity of the abutments. This made it easier to standardize the study population and perform appropriate measurements both clinically and radiographically as the landmarks could be easily determined for linear measurements.

Biocompatibility and chemical durability are highly important properties in dental materials. De Baker [**37]** reported that it is the baseline periodontal health that determines the long term periodontal success of a fixed restoration irrespective of margin configuration which was also supported by other researchers [**38, 40, 41]**.

On the basis of such varying evidences, it was decided to assess the effects of zirconia used in fixed prosthesis on the periodontal status of vital and non-vital abutments by evaluating the clinical and radiographic parameters.

Our results revealed that zirconia crowns on non –vital abutment teeth showed significant improvement in clinical and radiographic

parameters over the 2year follow –up period whereas no such change was observed on the crowns placed on vital abutments. These encouraging results strongly suggest that newer materials show definite promise for long term use. However, a comparison of the vital and non-vital abutments revealed significantly lower CAL at the end of 6months, 1year and 2 years in the non-vital abutments compared to the vital abutments with no significant changes observed radiographically.

Although a vital pulp and optimal periodontal health ensures the health of the periradicular areas, not much evidence is available with regard to the long term survival of a vital abutment serving an FPD. Many researchers have suggested that the long term prognosis of such abutment teeth may be guarded, yet, these teeth serve well if the health of the periodontium is maintained. However, the risk of root caries, post cementation sensitivity and pulpal necrosis still remains with the use of these teeth as abutments. Nevertheless, the type of material used for FPD seemed to have no effect on the periodontal health or the vitality of the abutment teeth.

In other articles that evaluated periodontal parameters in relation to the restoration material used, different levels of gingival bleeding were observed, which were sometimes contradictory. A clinical trial by Suárez found better results around zirconia crowns [**20]** and FDPs, while Sailer observed more bleeding around zirconia restorations **[26, 27]**. Additonally, recent studies with different FPD materials on vital and non vital abutment teeth, showed little or no effect on the periodontal status [**42, 43]**. A systematic review and meta-analysis by leon-Martinez et al concluded that no conclusive relations can be established between periodontal behavior and the materials used to fabricate crowns and FDPs **[44]**.

Limitations:

A larger sample size on a larger cross section of the population including other esthetic materials and a comparative evaluation is recommended for more authenticity in results.

CONCLUSION

Within the limitations of the study, overall, the type of material used in FDP, zirconia in this case, may not influence the long term periodontal status of the abutment, however the periodontal status of non-vital abutments was comparatively better than the vital.

Conflict of Interest: Nil

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