Clinical, Technical, and Esthetic Performance of Different Ceramic Materials Crown on Posterior Single Implant-Supported Restorations: Prospective Clinical Study 3 Years

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Abstract

The clinical evidence about using esthetic ceramic and resin-based ceramic to support posterior single implant crown still lacks and is rare. To evaluate the clinical, technical, and biologic efficiency of monolithic Zirconia, Zirconia reinforced lithium oxide, and Polymer infiltrated ceramic of single posterior implant-supported restoration. 36 patients (14 females,22 males) ranging from 20-58 years old. After implant placement and successful osseointegration with the bone, all patients underwent the prosthetic treatment after division into three groups considering the implant prosthetics after insertion of the solid standard titanium abutment (group I=12, the implant crown fabricated from translucent Zirconia, group II=12, the crown implant fabricated from Zirconia reinforced lithium disilicate and, group III =12, the crown implant fabricated from PICN (Polymer infiltrated ceramic network) randomly to compare the clinical effectiveness of three different restorations made by the CAD-CAM technology. The baseline follows up period started after one week of crown insertion and ended by 36 months to examine the clinical, technical, and esthetic parameters around the implant. The data were collected from patient's records in the 3-year observation period about the measured variables, esthetic performance at baseline, presence or absence of technical complications, and biological outcomes. All the records were registered on a particular form for each patient, and the data were scrutinized for evaluation. After three years of follow up to the 36 patients, neither titanium abutments and all-ceramic crowns of translucent Zirconia (TZ) were lost during the observation period, but two crowns from (ZLS) crowns and one (PICN) was fractured, yielding Overall, the success rates were 94.8 %: 86.2% for all abutments and different ceramic crowns, respectively. The esthetic outcomes were excellent except that two restorations got 2 in the score. Concerning technical complications, there was one case that showed loosening of abutment screw, two cases ceramic chipping, one restoration showed occlusal roughness, and three instances of crowns loosening. In biological performance, only one implant was classified in group II (good survival) in the Misch classification from group III (PICN). In contrast, all the others were classified in group I (excellent). The three different ceramic materials have proven successful in single crowns' esthetic and functional requirements over implants in the posterior region. Translucent Zirconia all-ceramic crowns showed a high survival rate, good biological and esthetic results. In comparison, some errors were seen with ZLS and PICN crowns in the observation period.

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Introduction

Although the metal-ceramic restorations had been the material of choice for single or multiple units fixed restorations, both clinicians and patients sought metal-free restorations like all-ceramic restorations. After growing new materials, an accurate choice of ceramic material requires careful esthetic and functional durability evaluation.[1]

Dentists preferred monolithic restorations due to fast, accurate design and fabrication with a computer's aid (CAD/CAM).[2] Except for the debonding or chipping of the facing material, layered Zirconia was effectively used.[3] Due to the considerable progress in material manufacturing techniques, the deficiencies of bad translucency

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and mono-layer appearance of previous Zirconia become treatable by obtaining high translucent ceramic with high purity and almost without porosity. [4] In addition to the high translucency and resistance against hydrothermal aging, the Zenostar zirconia material has advantages such as optical and mechanical properties; that is why it was added to esthetic restorations by providing a wide range of vital shades. [5]

The success of an implant-supported by a monolithic zirconia crown may last for four years with good esthetics. [67] During fabrication of screw-retained zirconia restoration, zirconia cylinder may be exposed to excessive stresses, While The clinical reports indicate proper treatment planning and case selection increases the durability of the monolithic Zirconia. [8]

A polymer infiltrated ceramic network (PICN) is a method to make enhanced CAD/CAM material by mixing the advantages of ceramics and polymers to produce the same mechanical properties as natural dentition. The PICN-material composition is 68 % ceramic. 14 % polymer, which is considered the same as dental composite resins, we can use the same idea in PICN-material by using a ceramic network compatible with fine structure feldspar ceramic enriched with aluminum oxide, then infiltration by the Polymer of UDMA and TEGDMA. [9]

Swain measured flexural strength, 130 MPa, and fracture toughness, which is 1.4MPa m-0.5, which is the same as conventional silicate ceramic. By comparing PICN with human enamel and dentin, it was found that the modulus of elasticity and Vickers hardness are similar to each other; that is why it was concluded that PICN has more flexibility than typical ceramics. It was found that PICN has lower resistance to fatigue than LDS; however, it can withstand regular masticatory forces' normal range. [10]
In the added research laboratory, failure of PICN crowns happened at exceedingly great loads above 1000 N. The combination of edge sharpness of PICN materials with high fracture strength and flexibility makes it easier to make the crowns thinner veneers which are 0.2 mm in thickness. [11]

Laboratory research issues such as modulus of elasticity, Weibull-modulus, and flexural strength also mentioned high flexibility and talented stability. The second method for CAD/CAM enhanced material is lithium silicate ceramics reinforced with 10% zirconia (ZLS ceramic). Zirconia can be transformed from tetragonal to the monoclinic by increasing the volume to prevent cracks propagation and resulting in good resistance to fractures. [12]

ZLS-ceramics combine improved translucency and high stability. ZLS has higher flexural strength and fracture toughness than that of lithium disilicate. Examination proved that adhesive cementation of ZLS increases crown fracture resistance. [13]

A few clinical studies are available to evaluate the primary characters of the recently developed PICN, and there are fewer studies about ZLS ceramic. [14]

Few clinical studies on restoration made for a single implant, those studies to check the restoration clinically and check technical performance, the esthetic and therapeutic effect of monolithic Zirconia, Zirconia reinforced lithium disilicate, and Polymer infiltrated ceramics crowns after using them in patients. [15]

There is no effect of fatigue from mastication concerning fracture strength of monolithic CAD/CAM materials. The molar crowns are made from, and the different materials have no difference in between.[1617]

The study aims to test the monolithic Zirconia's clinical, technical, & esthetic performance, Zirconia reinforced ceramics, and Polymer infiltrated ceramic full ceramic crown restorations at three years. The first null hypothesis was that no influence of fatigue from mastication regarding CAD/CAM molar crowns fracture. The second null hypothesis was that no difference between the varied materials.

Materials and methods

Case Selection:

Thirty-six patients (14 females -22 males) were enrolled in the study. Following the inclusion criteria from the outpatient clinics of fixed prosthodontics department, faculty of Dentistry, Assiut University, Egypt with age range 20-58 years.

The inclusion criteria included patients suffering from missing the first molar; implant recipient sites have no pathological conditions. Selection based on patient's cooperation, motivation, and hygiene compromised.
If any of the following exclusion criteria were met, the patients had to be excluded from the study; Patients unable to undergo minor surgical

procedures, drug abuse history, any prescription of catabolic drugs, history of psychiatric disorder, over expectations about the esthetic result of the implant procedure, Improper vertical dimensions in centric occlusion, to receive the restorative components and those who are suffering from any systemic condition that may hinder implant placement. Bad habits that may inhibit the process of osseointegration, such as heavy smoking and alcohol abuse, Para-functional that may cause extra occlusal loads on the implants, such as bruxism and clenching.

Patients were classified randomly into group I or II, or III using a sealed envelope, which had been previously prepared. Ethical approval was provided by the Ethics Committee of the medicine-Assiut university faculty (registration # 10/23453). The informed consent document was written following the "Declaration of Helsinki."

#	Implant crown material	manufacturer	Elastic moduli, GPA	Toughness, MPa·m1/2
1=group I	Translucent zirconia Zenostar	Wieland Dental	200-220	3.5-4.5
2=group II	VITA Suprinity	Vita Zahnfabrik	100-106	2-2.5
3=group III	PICN (Polymer infiltrated ceramic network)	Evonik Industries AG, Essen, Germany)	16-28	0.5-1.3

Table 1. Implant crown Materials used.

Surgical protocol

Local Anesthesia was introduced containing articaine with adrenaline 1:100,000. The surgical procedures performed by the periodontist (AM) were flapless in cases where the ridge width was more than 5mm and free of any bony defects or concavities. In other cases, a full-thickness flap elevation was performed, with para-crystal (palatal or lingual) incisions extended by one tooth mesially and distally to the implant site, with two vertical releasing incisions. The recommended rotation speed is 2000rpm, and the cooling is obtained by copious irrigation with normal saline.

The implants (General Implants GmbH, Internal hexagon connection with the conical sealing design, Villingen-Schwenningen, Germany) were placed according to a standard two-stage protocol by oral surgeons for submerged healing; the three-dimensional placement (4.3mm diameter and 11.5 mm in length) in a position with at least 2mmof buccal bone, approximately 3 mm apical to the cementoenamel junction of the adjacent teeth, and approximately 1.5 mm from the adjacent tooth.

The 36 edentulous sites were classified as Garber Class I, where the sites were with favorable soft and hard tissue, and ideal implant placement procedures were performed. No soft tissue augmentation was performed before implant placement in the 36 edentulous sites. During the healing period, the edentulous areas were restored with interim removable partial dentures or provisional fixed prostheses.

Primary stability was established and checked with the torque wrench to be more than 30Ncm. After implant placement, the surgical flaps (if performed) were sutured, achieving a soft tissue primary closure.

Postoperative care

Medications were prescribed 1000mg Augmentin (Glaxosmithkline) twice a day for seven days or Dalacin C 300mg (Pfizer) twice daily for penicillin-allergic patients. Paracetamol 500mg was also taken as pain control. Patients were not allowed to use any removable prosthesis. Sutures (where performed) were removed after ten days.

Fabrications and Insertion of the All-Ceramic Crowns.

After giving all patients three months to heal, all implants were exposed to place the healing abutments according to gingival contour and soft tissue condition before placing the implants to preserve the emergence profile. Then, the final impression was made. The prosthodontist used a silicone impression material and customized coping to take the impression.

Monolithic Zirconia:

Dry milling of zirconia blank (Wieland Dental +Technik Gmbh & Co.Kg, Pforzheim, Germany) was carried out with an in-lab milling machine. Zirconia crowns were then separated from the blank carefully with a turbine handpiece. The milled crowns were carefully cleaned thoroughly to remove any adherent milling dust using metal-free brushes and oil-free compressed air. According to manufacture instructions, sintering was carried out in a sintering furnace (CeraMill Therm, Amann Girbach, Germany).

After sintering, finishing of the restoration was carried out, adjustment of occlusal and proximal contact. Finishing was kept minimal after sintering and done under cooling water and with gentle pressure. After finishing,

characterization and glazing were carried out in firing furnace (VACUMAT 6000 M, VITA Zahnfabrik, Germany) according to the manufacturing program.

The abutment was seated onto the model and screwed into place. After this, Teflon tape was placed into the screw access hole, and the crown fit was verified on the abutment and then removed. Dual cure adhesive resin (TOTAL C-RAM, Itena, Paris, France), with an auto-mix tip, was applied into the crown's intaglio. The crown was seated on an abutment, and Teflon tape was immediately removed from the hole. Any excess around the hole was cleaned, and light-curing was carried out. Silicone high-shine rubber wheel was used to remove excess at margin after curing. The cemented crown with abutment was removed from the model to be screwed on the fixture.

Vita Suprinity:

Wet milling of Zirconia reinforced lithium silicate (vita suprinity, vita zahnfabrik, Germany) crown was carried out with an in-lab milling machine. Fine-grit diamond abrasive tools were used for contouring after the C.A.M. process, and finishing diamonds were used for polishing. Before crystallization, the restorations were cleaned in the ultra-sonic bath. The fitting surface of crowns was acid etched using 5% hydrofluoric acid gel(DENTOBOND, Itena, Paris, France) for 20 seconds and rinsed with a copious amount of water until all acid residue was removed. After drying of etched restoration, Silane was applied for 60 seconds. Dual cure adhesive resin, with auto-mix tip, was applied into the crown, and immediately crown was seated on the abutment, and Teflon tape was removed from the hole. Any excess around the hole was cleaned, and light-curing was carried out. Silicone high-shine rubber wheel was used to remove excess at margin after curing.

Vita Enamic:

After wet milling of Polymer infiltrated glass-ceramic (VITA Enamic, VITA Zahnfab- rik, Germany) crown, a diamond tool was used to cut the sprue. Carbide instruments were avoided since these instruments may damage the material. Only diamond-coated milling tools and special polishers with water and slight pressure were used. Sof-Lex polishing discs were used for pre-polishing; only the medium grain and excellent grain types of Sof-Lex discs were used. Vita Enamic Polishing Set was used for contouring and polishing of the restorations. The external surface was conditioned by sandblasting with 50 µm Al2O3 at a pressure of 1 bar. The surface was cleaned thoroughly with a copious amount of water and dried. Using a disposable micro brush, a single coat of Vita Enamic Glaze was applied to all surfaces and polymerized with standard clinical light cure with a spectral range of 350- 500 nm for 60 seconds.

The fitting surface of restoration was etched with 5% hydrofluoric acid for 60 seconds and rinsed with a copious amount of water to remove all acid residue and salinized subsequently for 60 seconds. Dual cure adhesive resin, with an auto-mix tip, was applied into the intaglio of the crown. The crown was seated on the abutment, and Teflon tape was immediately removed from the hole. Any excess around the hole was cleaned, and light-curing was carried out. Silicone high-shine rubber wheel was used to remove excess at margin after curing. The crown with abutment was removed from the model to be screwed on the fixture

Delivery of final prosthesis:

After measuring implant mobility, the Definitive prosthesis was tightened using 35 N/cm torques, the Teflon pack was applied over the screw, and finally, screw openings were sealed using light-cured composite resin (3M, E.S.P.E., U.S.A.).

Postoperative evaluation and instructions

After one week from the insertion of the crowns, the occlusion was rechecked. After one month, the implants' superstructures and tissues were reevaluated, and all participants were reinforced concerning adequate oral hygiene. Photographs and contacts controlled occlusal modifications were verified using the shim-stock protocol. It was also tested if any tested crowns or opposed dentition displayed discernable contact deterioration via the dental probe and magnifying glasses (magnification ×3.5).

In the next visit, the crowns were adjusted over their places on the registered abutments after adjusting the occlusion with the opposing teeth, shade selection, and polishing of the crowns' external surfaces not to catch stains.

Standard abutments were tightened to 35 N following the manufacturer's rules. All-ceramic CAD-CAM crowns (monolithic Zirconia (T-Zenostar) and Zirconia reinforced lithium silicate crown (vita suprinity), and Polymer strengthened ceramic (vita Enamic)) were fabricated according

to the manufacturer instruction Insertion of the All-Ceramic Crowns. Evaluation of occlusion was made in static and dynamic movements following the mutually protective occlusion concept and cemented to the implant abutments. Oral hygiene instructions were given and illustrated in detail to the patients.

Follow-up and maintenance

The week following, crown cementation was considered the baseline. Regular appointments were arranged at specific times after the baseline. The first visit was after one month, and then the second visit was after six months from the date of the baseline then an annual visit will be arranged. The clinical notes recorded in this study showed the following:

Esthetic Outcome:

A prosthodontist measured results. These outcomes were concluded using four groups with a four-point scale, shade matching, color harmony, and gingival contour.[18]

Technical findings: Many technical errors recorded included the following criteria: abutment fracture, abutment screw fracture, abutment screw loosening, crown framework fracture, ceramic veneer fracture, crown loosening, and wear of occlusal surface. [1920]

Biological findings: Implant sites were radiographed by periapical x-rays using the paralleling technique at the baseline and follow-up appointments. The condition of the soft tissue surrounding the implant was Evaluated

Result: no pain on biting, no mobility, no exudates, and less than 2 mm bone loss radiographically.

Compromised: showed some sensitivity on biting with no mobility, no exudates, and more than 4 mm bone loss radiographically, which means less than half of the implant body.

Failure: showed pain on function with mobility, many exudates, which is uncontrollable, bone loss more than the length half of the implant body, which means that the implant is removed.

The study was based on data collected from a total number of 36 patients. All the patients completed three years under observation. Survival here means that all the abutments and all zirconia crowns are still existing in their place all over the follow-up years. Success means that there are none of those, as mentioned earlier, technical errors. Survival and success rates were recorded.

Results

All 36 patients had been examined for three years. The titanium abutments and all-ceramic TZ crowns were not missed during the follow-up years. However, two crowns of ZLS were fractured, and one of PICN showing a total of 91.7 % survival rates for all different ceramic crowns with 12 cases for each ceramic material of translucent Zirconia (TZ), Zirconia reinforced lithium disilicate (ZLS-ceramic), and polymer-infiltrated ceramic network (PICN).

The Esthetic results revealed the following: TZ crowns: starting from baseline to 36 months follow up all the crowns recorded grade 1 excellent except one case which showed acceptable rate. ZLS crowns: 2 crowns recorded acceptable rate and then increased to four cases at the end of the follow-up period, and the rest of the crowns was evaluated as grade 1. While PICN crowns: one case showed a grade 2 rate and increased to 3 cases at the end of the evaluation period, but all the other cases were recorded as excellent. [21]

The technical results revealed the following: By the end of the follow-up period, seven cases of ceramic chipping, six abutments showed screw loosening, six crown loosening cases, and three crowns showed a fracture of the framework. Table (3)

Evaluation criteria / Type of Crowns	1 = Excellent		2 = Acceptable		3 =Poor	4 = Very poor
	Baseline	36 m	Baseline	36 m	36 m	36 m
Translucent zirconia (n=12)	1(n=12)	1(n=11)		2(n=1)	0	0
VITA Suprinity (n=12)	1(n=10)	1(n=10)	2(n=2)	2(n=2)	0	0
VITA Enamic (n=12)	1(n=9)	1(n=9)	3(n=3)	2(n=3)	0	0

Table 2. Esthetic view of implant-supported crowns at baseline.

The evaluation criteria	Translucent zirconia (n=12)	Vita suprinity (n=12)	Vita enamic (n=12)
Loosening of the abutment screw	1	2	3
Fracture of abutment screw	0	1	1
Crown framework fracture	0	1	2
Fracture of veneering porcelain (chipping)	1	2	3
Occlusal wear	1	2	3

Table 3. Technical errors within 3-year follow up period.

Regarding the Anatomic Form and Occlusal Wear: ZLS crowns showed 2 cases, PICN crowns showed seven cases, TZ crowns rated grade 1 for the whole evaluation period. For

the opposing teeth, there was no wear during the evaluation period. [22]

Evaluation results	Translucent zirconia(n=12)	Vita Suprinity(n=12)	Vita Enamic(n=12)
Group I. Success	11	10	10
Group II. Satisfactory Survival	1	1	2
Group III. Compromised Survival	0	1	2
Group IV. Failure	0	0	0

Table 4. Biological evaluation of implants [22] (n =36).

After examining implants, abutments, and crowns, the result was excellent, showing almost no biological errors at the implant site. Only one implant showed bone loss of 2.3 mm after one year, which can still be included in group II and the other cases showed good survival. After an extended follow-up, the 2 cases were classified as satisfactory survival group II, and all the other cases were evaluated as group I, which is excellent. [23]

As illustrated in the bar chart, the three groups showed no significant differences among the esthetic and biological parameters but were related to the technical performance; two cases from the ZLS group were failures, and one case of the PICN group. Finally, the translucent crowns showed the best recordings, followed by the other groups.

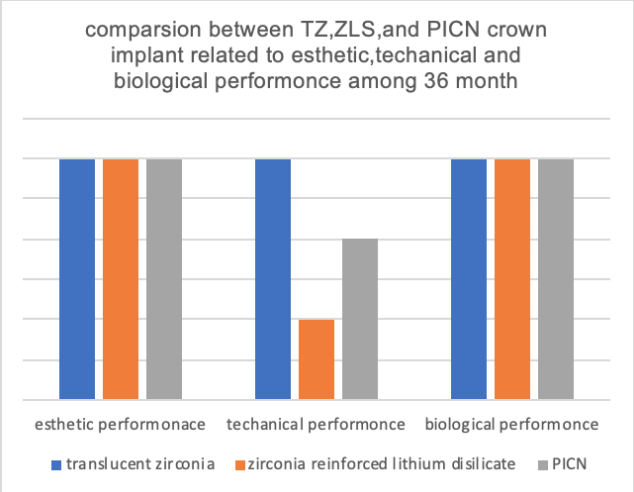

Figure 1. Barchart for all crown groups compared by evaluation parameters.

Discussion

The study findings partially support the first null hypothesis. The varied ceramic CAD-CAM ceramic crown materials have an excellent and clinically acceptable performance in the lower first molar restoration. Moreover, the current study's finding rejected the second null hypothesis. There were no significant differences between the three ceramic crown materials under the masticatory function, esthetic properties, and biological response in the posterior molar area.

The present study examined the clinical, esthetic, and technical behavior of CAD/CAM materials (translucent Zirconia, PICN & Zirconia reinforced lithium silicate). However, the Subjective Visual Analog Scale and Implant Esthetic Indices assess the esthetic results, which the indices that are mainly used are Pink Esthetic Score/White Esthetic Score [23.]

After examining the crowns made from three dissimilar materials, TZ crowns: all of them recorded grade 1 excellent except one case that recorded the accepted rate along the 36 months. In this type of crowns, the study was done on several patients that were classified as 10 cases group 1 rate and 2 cases group 2 and ended with 3 cases grade 2. monolithic crowns showed minimal color mismatch, that is why they were used in posterior teeth, that is why a study on only one patient was enough. PICN crowns: started with 9 cases grade 1 and 3 cases grade 2 and ended with the same results. However, gingival contours and gingival colors were all in harmony with adjacent teeth regarding the crown shape.

All the materials showed no significant differences between the three materials related to esthetic assessment. The best one is TZ, followed by ZLS, PICN is the last one, and this may be related to the composite used in veneering of PICN, and another reason is that it is light-cured, not heat cured.[21] these in disagreement study concluded that ZLS (Vita Suprinity) and IPS E-max could give excellent esthetic results to be used as complete coverage materials. [22]

After shade selection by shade guide and electronic shade-taking device and proper material selection for each case, all the patients showed no shade difference between the artificial crowns and the adjacent natural teeth. [23]The superior esthetic outcomes of Zirconia reinforced glass-ceramic (ZLS) came from mixing a homogenous structure. The mixture consists of very fine lithium disilicate and lithium metasilicate with a size of 0.5-0.7 µm, smaller than lithium disilicate crystals by 4 to eight times. [24]

The 4-point scale was used and aimed to make the esthetic evaluation simpler. Future research aims to make a designed study, and more reliable esthetic indices will be needed.

In single molar implant restorations, many technical errors are continuously reported by patients, like Abutment screw fracture the most frequent one, screw loosening chipping of ceramic, fracture of the framework, and loosening of the crown. [2526]

Comparing the screw loosening in the different three materials of crowns, studies showed these results after 36 months follow up: TZ crowns: one case showed screw loosening, ZLS crowns: two cases showed screw loosening, and PICN crowns: three cases showed screw loosening. These findings may be related to the amount of stress transfer related to the modulus of elasticity. This agrees that the most common technical error in single implant restoration is the loosening of the abutment screw. [27] This proves that the difference between the three materials was not significant in the esthetics findings.

Regarding the crown fracture, it was found that the weakest one is the PICN crown as its modulus of elasticity and fracture toughness is lower than TZ and ZLS crowns. This supports this study's finding, as no crown fracture in the TZ group, two crowns of ZLS, and one crown of PICN materials.

The error of porcelain chipping in the study was one case of TZ, two crowns of ZLS, and three crowns of PICN. However, many factors affected porcelain chipping, such as improper cooling time of Zirconia, type of cement, and these factors might have caused the relatively increased chipping rates [28].

Regarding the wear of ceramic crowns or the opposing natural dentition, there was one case of TZ, two cases of ZLS group, and three crowns of PICN group, and the best was the translucent Zirconia; this was supported by the Y-TZP ceramics high resistance to wear compared to the natural teeth. Although the high hardness, previously in-vitro studies had proved that monolithic zirconia restorations could be used to oppose natural human teeth. [29]

This agrees with a study that concluded that within a 96-week observation period, the monolithic zirconia crown has no side effect on periodontal tissues' health, showing good biocompatibility. The wear of opposing teeth is minimal, and the success rate of posterior restorations is high. However, longer-term effects still need more investigation [30]

The results of the current study related to wear of Vita Enamic and Vita Suprinity founded to be as the average level and this supported by study concluded that glass-ceramic in an interpenetrating resin matrix (Vita Enamic) and lithium silicate reinforced ceramic enriched with Zirconia (Vita Suprinity), the wear of the crowns and the opposing were on a comparable level. [31]

The recent study supports this investigated the mechanical properties of PICN; especially flexural strength (in the range of 131.1–159.9 MPa), elastic modulus (16.4–28.1 GPa), hardness (1.1–2.1 GPa), and strain at failure (0.5–1%) of the novel PICN (polymer-infiltrated-ceramic network) material.[32]

After examining implants, abutments, and crowns, the result was excellent, showing almost zero biological errors at the implant site. One implant showed bone loss of 2.3 mm after one year, which can still be included in group II and another case showed good survival. After an extended follow-up, the 2 cases were classified as satisfactory survival group II, and no more advanced bone loss was observed. The other 31 implants showed a minimal amount of bone loss and no inflammation surrounding the peri-implant tissues. These results confirmed the biocompatibility of Zirconia with less inflammation and a minimal accumulation of plaque in previous studies' results. [33]

From a biomechanical perspective, less stress was placed on its structure in a material with a less elastic module, which stressed the interface with its surfaces and area above the pre-existing link more easily. Similar findings in previous research support these findings. [34]

Owing to the heterogeneous passage of stress between the abutment and the crown, this rise in magnitude indicates the probability of initial fracturing in these stress concentration areas, as well as the possibility of debonding. All of the previously listed effects decreased as the crown's elastic modulus increased.

The option of restorative material will help to reduce stress concentration at the abutment interface . For example, when the crown's elastic modulus is similar to that of the abutment, as when the crown and abutment are made of Zirconia, or when the crown is made of Cr-Co and the abutment is made of titanium. If used with similar abutments, such as hybrid abutments

made with perforated ceramic blocks, materials with lower elastic modulus may have better mechanical behaviour. [3536]

Conclusions

Translucent Zirconia (TZ), Zirconia reinforced lithium silicate (ZLS), and Polymer infiltrated ceramic network (PICN) all-ceramic crowns in posterior single implant replacements constitute a promising treatment option in the medium-term observation period. Overall, a high implant survival rate, good biological integration, and excellent esthetic performance can be expected. Moreover, while some technical complications were frequently observed, the complication-free rates were 94.8% for abutments and 86.2% for crowns, respectively.

This study had some limitations, such as The number of patients was not enough with the intermediate observation period. Wear results may be different if more than two crowns or long-span bridges are used. Furthermore, more types of restorations are needed through a more extended observation period.

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Declaration of Interest

The authors declare no conflict of interest.

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