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Hybrid Abutment-Crowns with Offset Implant Placement: Effect of Titanium Base Height and Machinable Crown Material on Bacterial Leakage

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ABSTRACT

Background: The purpose of the current study was to assess the effect of two different titanium base heights and three different machinable crown materials on bacterial leakage around hybrid-abutment crowns.

Methods: 42 implant fixtures with typical external geometries hybrid-abutment crowns designed in CAD system were used. Samples were divided into six equal groups according to two variations, crown material, zirconia (Z), lithium disilicate (L), and hybrid ceramic (V) to accommodate two different heights of Ti-Base abutments either were short Ti-Bases (S) with 4 mm (n=21) or long Ti-Bases (L) 7mm (n=21). Each subgroup was equal 7 (n=7), groups were (ZS), (ZL), (LS), (LL), (VS) and (VL). Adhesive resin cement with a universal primer were used according to manufacturer instructions. Artifactial aging was done through water storage for 30 days, chewing stimulating for samples (50,000-cycles, 49 N, 1.67 Hz) and thermal cycling with (5000 cycles at 5-55°C) were applied. Samples were incubated in a bacterial suspension then leakage recorded by counting through colony forming unite (CFU).

Results: The average bacterial leakage among different material used was (2.88±1.01),short zirconia crown group (ZS) showed the least microbial leakage (1.86±0.9) followed by (VL) (2.57±0.7), (LL) (2.57±1.2) then (ZL) that was (3.29±0.7) and (LS) with (3.43±0.7). the (VS) group observed with the highest bacterial leakage with (3.57±0.5).

Conclusion: the CAD/CAM fabricated zirconia crowns can be used over other ceramic material in term of bacterial leakage around dental implant.

Key words: Hybrid abutment-Crowns - Titanium base – ceramics - Bacterial leakage, implant, CAD/CAM

I. BACKGROUND

Dental implants are composed of three main parts. The first part is the implant body, that is placed directly in the bone. The implant body mimics the root form, and is mainly made of titanium alloy with different surface roughness and special coating. The success factors of this part are traumatic surgery, adequate placement, and unloaded healing.(1)The second part of dental implants is the abutment, which is the main part that links the final restoration and the implant body. There are two types of abutments, custom-made and stock (prefabricated).**(2)** The stock abutment is already pre-fabricated by manufacturer and rarely offers proper shape and form. It may be under-contoured or over-contoured, which affects the shape of the gingival tissue, creates an unnatural appearance. Patients sometimes complain of poor esthetic and difficult cleaning. However, they are easier to use and less expensive.**(3)**

The selection of dental materials used for occlusal coverage of implant-supported restoration is very important as it could be destructive at the interface between the implant body and alveolar bone. Crown dental materials which have high elastic modulus as zirconia can transfer a high value of forces to the underlying bone, while the hybrid restorations have low elastic modulus that decreases the forces by about 95.5 %.(4) The implant material must be biocompatible with high mechanical properties to fulfill the requirements of patients for esthetic, function, and biological demands. In addition, it must be passively fit with the corresponding implant to avoid future complications such as restoration fracture, screw loosening, and finally give an accurate emergence profile that supports the surrounding soft tissue.**(5)**

Titanium has high mechanical properties, good biocompatibility, and high fatigue resistance that is not liable for corrosion or galvanism so adjunctive soft tissue health.(6) However, titanium has a higher elastic modulus than the bone and the difference can lead to stress-shielding, bone resorption, or implant fracture. Another disadvantage of titanium is the metallic allergy in some patients as well as the hyper-sensitivity and surface degradation in some cases of peri-implantitis.**(7)** The main disadvantage of this type is the metallic discoloration that can challenge the esthetic result. However, nowadays this challenge can be overcome by adding a thin coating that masks the color or using electro-chemical anodization which gives a colored titanium surface. The last challenge of titanium is the weak bond between the alloy and the cement. Alternatively, this can be improved by surface conditioning such as air abrasion or adding chemical agents, or using both of them.[8]

Zirconia has been used successfully for many years as a tooth-supported restoration. It is made of a polymorphic material that contains different crystalline components (**8**). Zirconia possesses good mechanical properties by adding stabilizing oxides (e.g. yttrium oxide) to pure zirconia to give a metastable phase that displays stress-induced transformation toughening from converting the tetragonal phase to monoclinic one with volume expansion that produces compressive stresses and prevents crack propagation. [8, 9] In general, lithium disilicate is classified as glass-ceramics which are commonly used as there are continuous updates in the mechanical characteristics, processing technique, and micro-structure that give longevity of the restoration[38]. The high translucency of the lithium disilicate gives an esthetic quality which is highly attractive for patients at the clinics. [10]

At first, this material was commercially available as ingots used by heat pressing procedures. Such procedures were similar to the lost-wax technique for metal alloys, which are pressed into a mold to reproduce the optical characteristics of natural teeth called.[11] A new processing technique appeared, allowing the formation of a new formula with smaller and more uniformly distributed crystals called (IPS-E.max Press) with improved mechanical and optical properties higher than older glass-ceramics. [12]

Pitta et al. (13) concluded that hybrid abutment crowns made of lithium disilicate bonded to titanium base are better alternatives to porcelain-fused metal-based restoration and vita enamic. Zirconia may less be recommended than lithium disilicate due to its inferior mechanical and bonding results.

Polymer infiltrated ceramic network is a new type of material used for fixed dental restoration. It contains two interlocking components; infiltrated polymer (14% in weight) and porous sintered ceramic (86% in weight). [14] The analysis of its composition is a mix of major leucite and minor zirconia phase. [15] The polymer of PICN is a mix of tri-ethylene glycol di-methacrylate and some amounts of carbon. It is a titanium insertion that connects the abutment to the implant. This base helps to avoid the weakest point of abutment connection at the implant-abutment contact area as this part distributes the force of internal friction. [16]

Recent studies found that the titanium base used in anterior teeth increases the strength of the ceramic abutment. The use of the base can range from a single tooth to multiple teeth. Furthermore, it gives the flexibility for the construction of different manufacturing techniques, digital or conventional, and other different types of materials. [17] The selection of the implant depends on the dimensions and density of bone. This is in accordance with the fact that states that favorable load distribution occurs when a greater surface area of bone is contacted by the implant to help in load transfer. [18] The height of the bone in vertical dimension and the distance between the missing tooth and adjacent teeth are the main ideal for selecting the length and diameter of the implant. The distance between the implant and the natural tooth must be not less than 1.25mm for proper blood supply and good osseointegration. [19]

The relation between microleakage and screw loosening for many types of implant-abutment connections. They measured the torque value before and after the leakage. They used (1) internal hex titanium (2) internal hex zirconium (3) Morse tapered titanium. Biocompatibility and esthetics are usually the main aims of restoration but zirconia in this study showed five times microleakage than titanium since the surface of zirconia was rougher than the surface of the titanium. Therefore, this leads to provoking bacterial adhesion and colonization, enhancing screw loosening. Moreover, due to lubricants in the mouth, saliva, blood, and microbial structures aggravate microorganism proliferation at the connection area between the fixture and the abutment, which will cause loss of soft and hard tissue later. [20]

The extent of bacterial adhesion on two materials (zirconia and polymer infiltrated ceramic networks) and whether they will affect soft tissue health. They used two different types of cement. The film was formed of three types of bacterial species (Streptococcus sanguinis, fusobacterium nucleatum, porphyromonas gingivalis) which were assessed over 72 hours using a flow chamber system. The biofilms were assessed by stains and visualized by SEM. The species biofilm adhesion depends on the prosthetic material composition. They concluded that (PICN) showed a lower biofilm than zirconia. However, with follow-up over a period of six months, they found that the polymer material showed some stains on its rough surface. This is more favorable for plaque accumulation and consequently, periimplantitis and tissue inflammation will increase the gap and leakage between the restoration and the implant. [21]

This study aimed to study the Hybrid abutment-Crowns with offset implant placement, through study the Effect of titanium base height and machinable crown material on bacterial leakage.

Hypothesis

The null hypotheses for this study are as follows:

1. There is no statistically significant difference in the bacterial leakage of hybrid-abutment-crowns that are bonded to titanium bases with varying heights.
2. The micro leakage of hybrid abutment crowns is not influenced by the type of definitive prosthetic materials used.

II. METHODS

A-Materials:

Materials used in this study were tabulated according to product names, patch numbers, main composition and manufactures in **(Table 1).**

Table (1): Material used in this study.

Materials	Product named	Patch numbers	composition	manufactures
fixture	V Plus Implant 4.2*13		Main component: Commercially pure titanium grade 4	Vitronex, Milano, Italy
Titanium base	TBASE-MPI		Main component: Commercially pure titanium grade 4	Vitronex, Milano, Italy
zirconia	Ceramill Zolled HT+white 98x18	2007001	Component: Zirconium dioxide (ZrO2) more than 99% by weight. Other contents: Aluminum oxide 0.25 wt % Yttrium oxide (Y2O3) 5.2 wt %	Amann Girrbach, Pforzheim, Germany
Feldspar hybrid ceramic polymer-infiltrated ceramic network (PICN)	VITA ENAMIC	91020	Hybrid ceramic The dominant fine structure ceramic network (86% by weight) is reinforce by an acrylate polymer network (14% by weight) ceramic-network material (UDMA, TEGDMA) with 86 wt% ceramic (Si02, Al203, Na2O, K20, B203, CaO,TiO2, colouring oxides)	Vita, Zahnfabrik, Germany
Glass ceramic	IPS e.max CAD	Z02FXV	Main component: Lithium disilicate (SiO2). Other contents: Liz0, K20, MgO, AL2O3, P2Os.	Ivoclar-Vivadent, Schaan/Liechtenstein
Adhesive resin cement	Multilink hybrid abutment	Z03NZG	Main component: Methacrylates, HEMA, barium glass, yttrium, trifluoride and spherical mixed oxide.	Ivoclar-Vivadent, Schaan/Liechtenstein
Hydrofluoric acid	Porcelain etchant	2300000134	9.5% Buffered Hydrofluoric acid gel	Bisco, Anaheim, CA, USA
Universal primer	Monobond plus	Z039MX	Alcohol, sulfide dimethacrylate, MDP, gamma-MPTS	Ivoclar-Vivadent, Schaan/Liechtenstein

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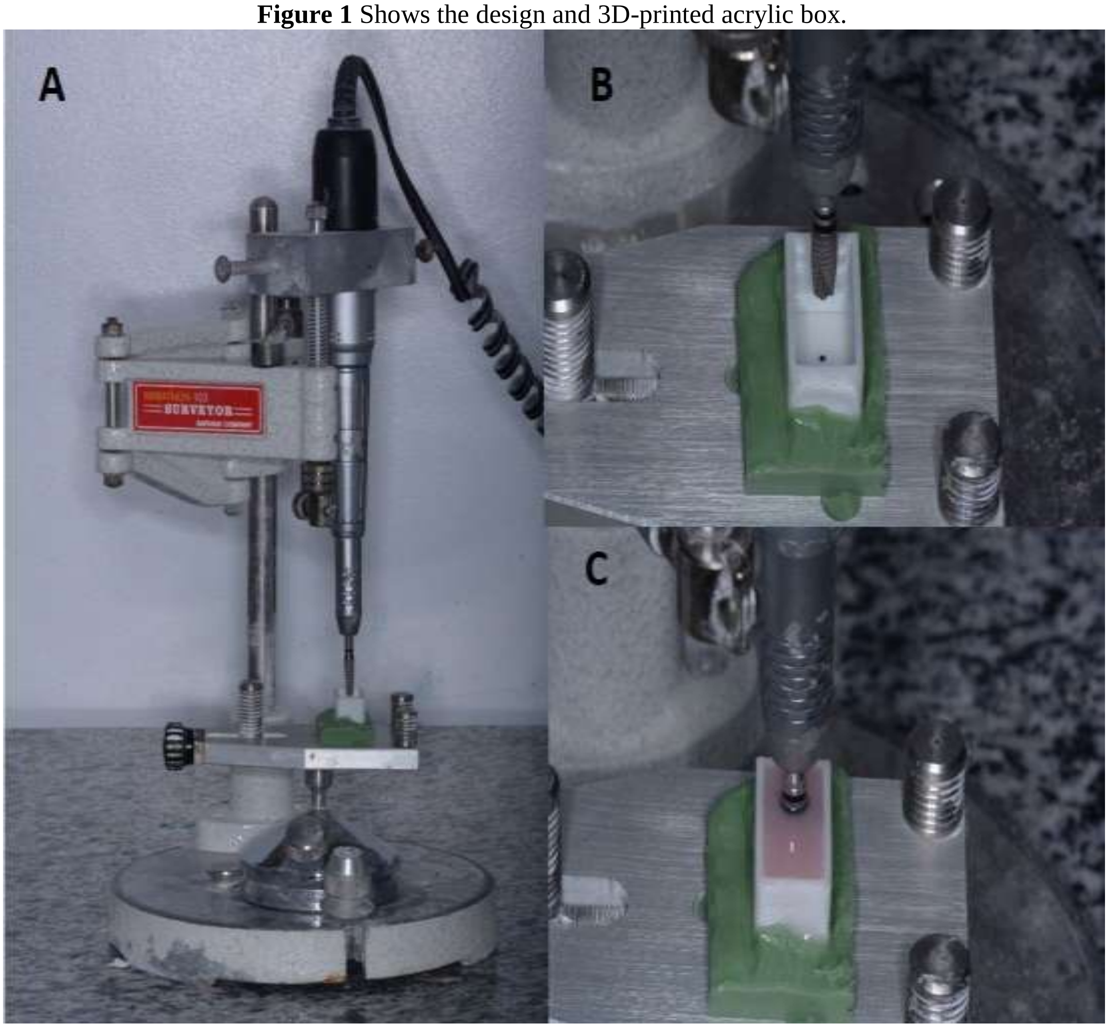
Forty two implant fixtures were used and divided into six equal groups **(Figure 7)** according to the material of the abutment and height of the titanium base into:

Group (ZS) : hybrid-abutment zirconia crown with short Ti-base, Group (ZL) : hybrid-abutment zirconia crown with long Ti-base, Group (L_2S): hybrid abutment glass ceramic crown with short Ti-base, Group (L_2L) : hybrid abutment glass ceramic crown with long Ti-base, Group (VS) : hybrid abutment vita enamic crown with short Ti-Base, Group (VL) : hybrid abutment vita enamic crown with long Ti-Base.

The sample size calculation was done using G* (version 3.0.10) to have a sample size of seven spaceman for each group with a 5% disparity and effect size 1.72.

A total of 42 3D-printed PMMA (NextDent, AV Soesterberg, Netherland) boxes with dimensions of 22x12x15 mm were designed and printed using a 3D printer (Mogassam, Cairo, Egypt) to act as a recipient for acrylic material using a marker to represent the off-set point which was 5 mm distal to the center of the box to determine the distally positioned implant (Figure 1) the Ti-Bases were screwed on the fixtures and fixed in the box using surveyor (Marathon-103, Saeyang, Daegu, Korea), mixing and pouring of acrylic material resin (Acrostone, Alex, Egypt) inside the boxes to insure accurate angulation without deviation form standered position and subsequent be ready for the test. (Figure 2)

Figure 1 Shows the design and 3D-printed acrylic box.



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(A) The designing (B) The 3D-printed model.

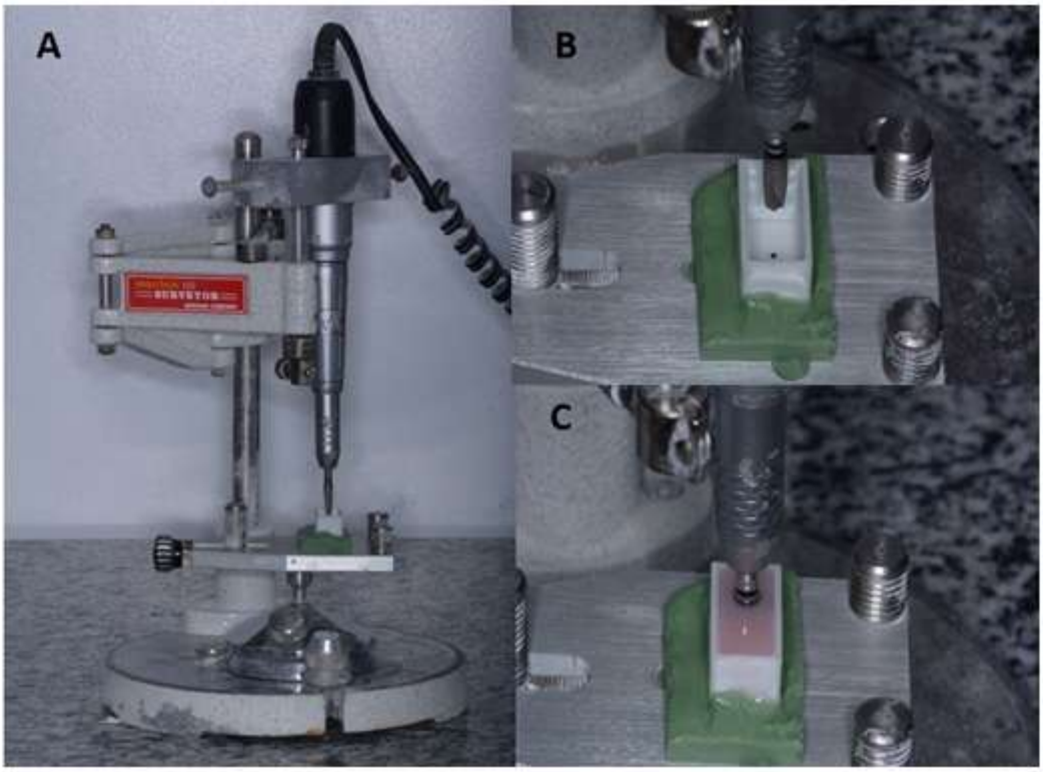

Figure 2 Shows the implant fixture being held in the surveyor.

One dental implant system with the same design and dimensions (4.2*13) were used. All materials utilized in the experiment were sterilized inside surgical bags. All sample preparations and all tests were performed by the same operator in a random sequence to avoid any error caused by increase in the operator's skill.

Different ceramic crowns were designed corresponding to lower molar teeth morphology by one dental lab technician for all groups. A scan body was attached to the implant and scanned using Medit i700 intraoral scanner (Medit, Seoul, South Korea). After that, a series of 42 crowns featuring uniform external geometries were meticulously crafted using a CAD software (Exocad dental CAD GmbH, 64293-Darmstadt, Germany) to accommodate two distinct Ti-base (MPI-TBASE, Vitronex, Milano, Italy) abutment heights (n=42): with two different heights 4 mm short (S) (N=21) and 7 mm long (L) (N=21) (Figure 3). The screw channels were located in a distal position. During CAD-CAM fabrication of all crowns. The offset was placed 5 mm distally **(Figure 4)** to mimic the distally-positioned implant. This was standardized to ensure that the implant is placed in the same position in all specimens.

In addition, the main group was further subdivided into two subgroups (n=7) based on the three ceramic materials employed for the manufacturing of the crowns, namely zirconia (Z), lithium disilicate (L), and Vita Enamic (V).

Three distinct types of machinable ceramics were utilized in this study, namely zirconia (ceramill zolid HT+, Amann Girrbach, Pforzheim, Germany), lithium disilicate (IPS e.max CAD, Ivoclar-Vivadent, Schaan/Liechtenstein), and hybrid ceramic (Vita Enamic, VITA Zahnfabrik, Bad Säckingen, Germany). These ceramics were divided into six groups, denoted as ZL, ZS, LL, LS, VL, and VS, with a total sample size of seven (N=7). The milling procedure was conducted using a 5-axis milling machine known as the Ceramill Motion 2 (Amann Girrbach AG, Herrschaftswiesen, Germany). **(Figure 4)**

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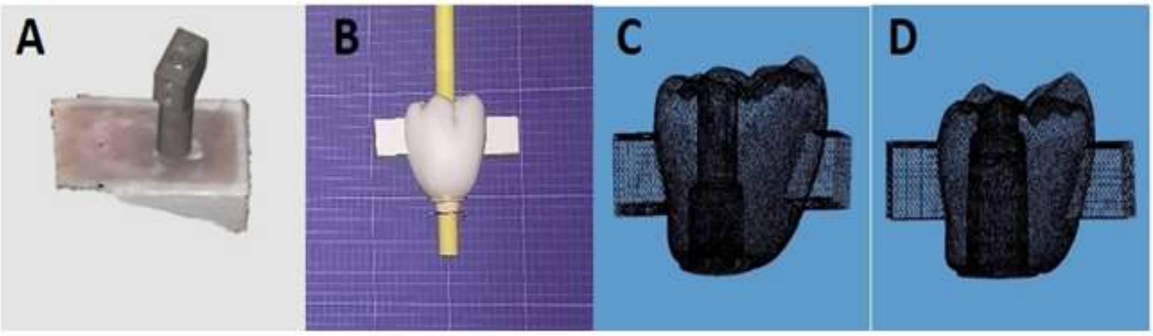

Figure 3. Shows the scanning and different crown designs according to Ti-base height.

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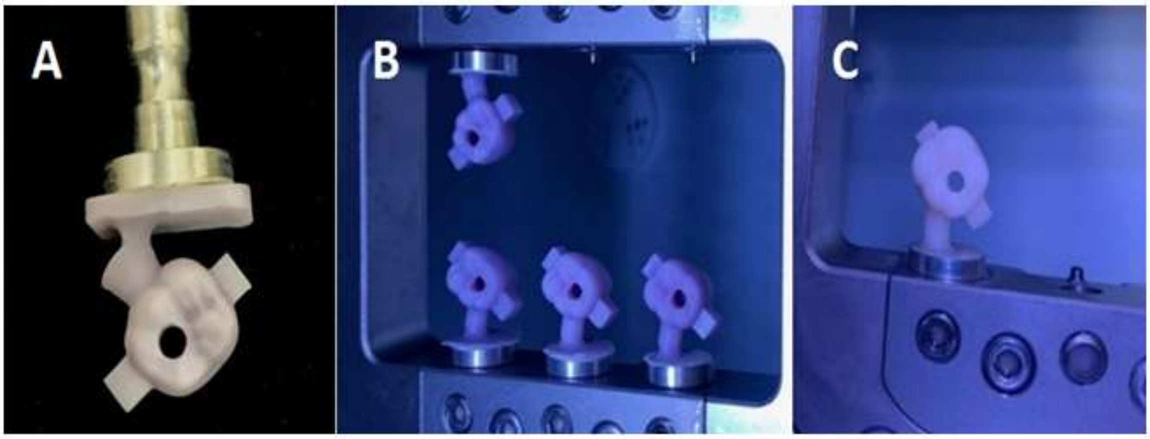

Figure 4. Shows the milled crowns with the offset distally placed.

Milling of 14 zirconia abutments using the milling machine (Doowonid ARUM, Korea) with a computer controlled five axis simultaneous milling unit. A zirconia block (metoxit Z-CAD) was fixed into its proper place in the milling chamber using special clamps, According to the manufacturer's instructions, the zirconia abutments were sintered on the firing tray of the firing furnace (SinterMax model T1700, SinterMax, USA) then Zirconia non segmented abutments were finished by (Schottlander zirconia finishing kit) (AlleconDental, Canada).

14 hybrid ceramic VE discs were fabricated using CAD/CAM technology. Milling of IPS e.max CAD abutments was done using the milling machine (Doowonid, ARUM, Korea) with a computer controlled five axis simultaneous milling unit. IPS e.max CAD block was fixed into its proper place in the milling machine using special clamps and the order was given to the milling unit. Crowns were milled using 2 milling burs (burs size 2 mm for gross milling. 1 mm for final adjustment) (ARUM, Korea), The crowns were finished using a (Schottlander finishing kit AlleconDental, Canada) finishing kit. Each crowns was inspected for any defects by (EASY view 3D, Renefert, Germany) magnifying screen and finished, According to the manufacturer's instructions, a ceramic furnace (EP 500 Programat, Ivoclar Vivdent) was used for crystallization of the IPS e.max CAD crowns. The crystallization program was selected according to manufacturer's instructions and finally furnace was activated according to manufacture instructions Temperature was elevated from room temperature till 820 °C in a heat rate of 60 °C per minute.

Surface treatment of different crown materials

Each titanium base was loosened from its fixture and screw channel was sealed with cotton pellet and covered with a temporary filling material (Litark, Italy) and the outer surface below finish line was covered and surrounded by wax, according to the manufacturer’s instructions, the surface of the titanium bases were sand blasted with 50 micron Al_2o_3 at maximum 2 bar pressure till be ready for cementation, A self-adhesive resin cement (multilink hybrid abutment cement) was the cement of choice for the study due to high bonding properties that maintain a good result for different spacemen’s material.

All milled crowns (ZS, ZL) were prepared for cementation by air abrasion by 50 µm Al_2o_3 at a 2 bar pressure for 15 seconds with a 2 cm step-over

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distance till be ready for cementation, The surfaces were then irrigated with water for 60 seconds and ultra-sonically cleaned (MCS digital ultrasonic cleaner) in 95% isopropanol for 3 minutes. The surfaces were then thoroughly dried with a compressed dry air stream for 10 seconds. Teflon was put on the crown channel to be completely closed and avoid any cement excess that might block the channel and prevent screwing of the samples. Universal bond (mono-bond) was brushed inside the interior surface of all samples.

IPS e.max CAD (LS, LL) and Vita enamic (VS, VL)

Samples were cleaned so the itchable material surface is prepared for cement by itching with hydrophloric acid 9.5% buffered HF acid (Porcelain etchant, Bisco, Anaheim, CA, USA) concentration for (20) second to make pores in the surface for the chemical bonds with the universal cement, The surfaces were then irrigated with water for 60 seconds and ultra-sonically cleaned (MCS digital ultrasonic cleaner) in 95% isopropanol for 3 minutes. The surfaces were then thoroughly dried with a compressed dry air stream for duration of 10 seconds. monobond was used in the interior surface, removing the excess, aplication of the cement, seating of the samples on the corresponding ti-bases using the cementation device, light curing after removing the excess cement.

Primer application

After dryness specimens of the test groups were conditioned with primer as follow: a thin layer of a universal primer (Monobond plus, Ivoclar Vivadent, Schaan/Liechtenstein) was brushed using a micro brush then allowed for sitting for 60 seconds. Removing of excess primer was done by blowing with a strong stream of air **[22].**

The Ti-bases air abraded with 50 µm Al_2O_3 particles at a pressure of 2 bar for 15 seconds, with a 5-mm step-over distance. then the specimens were cleaned utilizing an ultrasonic cleaner (CD-4820 digital ultrasonic cleaner, Codyson, China) with 95% isopropanol solution for a duration of 3 minutes, next they were dried procedure. Subsequently, the Ti-bases were treated with a universal primer (Monobond plus). The primer was gently rubbed onto the Ti-bases for a duration of 20 seconds, followed by a reaction period of 60 seconds. Finally, a moderate stream of air was used to dry the Ti-bases **[23].**

Bonding

Bonding was done using adhesive resin cement (Multilink Hybrid-abutment, Ivoclar Vivadent Schaan/Liechtenstein) according to the manufacturer's instructions. To secure the specimens, a specially cementation device was employed to apply a 5 kg load on the occlusal crown-abutment assembly during the bonding process. The bonded component was left under this static load for 5 minutes. Light curing was performed from four different directions, each lasting for 20 seconds. Finally, any excess cement was removed, and the surface was finished and polished **[24, 25]**.

Artificial aging

All specimens were kept in a 37°C water bath for 1 month, one hour later after cementation. Samples were stored in containers made of waterproof plastic material. then, fatigue tests under cyclic loading were done utilizing a CS-4 chewing simulator machine (manufactured by SD Mechatronik GMBH, located in Feldkirchen, Germany). The specimens were subjected to 5000 thermal cycles (ranging from 5°C to 55°C, with a 30-second dwell time at each temperature extreme) and 50000 repeated cyclic loads with a weight of 49 N and a loading frequency of 1.7 Hz to simulate 2.5 months of normal mastication. **[26].**

Microbiological assessment

Under aseptic conditions, flask sterile instruments and gloves were used without touch the surface of samples. Each of forty-two per-assembled sterile test specimens were incubated in a glass tube containing suspension which is a mix of streptococcus mutans and E.coli added to nutrient broth till reach turbidity equals 0.5 McFarland standards (500ml). All test specimens were incubated for 3 days. After this time, all test samples were removed from the suspension using sterile tweezers, using a peper point we took a bacterial sample from the inner surface of the implant and a bacterail count was done by counting number of colonies on the agar plats (Figure 5,6)

Statistical analysis:

The statistical analysis was made using SPSSPC+-version 24 computer program. Through using the t-test for comparison between the two groups of different treatments. And the kruskal-wallis test was applied for comparison between more than two groups. Also correlation test between the studed groups was applied. Post Hoc Tukey (HSD) tests were employed. Statistical significance was established by performed a p-value below 0.05 (P<0.05).


Figure 5,6: showing bacterial colonies formed on agar plates

III. RESULTS

The collected data were systematically arranged, coded and analyzed.

Our results observed in Table (1) cleared that, the base and crown material not differ significantly (P < 0.05) for bacterial leakage among different materials used. While, there was a significant differences (P < 0.01) for crown material / short titanium base material and there was no significant differences between the crown material / long titanium base material. The average bacterial leakage among different material used was 2.88±1.01

Table 1. Kruskal-Wallis's tests for factors and test-groups.

Factor	**p**
Crown Material	0.408
Base Material	0.563
Crown Material\Short Titanium Base Material	**0.006**[*a]
Crown Material\Long Titanium Base Material	0.290
Test Groups	**0.015**[*]
N = 42, Mean ± SD = 2.88 ± 1.017, Grand Median = 3, [*] Significant difference (p < 0.05), [a] Checked with Mann-Whitney test (p = 0.010).	

2-Bacterial leakage among crown material:

The results observed in Table (2), cleared that, the higher bacterial leakage observed in Vita enamic followed by lithium disilicate and zircona where the bacterial leakage in them were 3.7, 3.00 and 2.57, respectively.

Table (2): Bacterial leakage among crown material:

Bacterial Leakage	N	Minimum	Maximum	Sum	Mean
Crown Material					
Zirconia	14	1	4	36	2.57
Lithium Disilicate	14	1	4	42	3.00
Vita Enamic	14	2	4	43	3.07
Total	42	1	4	121	2.88

The results obtained in Table (3) cleared that, the bacterial leakage showed a significant differences among used crown material of crown material / short titanium base material.

The results cleared that the zircona (1.86) of lower bacterial leakage compared to lithium disilicate (3.43) and Vita Enamic (3.57) and the lithium disilicate (3.43) of lower bacterial leakage than Vita Enamic. (3.57).

Table (3): Kruskal-Wallis's tests pairwise comparisons for Crown Material\Short Titanium Base Material

Crown Material	Short Titanium				
	N	Mean ± SD	Med.	Average Rank	**p**
Zirconia	7	1.86 ± 0.90	2.00	05.14	**0.008***
Lithium Disilicate	7	3.43 ± 0.79	4.00	13.57	
Zirconia	7	1.86 ± 0.90	2.00	05.14	**0.004***
Vita Enamic	7	3.57 ± 0.54	4.00	14.29	
Lithium Disilicate	7	3.43 ± 0.79	4.00	13.57	0.821
Vita Enamic	7	3.57 ± 0.54	4.00	14.29	

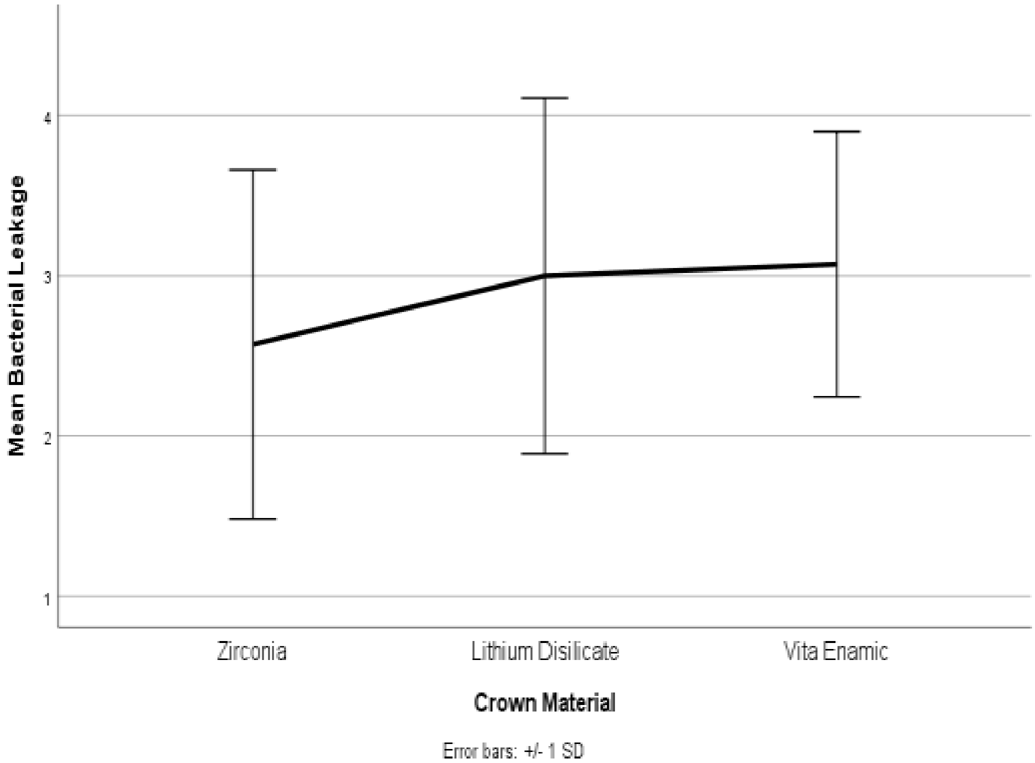
* Significant difference ($p < 0.05$).

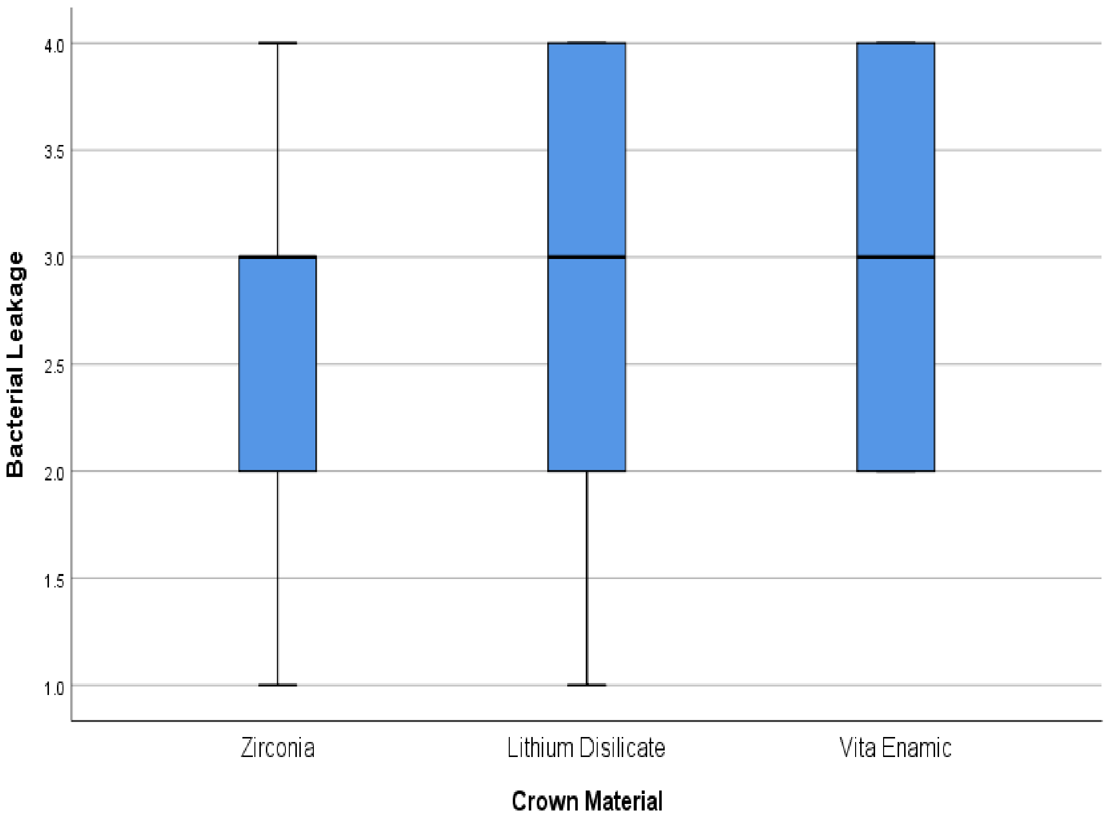
The results observed in Table (5) cleared that, the incidences of bacterial leakage showed a higher level in long titanium and in Vita Enamic and the lower bacterial leakage observed in short titanium base material heightespecially in lithium disillicate material that show a lower bacterial leakage.

Table (5): Cross Table count for bacterial leakage.

Bacterial Leakage			Base Material Height		Total
			Short Titanium	Long Titanium	
1	Crown Material	Zirconia	3	0	3
		Lithium Disilicate	0	2	2
	Total		3	2	5
2	Crown Material	Zirconia	2	1	3
		Lithium Disilicate	1	1	2
		Vita Enamic	0	4	4
	Total		3	6	9
3	Crown Material	Zirconia	2	3	5
		Lithium Disilicate	2	2	4
		Vita Enamic	3	2	5
	Total		7	7	14
4	Crown Material	Zirconia	0	3	3
		Lithium Disilicate	4	2	6
		Vita Enamic	4	1	5
	Total		8	6	14
Total	Crown Material	Zirconia	7	7	14
		Lithium Disilicate	7	7	14
		Vita Enamic	7	7	14
	Total		21	21	42

Figure 7: box plots illustrate the mean bacterial leakage values of three different crown materials


Mean Bacterial Leakage
1
2
3
4
Zirconia
Lithium Disilicate
Vita Enamic
Crown Material
Error bars: +/- 1 SD


Bacterial Leakage
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Zirconia
Lithium Disilicate
Vita Enamic
Crown Material

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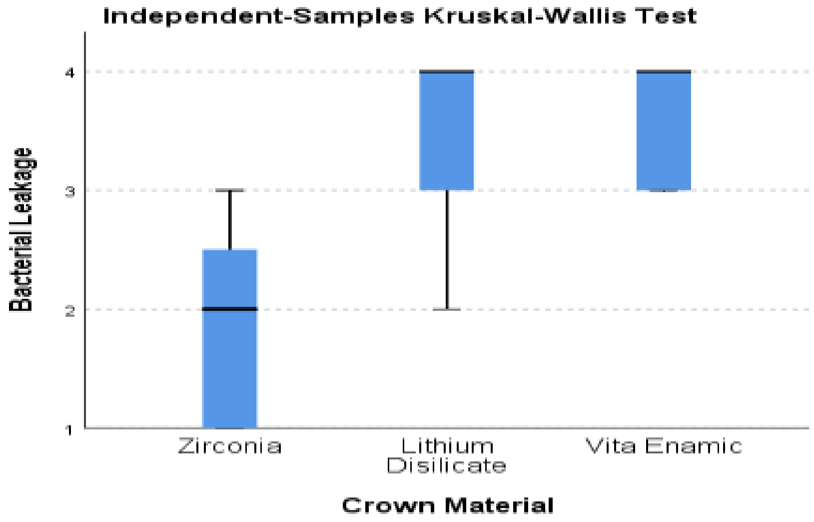

The results obtained in Table (7) cleared that, the bacterial leakage differ significantly (P < 0.05) among different base material height.

The higher bacterial leakage observed in short titanium as its level was 2.95, followed by long titanium as its level was 2.81.

Table (7): Bacterial leakage among the base material height.

Base Material Height	N	Minimum	Maximum	Sum	Mean
Short Titanium	21	1	4	62	2.95
Long Titanium	21	1	4	59	2.81
Total	42	1	4	121	2.88

The results observed in Table (8) indicated that, the differences between the Zirconia-Lithium Disilicate where the bacterial leakage in Zircona lower than its level in Lithium dsisillicate.

Also, between Zircona – Vita Enamic where the bacterial leakage in Vita Enamic higher than its level in Zircona.

While the comparison between the Lithium Disilicate-Vita Enamic not significant but the the level of bacterial leakage in Vita Enamic higher than bacterial leakage in lithium disillicate.

Table (9): Pairwise Comparisons of Crown Material

Sample 1-Sample 2	**Test Statistic**	**Std. Error**	**Std. Test Statistic**	**Sig.**
Zirconia-Lithium Disilicate	-8.429	3.153	-2.673	0.008
Zirconia-Vita Enamic	-9.143	3.153	-2.900	0.004
Lithium Disilicate-Vita Enamic	-0.714	3.153	-0.227	0.821

Our results observed in Table (11) cleared that the bacterial leakage among different studied groups differ significantly (P < 0.01).

The higher bacterial leakage observed in the group-5 (VS) that was 3.57, followed by group-3 that was 3.43 and group-2 (ZL) that was 3.29. While, the lower bacterial leakage observed in the group-1 (ZS) that was 1.86. while, I the group-4 (LL) that was 2.57 and group -6 (VL) that was 2.57.

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Table (11): Kruskal-Wallis's tests pairwise comparisons for test-groups

Group	Group-1	Group-2	Group-3	Group-4	Group-5	Group-6	N	Mean ± SD	Med.	Average Rank
Group-1 (ZS)	—	0.013*a	0.005*b	0.186	0.002*c	0.290	7	1.86 ± 0.90	2.00	10.29
Group-2 (ZL)		—	0.750	0.245	0.561	0.155	7	3.29 ± 0.76	3.00	25.86
Group-3 (LS)			—	0.139	0.793	0.081	7	3.43 ± 0.79	4.00	27.86
Group-4 (LL)				—	0.081	0.793	7	2.57 ± 1.27	3.00	18.57
Group-5 (VS)					—	0.045	7	3.57 ± 0.54	4.00	29.50
Group-6 (VL)						—	7	2.57 ± 0.79	2.00	16.93

[*] Significant mean difference ($p < 0.05$). (A cell represents a pairwise p-value.),
Grand Median = 3,
[a] Checked with Mann-Whitney test ($p = 0.014$),
[b] Checked with Mann-Whitney test ($p = 0.010$),
[c] Checked with Mann-Whitney test ($p = 0.004$).

Table (12): Pairwise Comparisons of different groups:-

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
Group-1 (ZS)-Group-6 (VL)	-6.643	6.272	-1.059	0.290	1.000
Group-1 (ZS)-Group-4 (LL)	-8.286	6.272	-1.321	0.186	1.000
Group-1 (ZS)-Group-2 (ZL)	-15.571	6.272	-2.483	0.013	0.196
Group-1 (ZS)-Group-3 (LS)	-17.571	6.272	-2.801	0.005	0.076
Group-1 (ZS)-Group-5 (VS)	-19.214	6.272	-3.063	0.002	0.033
Group-6 (VL)-Group-4 (LL)	1.643	6.272	0.262	0.793	1.000
Group-6 (VL)-Group-2 (ZL)	8.929	6.272	1.423	0.155	1.000
Group-6 (VL)-Group-3 (LS)	10.929	6.272	1.742	0.081	1.000
Group-6 (VL)-Group-5 (VS)	12.571	6.272	2.004	0.045	0.676
Group-4 (LL)-Group-2 (ZL)	7.286	6.272	1.162	0.245	1.000
Group-4 (LL)-Group-3 (LS)	9.286	6.272	1.480	0.139	1.000
Group-4 (LL)-Group-5 (VS)	-10.929	6.272	-1.742	0.081	1.000
Group-2 (ZL)-Group-3 (LS)	-2.000	6.272	-0.319	0.750	1.000
Group-2 (ZL)-Group-5 (VS)	-3.643	6.272	-0.581	0.561	1.000
Group-3 (LS)-Group-5 (VS)	-1.643	6.272	-0.262	0.793	1.000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same. Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

a. Significance values have been adjusted by the Bonferroni correction for multiple tests.

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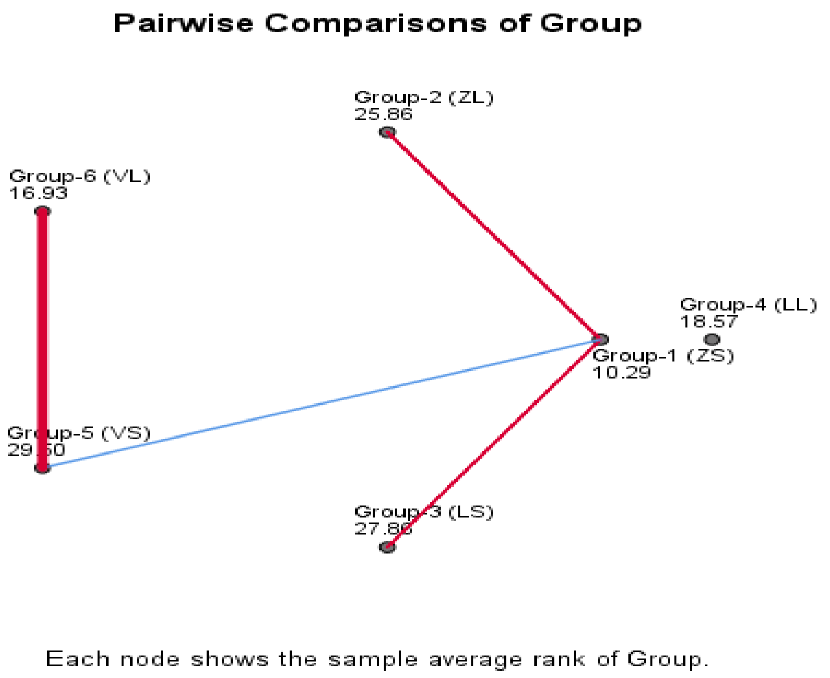

Figure 8: Each node shows the sample average rank of group

IV. DISCUSSION

The hybrid abutment is a prefabricated titanium base on which a CAD/CAM ceramic coping is cemented over. **(20)**. This type of abutment was proved to have an improved esthetic result without affecting the stability of restoration (**21)**. The clinical situations which require this specific type are: (1) The collar height needed is not offered by the manufacturer. (2) The insufficient inter-occlusal space for restoration. (3) For making angle correction which is more than 15 degrees. (4) For the reproduction of original cross-section profiles which will provide an ideal emergence profile (**27)**.

The results about the effect of different materials used on bacterial leakage indicated that, there was no differences between crown material for bacterial leakage. While, the bacterial leakage differ for crown material / short titanium base material and there was no differences the crown material / long titanium base material. This results attributed to the Titanium has high mechanical properties, good biocompatibility, and high fatigue resistance that is not liable for corrosion or galvanism so adjunctive soft tissue health **(27).** However, titanium has a higher elastic modulus than the bone and the difference can lead to stress-shielding, bone resorption, or implant fracture. This results agreed with those of Titanium has high mechanical properties, good biocompatibility, and high fatigue resistance that is not liable for corrosion or galvanism so adjunctive soft tissue health (**6)**.

While, the results of bacterial leakage among crown material cleared that, the higher bacterial leakage observed in Vita enamic followed by lithium disilicate and zircona. This results attributed to the zarcona **(9),** Although it has a favorable superior strength, it is a good biocompatible, radio-opaque material, with more corrosion resistance, and insoluble in water. It has no known allergic reaction to the material intraorally, and can be cemented or bonded. If it is well-polished, less plaque accumulation will occur in comparison to the other abutments. Furthermore, it gives a high esthetic due to the absence of metal display **(22).**

The results about the bacterial leakage among crown material cleared that the zircona of lower bacterial leakage compared to lithium disilicate and Vita Enamic and the lithium disilicate of lower bacterial leakage than Vita Enamic. This results agreed with the results of Tooth-colored alumina and zirconia, abutments have been proposed as an alternative to Ti for abutments to overcome this esthetic problem **(28)**. Several authors reported that all ceramic abutments made of alumina had unfavorable behavior after

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aging and possessed less favorable properties than zirconia and titanium abutments **(29).** From studies available, it is postulated that zirconia abutments not only induce significantly less mucosal discoloration than metal abutments8 but also allow less bacterial adhesion than Ti **(30).**

While, the results of bacterial leakage among the base material height indicated that, the higher bacterial leakage observed in short titanium , followed by long titanium. This results agreed with the results of (31) where they reported that, the zarcona more prone to microleakage to microleag and addition of titanium base increase its strength and its resistance to microleage.

The results about bacterial leakage among base material height indicated that, the incidences of bacterial leakage showed a higher level in long titanium and in Vita Enamic and the lower bacterial leakage observed in short titanium base material height especially in lithium disillicate material that show a lower bacterial leakage. While, the results on the comparison between the different base materials used in its leakeage level cleared that, the differences between the Zirconia-Lithium Disilicate where the bacterial leakage in Zircona lower than its level in Lithium dsisillicate. Also, between Zircona – Vita Enamic where the bacterial leakage in Vita Enamic higher than its level in Zircona. While the comparison between the Lithium Disilicate-Vita Enamic not significant but the the level of bacterial leakage in Vita Enamic higher than bacterial leakage in lithium disillicate. This results agreed with the results of **(32)**, where she reported that, recent developments in computer-aided designing / computer-aided manufacturing (CAD/ CAM) technique made it possible to use high strength ceramics (mainly zirconia) to fabricate implant-supported all-ceramic abutments with customized contour that match carefully the clinical situation **(33).** In addition, Lithium disilicate ceramic (E max cad) was also used for custom made implant abutments **(34)** . The ceramic CAD/CAM abutments combine most of the advantages of stock and cast custom abutments. Added to its predictable fit and durability, all the prosthesis parameters can be easily adjusted including the emergence profile, finish line thickness and location as well as external contour which results in improved final esthetics of implant supported restorations **(35, 36).**

Our results on the bacterial leakage among different groups indicated that, the higher bacterial leakage observed in the group-5 (VS), followed by group-3 and group-2 (ZL). While, the lower bacterial leakage observed in the group-1 (ZS). This results attributed to the using of zirconia, Vita Enamic and lithium disilicate alone as base material not pereferable due to didn't survive and showed the lowest resistance to failure. While, its using with a titanium base gives better support to brittle ceramics, more fracture resistance. Furthermore, it overcomes the weak contact at the implant-abutment interface and decrease the microleage to bacteria. This results agreed with the results of **(37)** where they reported that, zirconia abutments without titanium base didn't survive and showed the lowest resistance to failure. Lithium disilicate abutment with a titanium base and lithium disilicate hybrid abutment crown showed high durability, strength, and long-term survival.

This study concluded that, the crown material that resistant to bacterial leakage includes the zirconia, lithium dissilicat and vita Enamic. The base material height of short titanium of lower bacterial leakage than the long titanium. The incidences of bacterial leakage showed a higher level in long titanium and in Vita Enamic and the lower bacterial leakage observed in short titanium base material height especially in lithium disillicate material that show a lower bacterial leakage. The best base material for prevention of bacterial leakage observed in Zirconia-Lithium Disilicate, followed by Zirconia – Vita Enamic where the bacterial leakage in Vita Enamic higher than its level in Zirconia.

V. CONCLUSION

Within the limits of this in vitro study, it is possible to say the following:
The type of ceramic restoration affects bacterial leakage of hybrid-abutment crowns with zirconia exhibiting the least retention.

Limitation of the study

Although the bacterial leakage is uneccential reason for long-term durability pf restoration, other mechanical factors of the ceramic material should be considered during selection of the material. Therefore torque loss, retention and fracture resistance tests must be taken consideration.

List of abbreviations

HF	Hydrofluoric acid
CAD/CAM	Computer aided design; computer aided manufacture
3D	Three dimensional
SPSS	Social Package for Statistical Science

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