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Assessment of the fracture strength of straight and pre-angled (17°) zircon implant abutments supported CAD\CAM zerconium restoration: An in(vitro study).

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الخلاصة

الاهداف:لقد كان الهدف من هذه الدراسة المختبرية هو تقييم تأثير ميلان الدعامة على قوة الكسرلدعامة الزرعة الزركونية المسبقة الصنع والمدعومة بتيجانه الزركون نوع.(CAD/CAM) **المواد وطرق العمل:** تم استخدام عشرة نظائر للزرعات بقياسات (3,75×14) ملم حيث وضعت فى قوالب راتنجية وقسمت الى مجموعتين: المجموعة (أ) وعدد عيناتها خمسة موازية للمحور الطولى للزرعة والمجموعة (ب) وعدد عيناتها خمسة مثبتة بميلان (° 17) عن المحور الطولى. تم احكام شد الدعامات العشرة بقوة 25 نيوتن/سم 2. ثم تم تصنيع عشرة بتيجان زركونية تشريعية كاملة نوع (CAD/CAM) مماثلة للثنية العليا اليمنى بحيث اصبح لكل مجموعة خمسة بتجان. وبعد تثبيت جميع التيجان بمادة الالصاقة الراتنجي ثنائى التصلب، تم احرار جميع العينات بجهاز الدورات الحرارية (500) دورة عند (5-55) ±2 م°.ثم تم تسليط القوى باستخدام جهاز الاختبار العام وبميلانه مقداره 30 درجة عن المحور الطولى حتى حدث الكسر.**النتائج:** ظهر التحليل الاحصائى ان ميلان دعامات الزرعات قد أخفض بشكل معنوى مقاومة دعامات الزرعات الزركونية للكسر .(P<0.05) **الاستنتاجات:** ضمن محددات هذه الدراسة المختبرية يمكن الاستنتاجات بأن قوة الكسرة لدعامات الزرعات الزركونية الداعمة لتيجان الزركوني نوع (CAD/CAM) تنخفض معنويا حسب الميلان من الاستقامة الى ميلان(17°) للدعامات الزركونية.

ABSTRACT

Aims :evaluate the effect of abutment angulation on fracture strength of pre-fabricated zircon implant abutment supported CAD\CAM zircon crown. **Material and methods**: Ten analog with 3.75×14mm were placed into resin blocks divided in to 2 groups: group A (n=5) parallel to long axis and group B (n= 5) fixed at angulation (17°) to long axis. Then ten abutments were tightened to 25 N/cm2. Ten full anatomic zircon (CAD/CAM) crowns constructed as upper right central incisor: 5 on each group. After luting all crowns with dual cure resin-based luting, all samples passed to artificial aging using thermocycling machine, 500 cycles at (5 to 55 C°±2) degree. Then the load was applied by universal testing machine at 30 degree to the long axis until fracture occurred. **Results**: Statistical analysis showed that the implant abutment angulations significantly ($p < 0.05$) reduced the fracture resistance of zircon implant abutment. **Conclusions**: Within the limitation of this in vitro study it may be concluded that: the fracture strength of zircon implant abutment supported CAD\CAM zircon crown is significantly reduced in respect to the angulation fromstraight to angulated (17°) zircon abutment.

Keyword: zirconium, zirconium dioxide, implant abutment, fracture resistance.

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INTRODUCTION

In esthetically demanding anterior regions, restoring a single-tooth space with an implant-supported crown can be a challenge for a clinician.[1,2] For highly esthetic locations in the dental arch, especially for patients with a high lip line, implant-supported single-tooth restorations are subject to the most exacting requirements, in-

cluding optimal implant and superstructure positioning .[1]

Zirconium can be a very useful choice in spite of the higher degree of care required in working with it. Clearly, it possesses a higher flexural strength, approximately 1,200 MPa. .[3] Also clinically applied as abutment for implants and superior restoration devices.[4]

A critical determinant for placement of an implant is the height and width of bone available in the edentate sites. Ideally, implants should be placed parallel to each other and to adjacent teeth and be aligned vertically with axial forces.[5, 6, 7] However, achieving this may not be possible owing to deficiencies in the ridge's anatomy.[6, 7] So the clinician can: augment the ridge, change the intended location of an implant or insert

an implant with an angled trajectory. The latter technique may provide: facilitating placement of an implant with greater dimensions in width and height, permitting a greater number of patients to be treated because the procedure is not as restrictive as that used with straight implant abutments, avoiding guided bone regeneration (GBR) procedures, allowing circumferential insertion of implants into bone, reduced treatment time, easier execution of procedures and reduced fees. [6]

There are two concerns regarding the effect of angulation on the stress distribution with angled abutment: either there were no significant effect of the angulation, [5,8,9] or there were a significant effect [6,7,10,11,12,13]of the angulation on stress distribution and load bearing capacity. But fortunately even with increase stress distribution angulated abutment fracture strength w physiological bite tolerance force.

MATERIALS AND METHODS

Sample preparation and distribution

Ten analogs with a diameter 3.75×14mm (Leader italia- Italy) were placed into self-cure acrylic resin blocks (Veracril ®, Colombia) in a manner and by using surveyor (Dentalfarm, Torino, Italy) which divided in to 2 groups: group A (n=5) fixed perpendicular to horizontal plane of the resin blocks so as to resemble straight input implant while group B (n= 5) fixed at angulation (17°) to horizontal plane of resin blocks Figure (1)

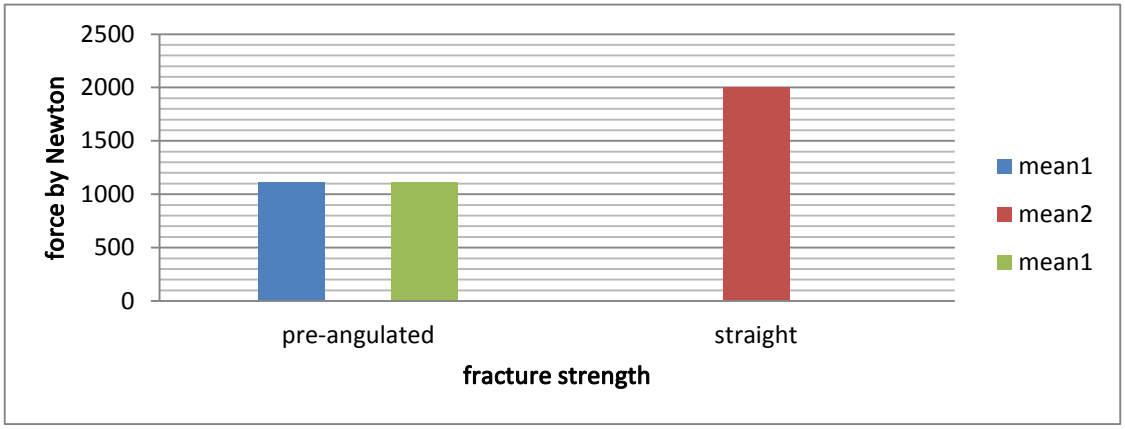

Figure (1): The mean of fracture strength.

Ten prefabricated zirconia abutments (Leader Italia- Italy) have been selected in type of: zircon abutment reinforced by titanium abutment. Five pre-angled (17°) zirconia abutment to the five angulated analogs so as to restore the parallelism of angulated analog & five straight zirconia abutments for straight analogs inside resin blocks. Then the zircon abutments were luted on the metallic base with resin-based dual cure luting material (multilink implant cement - IvoclarVivadent) according to the manufacture instruction, after that all abutments were tightened to 25 N/ cm2 using torque meter (Leader Italia - Italy) and the access or holes of the abutmescrews covered with glass ionomer cement (Equia fill, GC).

After that one straight and one pre-angled (17°) zirconia abutment covered with cercon scan- spray (degdunt scanner spray, K.A.Rasmussen, Norway) so as to improve visual characteristic of the abutment surface. Then both of them scanned inside scanner using software computer aided manufacturing(CAD)(ceramillamanngirrbach motion 2, austria&germany). Ten full anatomic zircon crown (ceramillzolid ,aminngirrbach, austria&germany) deigned as upper right central incisor and milled using same computer aided manufacturing machine (CAM)(ceramillamanngirrbach motion 2, austria&germany) five of them were placed on the straight abutmentsand 5 on pre-angled (17°) abutments. after milling before sintering a shallow groove of 4 mm diameter and 0, 6 mm depth by using special bur (ceramillroto, 0, 6 mm, aminngarbach) was prepared on the palatal surface of the crowns 2 mm below incisal edge to retain the pin load and prevent slipping during load application. All 10 crowns after milling were sintered by sinteringfurnace(amanngirrbachceramilltherm,austria& germany) for duration of (8) hours at 1450 C°. The samples were randomly distributed into two groups mentioned before.

The inner surface of all crowns conditioned and treated with 9.5 % buffered hydrofluoric acid gel (Choice™ 2, Bisco) andluted with resin-based dual cure luting material and fixed to the zircon abutments of the both groups Figure (2,3).

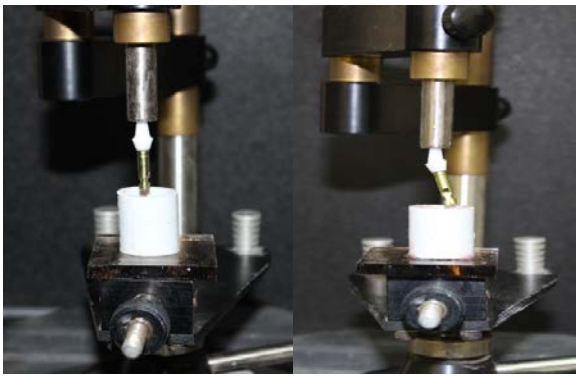

Figure (2): Placement of specimens via surveyor (a) straight (b) angulated implant abutment.

Figure(3): Prefabricated zircon abutment covered with all zircon CAD\CAM crown.

Then all samples were passed to artificial aging using thermo cycling machine(14)five hundred cycles at (5 to 55 C°±2).

Fracture strength testing

A special sample base was constructed to hold each sample under pin load of universal testing machine (WP universal material tester, 20 KN, gunthamburg) at 30 degree angulation to the long axis. The samples fixed inside the base and the load was applied via stain less steel pin load (4mm) head ball on the crown directed to the groove which control the direction of the force to the implant apparatus Figure (4)

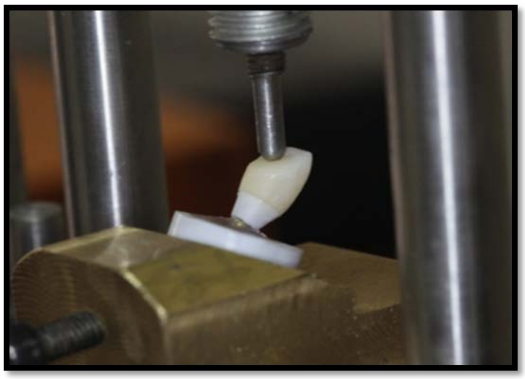

Figure (4): Specimens under pin load inside universal testing machine.

The load started from zero and increased manually and gradually until fracture occurred then the fracture strength recorded, the data were collected and analyzed with SPSS version.

RESULT

Mean fracture strength of the prefabricated straight zircon abutment was (2000) N, while for the pre-angled (17°) group was (114.00) N .Statistical analysis showed that the implant abutment angulations significantly reduced the fracture resistance of zircon implant abutment ($p < 0.05$) see Table (1).

	No.	Mean	Std. deviation	t	Df	p-value
Straight	5	2000.00 N	331.813	4.606	8	0.002
Pre-angled	5	114.00 N	273.642			

DISCUSSION

To resemble the clinical oral environment the prefabricated abutments were covered with full zircon crown and stimulated clinical measurement of upper right central incisor.

Unfavorable inclination of implants is a common problem that may compromise esthetics, phonetics, and function of the implant-supported fixed prosthesis. Standard angulated abutments are available from most implant manufacturers. Deflections and stress concentrations generally increase with an increase in either the magnitude or angle of the load.[11]

The results of our invitro test showed that the angulation of 17° pre-angled straight implant abutment significantly affect the fracture resistance of the zirconimplant abutment, i.e.: with increasing angulation in anterior maxilla there will be decreasing of fracture strength of abutment. This may be due to force transmission consideration, because during applying force up on straight abutment, most of the applied force will transmit to the implant body and surrounding bone, while with 17° pre-angled the same amount of force cannot be transmitted as straight one leading to stress generation inside abutment which may lead to decreasing of fracture resistance of angulated abutment.

The result of this study come in agreement with the following study:Saab *et al.*, [15]in their 2-dimensional finite element models predicted a 15% higher maximum bone strain for a straight abutment compared to an angled abutment. The results of their study suggested that using an angled abutment, compared to a straight abutment, and may decrease the strain on the bone when restoring implants in the anterior maxilla. K.Tian*et al.*,[7] with FEA recognized that angled abutments could result in decreased stresses on the surrounding bone of dental implants when implants are not placed in an ideal axial position and had a significant effect on the stress and strain distribution pattern of the implant system.Cavallaro and Greenstein 2011conducted that angled abutments result in increased stress on the implants and adjacent bone. These increased stresses usually are within physiological tolerance.

Hsu *et al.*,[13] in their 3D finite element analysis of occlusal force at varies angle concluded that: the maximum EQV stress\strain imported to bone increased linearly with an increase in the angle off-axis loading. Cho *et al.*,[16]concluded that the Fracture strengths under vertical loading were greater than those under oblique loading. Nothdurft*et al.*,[9] disagree in estimated effect of angulation on load-bearing capacity and they concluded that compensation for angulated implant positions with an angulated zirconium abutment is possible without reducing the load-bearing capacity of implant-supported single crowns.

CONCLUSIONS

Within the limitation of this in vitro study it may be concluded that: the fracture strength of zircon implant abutment supported CAD\CAM zircon crown is significantlyreduced in respect to the angulation from straight to angulated (17°) zircon abutment.

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