

دراسة تقييم تحضير الأسنان المعدّة لاستقبال جسور ثابتة باستخدام ماسح ثلاثي الأبعاد دراسة مخبرية

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ملخص

خلفية البحث وهدفه: يتعلق النجاح طويل الأمد لأي تعويض سني ثابت بتحضير الدعامة من حيث الثبات والاستقرار. هدفت هذه الدراسة لتقييم ميلان جدران الدعامات و التوازي بين الدعامات لجسور خلفية على أسنان معدّة لاستقبال تعويضات ثابتة.

مواد البحث وطرائقه: قِيمَتِ الدراسة بتقييم الأمثلة الجسبية النهائية لخمسة وعشرين جسراً خلفياً يحتوي كل منها على دعامتين من أعمال سريرية لطلاب في كلية طب الأسنان في الجامعة الدولية للعلوم و التكنولوجيا في دمشق . مُسِحَتْ 50 دعامة باستخدام ماسح سني ثلاثي الأبعاد Ceramil Map 100 dental 3D scanner من شركة Aman Girrbach, Vorarlberg, Austria . استُخْدِمَ برنامج حاسوب للعرض ثلاثي الأبعاد MiniMagics2.0 لفحص الدعامات و قياسها على شاشة الحاسوب. قِيسَ تقارب الجدران لكل دعامة و كذلك التوازي بين الدعامات في كلا الاتجاهين الإنسي الوحشي و الدهليزي اللساني.

النتائج: بيّنت الدراسة أنّ الدعامات لم تكن متوازية بالاتجاه الإنسي الوحشي بمتوسط قدره 10.63 درجة. أمّا في الاتجاه الدهليزي اللساني فالدعامة لم تكن متوازية بمتوسط قدره 7.24 درجة. هذا الفارق ليس ذا دلالة إحصائية $P=0.137$. بلغ متوسط ميلان الجدران للدعامة الأمامية لكل جسر 19.56 درجة في الاتجاه الإنسي الوحشي، و 21.32 درجة في الاتجاه الدهليزي اللساني. أمّا في الدعامة الخلفية فكان متوسط ميلان الجدران أكبر ممّا كان عليه في الدعامة الأمامية (الموجودة إلى الإنسي من الفقد التي تكون عادة ضواحك أصغر من الخلفية) بكلا الاتجاهين، و بلغ 25.14 درجة، و 28.44 درجة على الترتيب. هذا الفارق دال إحصائياً $P= 0.004$.

الاستنتاجات: إنّ قيم ميلان جدران الأسنان المحضرة في هذه الدراسة متقاربة مع دراسات سابقة، إلّا أنّ الدعامات الخلفية كانت مفرطة الميلان بمعظمها، كما أنّ الدعامات بمعظمها لم تكن متوازية. توصيات: على طبيب الأسنان أن يحاول تقليل إمالة جدران التحضير عندما يكون الفقد طويلاً و الدعامات قصيرة.

*مدرس في التعويضات الثابتة في الجامعة الدولية للعلوم و التكنولوجيا في دمشق

A Study To Evaluate Tooth Preparation Of Teeth Prepared To Receive Fixed Bridges Using 3D Scanner, In Vitro Study.

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Abstract

Background and Aim of study: The long term success of any fixed partial denture is related to the proper retention and resistance form of the abutment teeth. This study aimed to evaluate the abutment's taper and parallelism of some posterior abutment teeth prepared clinically to receive fixed partial dentures using a 3D scanner.

Materials and methods: The final casts of twenty five posterior bridges each containing two abutments were the subject of this study. A total of 50 dies were scanned using Ceramil Map 100 dental 3D scanner (Amann Girrbach, Vorarlberg, Austria). A 3D viewer software (MiniMagics2.0) was used to examine and measure the abutments on the computer screen. The wall taper of each abutment and the abutment's parallelism in both bucco-lingual and mesio-distal directions were measured.

Results: The abutments were not parallel in mesio-distal direction by an average of 10.63° while in the bucco-lingual direction they were not parallel by an average of 7.24° ; this difference was not statistically significant ($P=0.137$). The average taper of the anterior abutment of each bridge was 19.56° in mesio-distal direction and 21.32° in bucco-lingual direction. In the posterior abutments the average taper in both directions was more than that on the anterior teeth, 25.14° and 28.44° respectively, and the difference was statistically significant ($P= 0.004$).

Conclusion: The taper of the prepared teeth in this study were comparable to the values reported in earlier studies. However, the posterior abutments were mostly over tapered. In most cases, parallelism between the abutments was not achieved.

Recommendations: The dentist should attempt to decrease the taper of tooth preparations when the span is long and the abutments short.

Key words: 3D scanner, abutment taper, total occlusal convergence, tooth preparation evaluation.

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Introduction and review of literature:

The long term service of any fixed dental bridge depends on the retentive and stability form of the supporting abutment teeth.

In Fixed Prosthodontics, the practitioners are instructed to prepare the teeth with minimal abutment taper and maximum abutment parallelism¹. This type of preparation will ensure better retention² of the bridge on the supporting teeth. The retainers will have more frictional fit over the prepared teeth³, and the long term service of the bridge will be drastically improved⁴. However, some studies have shown that in clinical circumstances, the abutment preparations are not ideal. Actually they may differ from the requested norms to a certain degree⁵⁻⁶.

The clinically achieved surface taper of the abutment teeth and the parallelism amongst the abutment teeth depend on many controllable and non controllable factors. The operator's position is controllable and plays an important role in the access of the practitioner to the prepared tooth surface⁷. The use of special paralleling devices may help to better control the preparation procedure⁸⁻⁹. Special burs have been invented in order to better prepare the abutment teeth¹⁰. The experience of the clinical supervisor and the manual dexterity of the student have been shown to play an important role in the quality of the abutment preparations¹¹⁻¹². On the other side, some local uncontrollable factors such as tooth position and the initial tooth shape may complicate tooth preparation, especially in the posterior region of the oral cavity¹³.

The taper of a single crown preparation has been studied extensively in the dental literature. On study has used Shadowgraphs to measure the taper of the abutments⁵. Another study has used Tool Maker Microscope for the same purpose¹⁴. Goniometric microscope¹⁵, paper prints from a scanner¹⁶, CAD CAM database¹⁷, 3D laser measuring device⁸, and the shadow casting of the prepared die were used to evaluate tooth preparation. A summarized table of the values obtained in some of these studies is presented in a

study by Al Ali et al¹¹.

Studies on abutment parallelism in the dental literature are rare. In a preclinical setting, Nishida has assessed the abutments' parallelism after using a special device⁸. Al Omari et al measured the abutment parallelism of the student's clinical preparations using shadowgraphs in a mesio-distal direction¹⁸. One recent study has used a microscope to assess the abutment parallelism from an occlusal view¹⁹.

Aim: This study aims to evaluate the abutment taper and parallelism of tooth preparation using 3D scanner in all directions.

Materials and Methods:

A sample of 25 master cast models was randomly collected from a clinical setting after bridge fabrication and cementation. Each model had two posterior abutments with a single tooth loss to be restored with a metal- ceramic 3 unit fixed- fixed prosthesis. The abutment dies were scanned in a CAD-CAM privet dental laboratory (Kawak dental lab, Damascus City). Each cast was sprayed with a reflecting agent then scanned using a calibrated 3D scanner, Ceramil Map 100 (Amann Girrbach, Vorarlberg, Austria). The three dimensional shape of the abutments was stored in an exportable Standard Tessellation Format (STL) file. A special free software MiniMagics 2.0(Materialise Inc.) was used to open the abutments' files. This software enables the investigator to navigate through the preparations and measure the taper of each axial wall to the nearest degree.

Measurements:

Taper: For every abutment, the inclination of each wall toward the long axis of the tooth was measured. The total occlusal convergence which represents the addition of the taper of each two opposing walls in both directions (mesio distal and bucco lingual)has been calculated.

Parallelism: The bisecting angle of the total occlusal convergence for each abutment has been considered to be the long axis of the prepared abutment. The parallelism or more precisely the

lack of parallelism, between any two abutments has been expressed by the absolute difference between the axes of the abutments in mesio distal plane. Fig 1; and in bucco lingual plane. Fig 2.

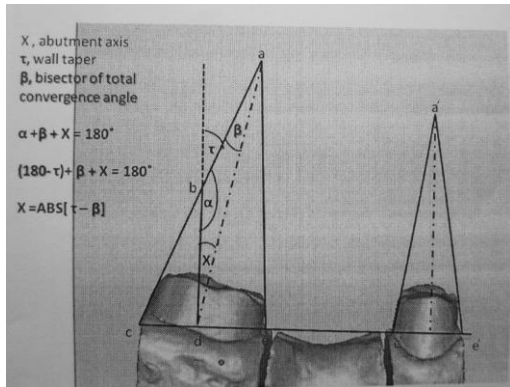


Fig1: Representation of the mathematical equation used to calculate the abutment long axis and parallelism between the abutments. x, the abutment axis inclination over the horizon (the dot- hyphenated line) expressed in degrees; t, the wall taper expressed in degrees; B the bisector of the total convergence angle.

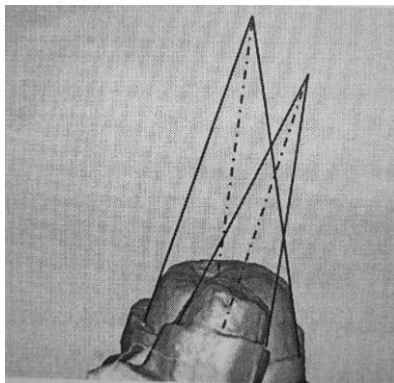


Fig 2: lack of parallelism between two abutments in bucco-lingual plane.

To calculate the measurement error, ten samples were measured again to obtain the parallelism degree of each bridge. The average difference between any two repeated parallelism degrees measurements of the same sample was 1.6°, and the standard deviation 1.02°.

The average taper of each abutment tooth in both

directions and the inter abutment s' parallelism were calculated and tested for statistical significance using Excel software.

Results:

The average taper and parallelism values of both anterior and posterior abutments in mesio-distal and bucco-lingual directions together with the standard deviations, and minimal and maximal values are presented in Table 1.

Table 1: The average total occlusal convergence (TOC) for both the anterior and posterior abutments and the inter abutment deviation (IAD) in both directions.

Tooth	Mean	SD	Min.	Max.
TOC(°)				
Anterior abutment(mesio-distally)	19.56	8.78	5	44
Anterior abutment(bucco-lingually)	21.32	6.54	10	34
Posterior abutment(mesio-distally)	25.14	9.4	4	44
Posterior abutment(bucco-lingually)	28.44	12.51	1	52
IAD(°)				
Mesio-distally	10.63	9.91	0.5	33.5
Bucco-lingually	7.24	5.14	0	17.5

The average IAD in the mesio - distal direction 10.63° was greater than the average IAD in bucco-lingual direction 7.24° but the difference wasn't statistically significant (P=0.137).

The average TOC of the anterior abutments in mesio-distal direction was 19.56° and in bucco-lingual direction was 21.32°. The average TOC of the posterior abutments in mesio - distal direction was 25.14° and in bucco-lingual direction was 8.44°. Table 2 compares the TOC of the anterior and posterior directions in terms of statistical significance. It shows that the average TOC of the posterior abutments is significantly greater than the average TOC of the anterior abutments both in mesio-distal and bucco-lingual directions.

Table 2: the TOC of the anterior and posterior directions in terms of statistical significance. *, statistically significant difference at P <0.05.

	Anterior abutment(MD)	Anterior abutment(BL)
Posterior abutment (BL)	0.000541*	0.044224*
Posterior abutment (MD)	0.000697*	0.001657*

Discussion:

This study showed that the abutment teeth prepared by the students, in general, were not parallel. However the inter abutment deviation average in the mesio - distal direction 10.63° was not far from the average obtained in the study of Al Omari et al ¹⁸ showing that the preparations of the students in this study are comparable to other faculties. In this study, the 3D scanning method used to evaluate the taper and parallelism of the prepared teeth allowed the evaluation to be done in both bucco-lingual and mesio distal directions. This permits more detailed evaluation of tooth preparations.

The results show that the posterior abutments prepared in this study are significantly more tapered, in both mesio-distal and bucco-lingual directions, than the anterior abutments. This finding suggests that students tend to over tilt the axial walls, of the less visible and more difficult to access, posterior abutments.

The taper and parallelism averages obtained in this study are much higher than those obtained in the study of Nishida ⁸ which has been done in a preclinical setting on phantom heads. This may

reveal the difficulties encountered by the practitioner when trying to accomplish the desired wall taper and parallelism clinically. Recently automated tooth preparations using 3d assisted robots has been developed.²⁰ This promising technique may reduce the subjective variations in the dental clinics during crown preparations. Additionally, 3D scanner has been used successfully in a recent study to evaluate the marginal discrepancy between crowns and margins in tooth preparations.²¹ The functional occlusal landmarks of the provisional restorations has been also designed using intraoral 3D scanner as an attempt to digitalize the dental clinic.²² It should be mentioned that the type and resolution of the scanner plays an important role in the precision of the scans.²³

Conclusion:

The 3D evaluation tooth preparations clinically revealed that the taper and parallelism of the abutment teeth are comparable to those obtained in other studies. However, the clinicians should be warned not to over- taper the posterior abutments of the fixed bridges and to spend more effort to prepare the abutments parallel one to the other.

Recommendations: The dentist should attempt to decrease the taper of tooth preparations when the span is long and the abutments short.

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