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Evaluation of the impact of optical magnification on the precision of tooth preparation for laminate veneers.

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Abstract: ***Introduction:*** *The preparation in prosthodontics and especially in dental laminate veneers is very technically demanding.. Magnification improves the ability of the eye to resolve details and allows the clinician to see greater than it is possible with the eye alone.* ***Aim:****The study is to evaluate the impact of optical magnification on the precision of tooth preparation under simulated clinical conditions in digital manner.* ***Material and methods:*** *40 plastic upper left incisors are divided into 2 groups- prepared with naked eye and with compound loups. Laboratory scanning device is used to scan the teeth both before and after the preparation and digital measurements are done to evaluate the accurateness of tooth preparation depending on the magnification.* ***Results:*** *The results show statistical difference in precision between naked eye and optical magnification.* ***Conclusion:*** *The preparation under magnification of loups is much more precise. Even though, in both groups the quantity of cut tissues it more than the supposed quantity which may affects the quality of the adhesive bond.*

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I. Introduction

The preparation of enamel and dentin in prosthodontics is very technically demanding and especially in dental laminate veneers, where minimal invasive manner matters. Many factors determine the final outcome of the treatment and one of the most basic one is the quality and accurateness of prepared structures.

Bonded dentistry considers restorative margins as the key of successful restorations with longevity. Margin preparation and outline for a veneer preparation can also be perfected with thorough precision under the scope. (1)

Carr reported that the human eye, when unaided by magnification, has the ability to resolve or distinguish 2 discrete lines or objects separated by a space of 200 μm (0.2 mm). Clinically, most dental practitioners are not able to see an open margin smaller than 0.2 mm. Magnification improves the ability of the eye to resolve these objects, and allows the clinician to see greater detail than is possible with the eye alone. For example, 2x magnifiers such as telescopic loupes improve resolution to 100 μm, and 4x loupes improve the resolution of the human eye to 50 μm, or 0.05 mm. (2) In the 20th century the clinical application of magnification- loups and operating microscopes is widely spread all over the world.

Compound loupes or telescopic loupes consist of multiple lenses with intervening air spaces, thus allowing adjustment of magnification, working distance, and depth of field without increase in size or weight (1). Their magnification range is from 2x to 8x. Typically, loupes require some form of illumination from an accessory headlamp for adequate visualization of the operating field, especially in cases with magnification greater than 3.5x. (3)

Less expensive and initially easier to use since they are head mounted, loupes tend to be less cumbersome in the operating field. (1)

Leiknius and Geissberger have shown that loupes' magnification when used by dental students, helped reduce errors in preparation design and laboratory processing by half when compared to a control group not using magnification. (4)

II. Aim

The purpose of the study is to evaluate the impact of optical magnification on the precision of tooth preparation under simulated clinical conditions. The null hypothesis was that magnification has no influence on the precision of tooth preparation.

III. Material and methods

1. Tooth preparation

For the test specimens 40 plastic upper left incisors are divided into 2 groups (n= 20): 1st group- teeth prepared with naked human eye.; 2nd group -teeth prepared using compound loupes (Rose Microsolution, USA) under x2,5 magnification (fig 1).

To minimize the influence of technical sensitivities in the fabrication of the prostheses and to standardize their volume and size, one dentist prepared all the specimens and there was standardization of the preparation design as follow: shoulder marginal finish shape preparation with incisal reduction, cut of the tissues by 0,3mm at the cervically, by 0,5mm at the middle third of the clinical crown and 1,00mm incisal reduction. The operating dentist performed tooth preparations two different days in the same part of the day.

Figure no 1: Veneer preparation on plastic teeth with magnifying loups x2,5

Three types of turbine burs are used: depth cutter with depth of preparation 0,3 mm and 0,5 mm; a cylinder bur with beveled tip shape to avoid generation of under- cuts during tooth preparation and a superfine diamond bur with red coloring (Axis Dental, Switzerland).

The preparation begins with marking the depth of preparation in three planes: for cervical area a depth-cutter 0,3 mm positioned parallel to the area; for middle third – depth-cutter 0,5 mm positioned parallelly; for the incisal edge – cylindric bur with rounded tip ∅ 1,0 mm, positioned perpendicularly to the edge. The cut fissures are colored with a marker. Using a cylindric bur the buccal wall and the incisal edge are fully prepared up to the chosen depth. The preparation ends with finishing and smoothing the walls with superfine diamond bur (Fig.2)

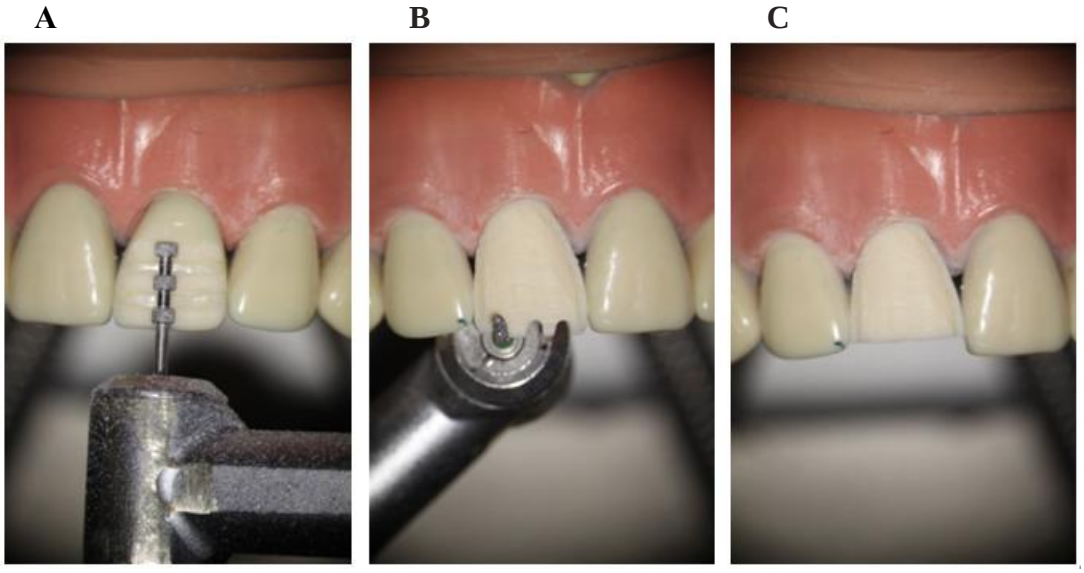

Figure no 2: Steps in the preparation for veneer: A/ buccal wall; B/ incisal edge; B/ finished preparation.

Laboratory scanning device is used to scan the teeth both before and after the preparation (Wieland D800 (Ivoclar Vivadent Group, Germany) (Fig.3). Computer- aided design (CAD 3Shape Trios) software is used to overlay the outlines of the teeth it the three groups. A sagital plane is constructed throughout the digital teeth images and measurements of cut hard dental tissues in cervical, middle and incisal part are performed. These measurements are to evaluate the accurateness of tooth preparation with the following magnification according to the pre-established parameters (Fig.5)

Figure no 3: Laboratory scanning of an intact plastic tooth.

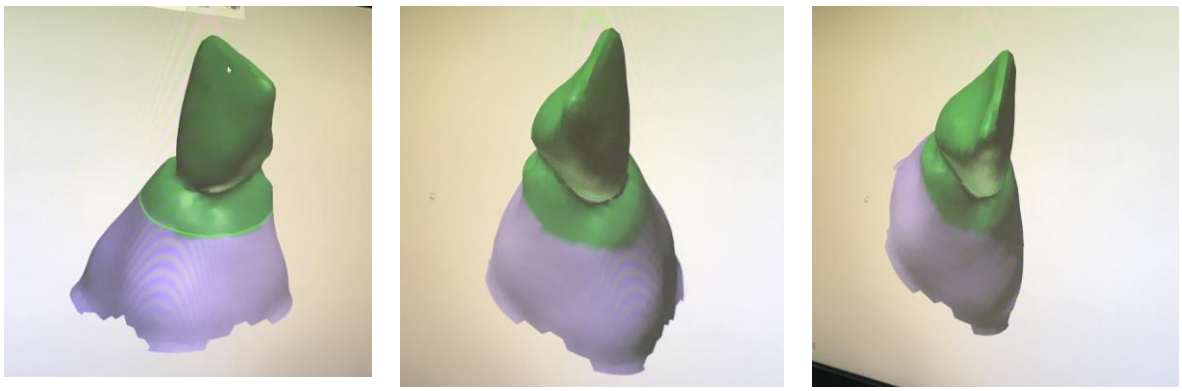

Figure no 4*:* Digital images of an intact tooth.

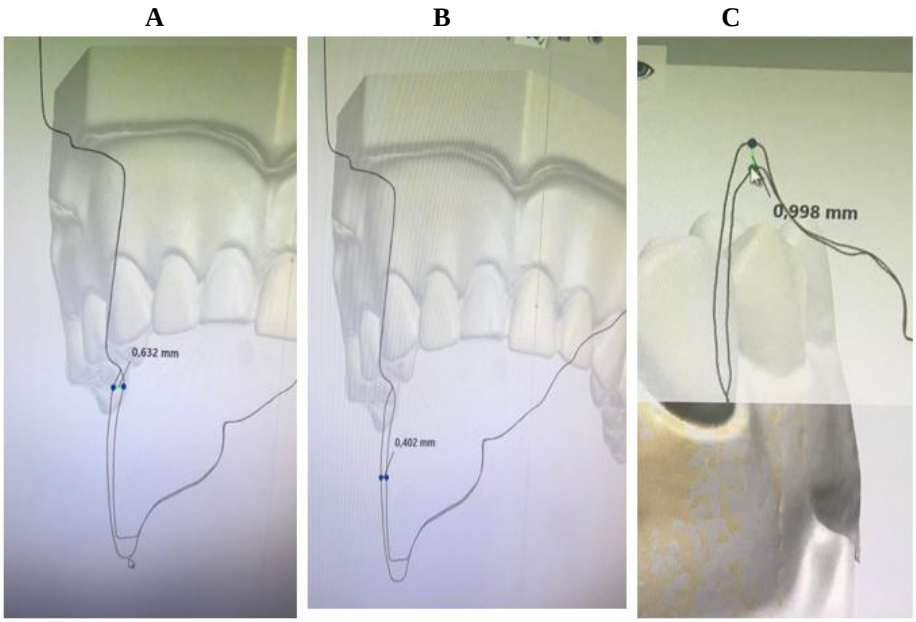

Figure no 5: Measurement of the depth of preparation according to the pre- established parametres: A/ cervical third; B/ middle third; C/ incisal third.

2. Statistical analysis

Descriptive statistics are expressed as mean±SE (standard error). Saphiro-Wilk's test is performed to verify departures from basic assumptions about normality of the data. The comparisons between study groups and baseline depth preparation are performed using one sample t-test. The comparisons between study groups (naked eye vs. loupes) are performed using independent sample t-test. Statistical significance is accepted at $p<0.05$. All statistical computations are made using the IBM SPSS Statistics 22 software package (IBM SPSS Inc., Chicago, IL, USA).

IV. Results

The descriptive statistics resulted in tooth preparations with naked eye (Fig. 7) mean for the cervical third of 0.57±0.03mm, for the middle third 0.67±0.04 mm and for the incisal edge 1.22±0.04mm and with magnifying loups (Fig.8) mean for the cervical third of 0.47±0.02mm, for the middle third 0.55± 0.02 mm and for the incisal edge 1.10±0.02 mm.

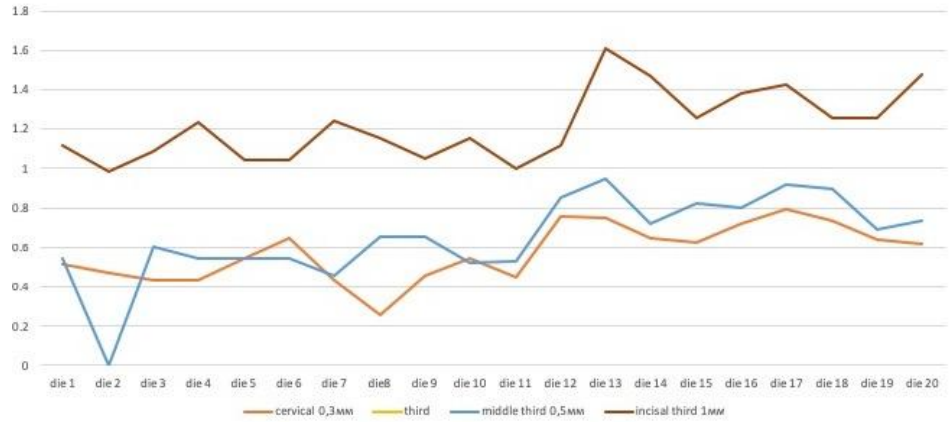

Fig. 7 Chart no magnification

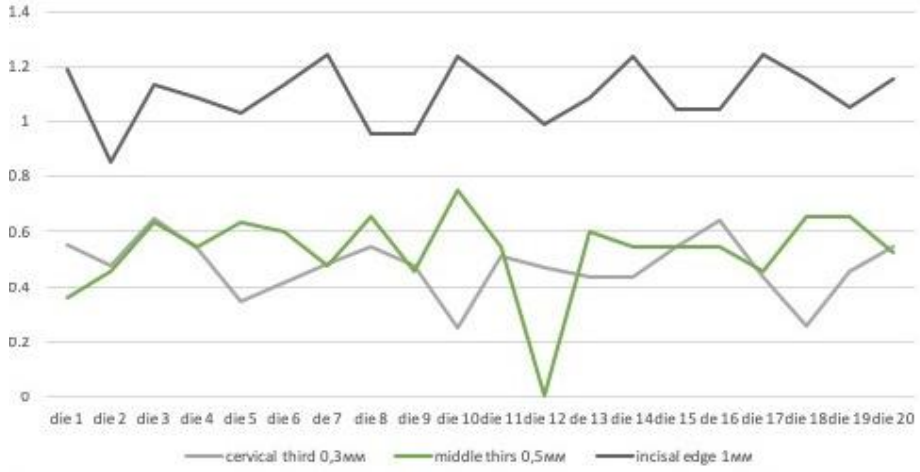

Fig.8 Chart loups

One sample t-test proved statistically significant difference between mean values of preparation done with naked eye for all areas and for all baseline depths of preparation: cervical third 0.3mm vs. baseline 0.3mm ($t=8.56$, $p=0.00$), middle third 0.5mm vs. baseline 0.5mm ($t=4.92$, $p=0.000$), and incisal third 1mm vs. baseline 1mm ($t=5.54$, $p=0.000$). Similar results are obtained between mean values of preparation done with loupes for all areas and for all baseline depths of preparation: cervical third 0.3mm vs. baseline 0.3mm ($t=7.34$, $p=0.00$), middle third 0.5mm vs. baseline 0.5mm ($t=2.60$, $p=0.018$), and incisal third 1mm vs. baseline 1mm ($t=3.98$, $p=0.001$).

There is statistically significant difference between groups in mean values of preparation as follows: (1) in incisal area between naked eye (1.22±0.04mm) vs. loupes (1.10±0.02mm) $t=2.54$, $p= 0.015$ and (2) in middle third between naked eye (0.67±0.05mm) vs. loupes (0.55±0.02mm) $t=2.89$, $p= 0.006$.

Hence, there is statistical difference between the preestablished volume of preparation and the actual cut of hard dentinal tissues no matter the magnification.

V. Discussion

In the preparation with naked eye much more dentinal tissues are cut than needed and there is a great chance for exposing dentin. This is controversy to the concept of "minimal invasive approach" we aim to apply and it's going to reflect on the adhesive bond between the indirect restoration and hard dental tissues. In a study from 1992 Ferrari et al measure thickness of enamel in cervical area 1 mm above the cement- enamel junction from 0,17mm to 0,52mm (8). The conclusion is in cervical area dentin would be exposed. But in this delicate zone this dentin exposure may be critical for long lasting bonding of veneers.

Statistically significant difference is proven between precision of preparation in the group with naked eye and the group with loups. This corresponds with the results of many authors working in the field. An in vitro trial comparing preparation of Class II with loupes and without loups (9) revealed that cavity preparations are better under magnifying loupes than without loupes, with a statistically significant difference as per kappa values (0.64 with loupes and 0.76 without loupes) and Chi-square value (8.01). While evaluating the quality of tooth preparation around 80% of the cavity preparations was categorized "satisfactory" with the loupes as compared to 20%, which were categorized "nonsatisfactory". This could be due to the use of loupes to provide greater detail of the oral cavity with better, clearer vision of the operating area, thereby reducing eyestrain, but do so without the need to be closer to the patient.

Similar studies conducted by Buhrley *et al*., Farook *et al*. and Maggio *et al*. showed that working with the magnifying loupes is always better. Loupes not only influence the musculoskeletal health of the professional but also help improve the quality of the treatment. (10), (11), (12)

The preparation quality improves through the usage of magnifying loups. The ability to work with a high level of accuracy and improved control reduces treatment time and reduces operator fatigue. (13).

VI. Conclusion

The preparation under magnification of loups is much more precise. Even though, in both groups the quantity of cut tissues it more than the supposed quantity which may affects the quality of the adhesive bond.

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