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The Influence of Using Rotary and Ultrasonic Instruments on The Surface Roughness of Finishing Line and Marginal Adaptation In Metal-Porcelain Restoration

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Abstract

Fixed dental prostheses that is still popular today is metal-porcelain restoration due to its strength and affordable price and indicated more to the cases that require strength and longevity. One of the important procedure in making porcelain metal restorations is dental preparation. Rough surface preparation especially finishing lines can cause the adaptation of the restoration to the tooth thatis reduced and cause the formation of gaps on the tooth surface and restoration. Restoration with an ill fitting causes marginal microleakage and risk of secondary caries, thus causing failure in making metal-porcelain restorations. The smooth surface of the gingival margin has an important role in maintaining the accuracy at the clinical and laboratory stages. A smooth surface with good finishing line contours can help in getting good clinical impression. At the laboratory stage, it allows porcelain lift-off from the dye and eliminates unsupported tooth structure, which can rupture from the dye causing disruption during fixing, as well as marginal gaps. Smooth finishing line can increase surface wettability when cementing to avoid the formation of cracks, margin leakage, and dissolved cement which can cause caries and restoration failure. Ideally, after preparation, the surface of the preparation results should be smoothed. Surface finishing of preparation can be done with rotary or ultrasonic instruments. The purpose of this research was to determine the effect of the use of finishing instruments: fine diamond bur, tungsten carbide finishing bur, whitestone bur and UDTs finishing kit on the surface roughness of the finishing line and marginal adaptation in metal-porcelain restoration and the relationship between surface roughness of the finishing line using the instrument finishing to marginal adaptation to metal-porcelain restorations. This research type is an experimental laboratory. Overall a total of 40 samples are divided into 2 groups for surface roughness (20 samples) and marginal adaptation (20 samples). Each group was divided into four treatment groups which were prepared using coarse diamond bur followed by finishing with fine diamond bur, tungsten carbide, dura whitestone, UDTs finishing kit. The surface roughness measurement finishing line using the Mitutoyo Surftest Profilometer SJ-310 Series Handheld Roughness Tester, Japan. Measurements were done 3 times at the marked surface points on the sample. The average of the 3 measurements was calculated in µm. The stylus runs 1mm from the external finishing line. Measurement of marginal gap on the metal-porcelain crown is using a stereomicroscope (Zeiss Stereo Discovery, V12, Germany). Four reference lines were made on the tooth, the lines on the tooth wasmid-mesial proximal, mid-distal proximal, mid-palatal, and mid-buccal, with each measurement on the line was done 3 times so that the total measurement in 1 sample was 12 times. Measurement of marginal adaptation with a 12.0x magnification stereomicroscope using a computer with the Axiovision Rail software. 4.8. The results of univariate analysis found that the greatest surface roughness of finishing lines was using a fine diamond bur at 2.32 $\pm$ 0,36 µm, followed by whitestone 2.26$\pm$ 0,35 µm, tungsten carbide 1.72 $\pm$ 1,28 µmand the smallest using UDTs with an average at 1.47$\pm$ 0,25µm.Based on the ANOVA test results, the value of p = 0.001 * ($p < 0.05$) can be concluded that there is a significant influence of the finishing instrument on the surface roughness of the finishing line. The results of univariate analysis found that the greatest average marginal adaptation is using a fine diamond that is equal to 20.60 $\pm$ 7,13 μm, then followed by whitestone instrument 16.91 $\pm$ 2,97 μm, tungsten carbide 13.39$\pm$ 3,31 $\mu m$and the smallest using UDTs, with an average of 6,39$\pm$ 1,22 μm. Based on the ANOVA test results, it is seen that the value of p = 0.001 * (p <0.05), it can be concluded that there is a significant influence of finishing instruments on the marginal adaptation of metal-porcelain restoration. Spearman Correlation Test to determine the strength of the relationship between surface roughness of the finishing line and the marginal adaptation of the metal-porcelain restoration based on the finishing instrument, by looking at the correlation value (r). All instruments were positive for the direction of the strength of the roughness of the surface finishing line and the marginal adaptation of the metal-porcelain restoration based on the finishing instrument, meaning that the greater of surface roughness value, the absolute marginal discrepancy value would also be greater (marginal adaptation metal-porcelain restoration isbad), however significant was the whitestone and fine diamond instruments whose strength was very strong (r = 0.9, p value = <0.05). The research can be concluded that fine diamond which is often used in daily clinical life turned out to produce the highest roughness compared to finishing tungsten carbide, whitestone and UDTs finishing kit. UDTs bur from ultrasonic instruments produce the smallest surfaceroughness finishing line and the best marginal adaptation to restoration (smallest marginal gap) compared to rotary instruments (fine diamond bur, tungsten carbide finishing, and whitestone). UDTs finishing kits are appropriate for daily clinical use especially for sub gingival case preparation because they can produce the smallest surface roughness value and marginal gaps. The ultrasonic movements do not injure the periodontium tissue.

Keywords: Surface Roughness, Finishing Line, Marginal Adaptation, Rotary Instrument, Ultrasonic Instrument

Introduction

The use of fixed dental prostheses is still popular today because metal-porcelain restorations have good strength, everlasting, and are reasonably priced compared to full porcelain[1]. One of the important procedures in the manufacture of porcelain metal restoration is the preparation of teeth[2]. Dental preparation must be in accordance with the principle of dental preparation in order to obtain a good restoration, retentive, and long-term survival [3]. The success or failure of the manufacture of metal-porcelain restoration is determined by factors such as biological, mechanical, and aesthetic considerations. Surface roughness is part of mechanical considerations that can affect the retention and marginal accuracy of restoration [3,4]. The rough surface of the preparation, especially finishing line preparation of teeth can cause difficulties in making aesthetic restoration and have a good position. Ill fittings lead to reduce adaptation to the surface of the teeth, which increases marginal microleakage and the risk of secondary caries, leading to failure in the manufacture of metal-porcelain restoration [5-11].

The smooth surface at the finishing line has an important role to play in maintaining accuracy at the clinical and laboratory stages. A smooth surface with good finishing line contours can help get a good clinical mold. At the laboratory stage, it allows porcelain lift-offs from the dye and eliminates unsupported tooth structures which can break from the dye, causing disruption during fixing, as well as the emergence of marginal gaps. Smooth finishing line improves surface wettability when cementing, thus avoiding gap formation, margin leakage, and cement dissolving that can cause caries and failures in restoration [12].

The initial stage of preparation for the manufacture of dental crowns using coarse diamond bur with reduction of labial or buccal parts of 1-1.5mm, aspect of ≥ 1.2mm, cusp buccal and lingual by 1.3-

1.7mm, and central pit of 0.8-1.2mm, and lingual aspect reduced by ≥ 0.6mm [13]. Ideally after preparation, the surface of the preparation must be smoothed. Research suggests that the use of high-speed diamonds bur will produce a very rough enamel surface[14]. All finished preparations proved effective for smoothing the surface equivalent to enamel before preparation [15].

Smoothed surface preparations can be done with both rotary and ultrasonic instruments. Rotary instruments work with rotational movements, where the advantage is a short working time, thereby improving patient comfort and efficiency for dentists. However, this instrument produces a rough surface. Meanwhile, ultrasonic instruments work with oscillation movements resulting a smooth finishing line [8,9].

In 2011, Horne et al examined the roughness of finishing line surfaces finished with rotary instruments (bur end cutting fine grit) and Ultrasonic Diamonds Tips (UDTs) with finishing kits (Perfect Margin Shoulder/ PMS 1, 2, 3) and examination under a light microscope showed the finishing line with ultrasonics looked smoother. Ellis et al in 2011 also examined the roughness of the finished preparation surface with complete finishing (PMS 1, 2, and 3) and partial finishing (PMS 1 and 2) to identify the effects of ultrasonic tips of PMS 3. The results showed that complete finishing increases the disposal of smear layers and opensdentinaltubules which increases mechanical bonds by forming resin tags [9].

Sous et al, 2009 states the use of ultrasonic instrument smooth tips produces greater surface roughness compared to red fine diamond rotary instruments, but ultrasonics produce a sharp, clean and clear finishing line[16].

CortecVaz's research (2013) stated that the use of ultrasonic tips increases the surface roughness compared to finishing with diamondsbur. Laufer et al (1996) stated that based onScanning Electron Microscope(SEM), ultrasonic instruments produce rougher surfaces than preparations with red fine diamonds [17]. Clarke et al, 2015 also examined the roughness of finishing line with various instruments and found that UDTs produce rougher surfaces followed by bur tungsten carbide (8/12 blade), bur dura whitestone, bur fine diamond (25 µm). In addition, tungsten carbide produces chipping on enamel. Fine diamond burcauses the damaged finishing line due to the hardy of diamond particles. Clarke stated that dura whitestone is the most effective instrument to use because it can provide cutting efficiency and reducing the risk of damage to finishing line [12].

Shillingburg et al also stated that whitestones and fine cuttle disks produce the smallest margin gaps and the smoothest surfaces in gold and enamel. According to Theuniers et al, the elastic aluminum oxide fibers of dura whitestone can smooth the preparation surface to a certain degree. Theuniers stated that the diamond bur produces the largest surface roughness compared to dura whitestone and is followed by the smoothest carbide finishing bur [19]. Shafiee's research, et al (2015) showed no significant difference in surface roughness obtained between whitestone and tungsten carbide bur 12 flutes (fine) but the use of carbide tungsten bur is more recommended because it has faster cutting power. Tungsten carbide bur16 blade / fine produces a smoother surface compared to diamond bur (46 µm) / fine, while in tungsten carbide bur 30 blade / ultrafine there is no difference in surface roughness compared to extra and ultrafine diamonds bur (25 and 8 µm) [20].

Iovan research (2017) showed that diamond bur perform grinding action while finishing carbide doing cutting action. Scratches from carbide bur are superficial, non-constant, no grooves are deep and wide. Finishing with extra fine carbide shows a clear demarcation line between the enamel and the flattened perikymata area due to bur cutting action. In this area, the bur smoothedthe enamel without scratching it. At high magnification, finishing with ultrafine carbide bur produces margins with almost no scratches at all [21].

Price and Sutow (1988) stated that tungsten carbide finishing produces smoothness of finishing line surface compared to fine diamondbur, but since carbide produces chipping at margins, this research suggests the use of fine diamonds with an acceptable finishing line on all parts of the surface. Attar, et al (2013) stated that finishing carbide bur (no cross cut) produces smooth finishing line compared to tungsten carbide bur (crosscut) and fine diamondbur[22].

Ayad, et al (1996) examined the roughness of the rotary surface of diamond instruments, tungsten carbide finishing, and carbide tungsten with profilometer, stating that carbide tungsten finishing produces the best smoothness of performance. In 2009, Ayad et al examined again that three bur and found carbide tungsten finishing produced the best marginal adaptation with the smallest marginal discrepancy. This result is different from Tuntiprawon research (1999) stated that there is no significant difference between marginal adaptation to surface roughness in coarse and fine diamond bur [4,10].

Marginal gaps can be reduced by loweringthe surface roughness value [23]. Marginal adaptation is influenced by the type and compressibility of cement, as well as surface roughness. Other influencing factors such as how well restoration is attached to the preparation surface, how effective the cement is used, and the adhesive characteristics isused to attach therestoration to the tooth [24]. Ideally the marginal gap between fixed dental prostheses and finishing line is 0 µm [23]. According to the literature review, acceptable marginal gaps range from 25-40 µm [25]. McLean et al (1917) stated that the maximum tolerable marginal gap is120 µm, but Sadaf (2011) stated that above 50 µmis unacceptable and can lead prob insertion into the gap. According to the American Dental Association (ADA) specification no. 8 states cement thickness for restoration should not exceed 25 µm when using type I cement or not exceed 40 µm when using type II cement[26].

Despite the development of finishing instruments in smoothing the preparation surface, existing research till now still raises dissent. Because of these differences of opinion, the researchers wanted to conduct research to find out the roughness of the finishing line surface and the marginal adaptation of the teeth that are prepared with fine diamondbur, carbide tungsten finishing bur, whitestone, and UDTs as well as instruments that produce the smoothest surfaces and the smallest marginal gaps in order to be applied in clinical use.

Materials and Methods

This type of research is experimental laboratory with post-test only control group design. The sample is the original teeth of patients aged 15-30 years who will undergo orthodontic treatment where the treatment plan requires maxilla premolar tooth extraction, with the criteria for inclusion of the subject willing to be sampled by signing informed consent, caries-free teeth or fillings, no crack lines and wear on the teeth, no discolorization, and teeth collected within a period of 3 months (November 2019 - January 2020). Exclusion criterias are anomalies in the anatomical form of teeth or dental structure (amelogenesis imperfecta), as well as subjects who are not willing to use their teeth to be used as research samples. The selection of research samples is conducted by purposive sampling method through numerical analytics research formulas are not paired :

$$n = \frac{2\sigma^2 (z_{1-\alpha/2} + z_{1-\beta})^2}{(\mu_1 - \mu_2)^2}$$

$$n = \frac{2\ (0{,}9-0{,}2)^2\ (1{,}96 + 0{,}84)^2}{(2{,}3-0{,}9)^2}$$

$$= 3{,}92$$

Description

n = minimum sample size required in one group

$Z_{1-\alpha/2}$ = normal default derivate for alpha, α= 5 % (1.96)

$Z_{1-\beta}$ = normal default derivate for beta, β=20% (0.84)

μ1-μ2 = minimum difference in average considered meaningful

σ = variance or standard deviation combined from previous research (Clark, 2015)

The minimum sample required for each group is 4 samples, but to avoid bias or damaged samples, the required sample size is added for each group to 5 samples with the total number of samples are 40.

The sampling of the research was carried out in the Laboratory of the Department of Prostodonsia Faculty of Dentistry -Universitas Sumatra Utara (USU). The samples were divided into surface roughness groups and marginal adaptation groups. The two groups weredivided into 4 groups based on the finishing instruments used. The control group in this study is fine diamond because it is a standard reference procedure and is recommended for the use of prosthodontics text book.

The freshly extracted tooth sample is soaked in saline solution, then planted with a cemento-enamel junction (CEJ) of 1 mm above the mesial proximal and distal in acrylic resin size 1x1x1.5 cm. One week before preparation the entire sample is soaked in artificial saliva to simulate the state of the oral cavity (37^{0}C).

In the surface roughness group, preparations are carried out by cutting the crown of the teeth with a diamond cutting disc bur so all that remains, is the margin of the teeth as high as 3 mm (seen from the buccal and palatal sides) of the limit from the planted acrylic. Preparation removes the entire crown of the tooth so as not to interfere with the movement of the stylus from the profilometer. Preparations were carried out at a depth of about 2 mm with coarse diamond bur (125 µm grit), with a speed of 200,000 rpm and a pressure of 60 -120 g and preparations ending 1 mm above CEJ mesial and distal.

For the marginal adaptation group, the preparations of samples were made for the fabrication of dental crowns using coarse diamond bur (125 µm grit), with a speed of 200,000 rpm and a pressure of 60 -120 g and placed 1mm above the tooth CEJ. Preparation begins with the reduction of the buccal section with a depth of 1-1.5 mm, buccal and palatal cusp by 1.3-1.7 mm, central pit by 0.8-1.2mm, and the palatal aspect by ≥ 0.6 mm.

After the preparation of teeth is completed, in each group, smoothing the preparation results by:

- Group 1 and 5 with diamond fine finishing bur (74 µm grit) at 200,000 rpm and pressure 60-120 g
- Group 2 and 6 with non cross-cut carbide tungsten finishing bur (12 blades) at 200,000 rpm and 60-120 g pressure
- Group 3 and 7 with dura whitestone bur at 5,000 rpm and 200 g (2 N) pressure
- Groups 4 and 8 with piezoelectric UDTs finishing kit (PMS = Perfect Margin Shoulder 1, 2, 3) in the following order: PMS 1 (76 µm grit) for 30 seconds with power setting of 15 PMS 2 (46 µm grit) for 60 seconds with power setting 15 to 6 PMS 3 (smooth) for 120 seconds with power setting 10.

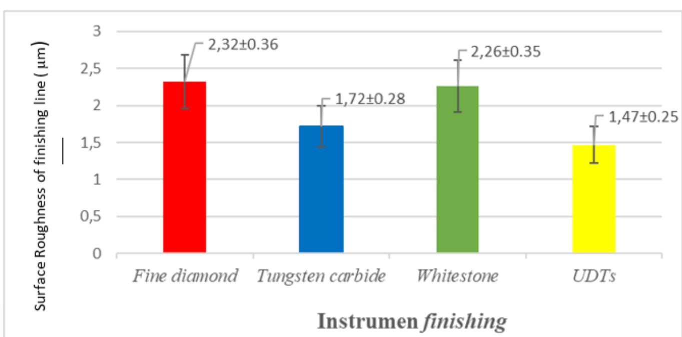
Before measurements began a sample of teeth soaked in artificial saliva for 24 hours and inserted in an incubator to simulate the state of the oral cavity (37^{0}C), the finishing line of the teeth was cleaned using a soft brush before a profilometer assessment was carried out then the teeth were madedry. Measurement of surface roughness value is done by surftest profilometer SJ-310 Series Handheld Roughness Tester (Mitutoyo, Japan) in Material Strength Material Laboratory, Faculty of Mechanical Engineering, USU. The measurement of the value of surface roughness recorded digitally and graphs is in the form of units of microns (µm). Each sample is divided into 3 measurement lines. From all the three lines, the average surface roughness value is obtained in one sample.

The smoothedsamples were impressed with polyvinyl siloxan on the mica box and then casted with gypstype IV. Samples were sent to the Uji Dental Laboratory of the Faculty of Dentistry, USU for fabrication of metal-porcelain restoration. Measurement of marginal adaptation values in the control group and samples were performed with stereomicroscopes (Zeiss Stereo Discovery. V12, Germany) in the Biology Laboratory of the Faculty of Mathematics and Natural Sciences (FMIPA) Universitas Negeri Medan (UNIMED). Measurement results from marginal adaptation values recorded computerized using Axiovision Rel software. 4.8 is in the form of a micron unit (µm), with an magnification of 12.0x. The sample was divided into 4 measurement points of surface point :mid-mesial proximal, mid-distalproximal, mid palatal and mid buccal with each measurement on the line carried out 3 times.The measurement of the four points was obtained the average value of marginal adaptation in one sample, so that the total measurement on 1 sample was 12 times.

Data wasanalizedbyusingone-way ANOVA test to determine the effect of instrument use on theroughness of the finishing line surface and marginal adaptation of metal-porcelain restoration in each group. Manova test to see the influence between the use of instruments on the roughness of the finishing line surface and the marginal adaptation of metal-porcelain restoration simultaneously. If there is a significant difference, then continue with post Hoc Bonferroni test to see the difference in roughness of finishing line surface and marginal adaptation of metal-porcelain restoration based on various finishing instruments used compared to fine diamond as standard value/ reference. Furthermore Spearman Correlation test is used to determine the direction of strength of the relationship between the roughness of the finishing line surface and the marginal adaptation of metal-porcelain restoration based on finishing instruments.

Result

Graph 1. Average Value of Surface Roughness Finishing Line Based on Use of Finishing Instruments: Finishing Fine Diamond Bur, Carbide Tungsten Finishing Bur, Whitestone, and UDTs Finishing Kit



Graph 2. Average Value of Marginal Adaptation of Metal-Porcelain Restoration Based on Use of Finishing Instruments : Fine Diamond, Tungsten Carbide, Whitestone, and UDTs Finishing Kit

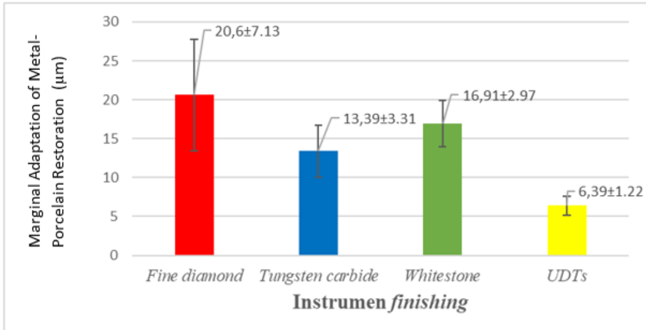


Table 1. ANOVA Test Results For The Use of Finishing Instruments: Fine Diamond, Tungsten Carbide, Whitestone, and UDTs finishing kit for Surface Roughness Finishing Line

Instrument	***X ± SD***	***Standard Error***	**p**
Fine Diamond	2,32 ± 0,36	0,16	0,001*
Tungsten Carbide	1,72 ± 0,28	1,12	
WhiteStone	2,26 0,35	0,16	
UDTs	1,47 ± 0,25	0,11	

Description: *significant

Table 2. ANOVA Test Results for The Use of Finishing Instruments: Fine Diamond, Tungsten Carbide, Whitestone, and UDTs finishing kit for Marginal Adaptation of Metal-Porcelain Restoration

Instrument	**X ± SD**	**Standard Error**	**p**
Fine Diamond	20,60 7,13	1,48	0,001*
Tungsten Carbide	13,39 3,31	1,48	
WhiteStone	16,91 ± 2,97	1,33	
UDTs	6,39 1,22	0,55	

Description : *significant

Table 3. Differences of Surface Roughness Finishing Line and Marginal Adaptation of Metal-Porcelain Restoration Based on Finishing Instruments Used Compared to Fine Diamond (Reference Value / Standard)

Variable	**Reference Intruments**	**Instrument**	**Average Difference (95%CI)**	**p**
Surface Roughness finishing line	*Fine Diamond*	UDTs	0,86 (0,26 – 1,46)	0,003*
		Finishing tungsten carbide	0,61 (0,01 – 1,20)	0,045*
		White Stone	0,06 (-0,53 – 0,66)	1,000
Marginal Adaptation of Metal-Porcelain Restoration	*Fine Diamond*	UDTs	14,21 (1,40 – 27,02)	0,035*
		Finishing tungsten carbide	7,21 (-5,20 – 19,63)	0,273
		White Stone	3,69 (-8,74 – 16,12)	0,270

Description: *significant

Table 4. Correlation of Surface Roughness and Marginal Adaptation

Instrument	**Correlation Value (r)**	**P**
UDTs	0,7	0,188
Tungsten Carbide	0,8	0,104
Whitestone	0,9	0,037*
Fine Diamond	0,9	0,037*

Description : *significant

Discussion, berikan nomor referensi

The result of the analysis above obtained the largest average of surface roughness finishing line is used with fine diamond bur, followed by whitestone, tungsten carbide, and the last using UDTs. ANOVA test results showed that there was an influence of finishing instruments on the surface roughness of the finishing line.

UDTs produced smooth and precise margin preparation thus improving the quality and accurate results of dental preparation. The results of this study are similar to the research with Horne et al (2011) and Ellis et al (2011). UDTs produce the smallest surface roughness due to the scratches from PMS1 and PMS2 diamond tips as well as polishing metal smooth tips (no diamond coating grit) from PMS3. PMS3 is also believed to eliminate unsupported enamel while fine diamond bur produces the greatest roughness due to the rapid rotational movement (high speed) of the rotary thus producing a deep indentation on the preparation surface [8,9].

The results of this study are similar to the research with da Silva et al (2016), Al-Omari et al (2001) and Attar et al (2013) which stated that the finishing tungsten carbide burproduces least value of surface roughness compared to fine diamond bur and carbide tungsten bur. The fine diamond bur has a larger surface roughness than the whitestonebur, but these two burs have no significant difference in surface roughness. The results of this study are similar to the research with Clarke, et al (2015) which stated that these two burs produce surface roughness that are not different significantly. Theunies, et al (1987) stated that whitestone produces better surface roughness for fine diamonds than bur fine diamonds [6,14,27].

Kaplan et al (2012) reported that the surface roughness value below 10µm was still acceptable as a finishing surface. All finishing instruments are on the recommended threshold for marginal roughness of the finishing line so that when it is done properly according to theexact procedures it should not be difficult to obtain marginal smoothness [28].

According to Price and Sutow, the characteristics that appear on the surface of the teeth are determined by the shape of the instruments used during finishing. If we observe from the mechanism of working rotary bur of fine diamond (74 µm grit) that is abrasion / grinding will produce a lot of debris at high speed, tungsten carbide burcuts and produces large particles at high speed, soft whitestone aluminum oxide bur with low speed, UDTs finishing kit with vibrations and slow oscillation movements of ultrasonic, smooth form (no grit) of UDTs tip particles provide a small marginal roughness value [22].

One of the important factors of fabrication fixed dentalprosthesesis is the preparation of finishing line. The location, configuration, and characteristics of the finishing line surface have implications for aesthetics, periodontal health, and restoration resistance. In relation to location, it is usually recommended that margins be placed on the supra or equigingival because subgingiva can damage biologic width and disturbances dentogingival complex which can result in inflammation of the gingiva and subsequent loss of periodontal attachment. Supragingiva margins are fully exposed to cleansing action, easier to prepare and biologically acceptable. However, supragingiva margins are not always suitable and subgingiva margins may be necessary for aesthetic or retention. In circumstances where subgingiva margins are required, periodontal health can be maintained when good marginal adaptation is achieved [12].Atraumatic ultrasonic oscillation equipment has recently been developed for prostodontic finishing margins. The preparation of metal-porcelain restoration margins is finished with a new ultrasonic tool (Satelec Acteon, France) compared to the margin finishing with conventional rotary tools researched by Ellis et al have smoother surfaces, good restoration fittings, and increased smear layer removal [8,9].

In the marginal adaptation group, it was found that the largest marginal adaptations were obtained with fine diamonds, followed by whitestone, tungsten carbide, and the last using UDTs. ANOVA test results showed that there was an influence of finishing instruments on the marginal adaptation of metal-porcelain restoration.

According to the American Dental Association (ADA) specification no. 8 stated the thickness of cement for crowns should not exceed 25µm when using type I cement or not exceed 40 µm when using type II cement [26]. In this study, the average marginal adaptation of crowns using fine diamonds was 20.60 µm, followed by whitestone 16.91 µm, tungsten carbide 13.39 µm and UDTs 6.39 µm. All finishing instruments are on the recommended threshold for marginal adaptation so as not to provide access to bacterial attachments that can cause secondary caries and/or irritation of gingival. Poor marginal accuracy can injure dental tissue and periodonsium. Restoration of metal-porcelain that has a good marginal adaptation will prevent the sensitivity of pulp and dissolvedcement.

In this study, metal-porcelain restoration samples were not cemented because it was expected that the marginal adaptation results obtained were not influenced by the cementing process. Marginal adaptation measurements of metal-porcelain restoration before and after cementing affect the measurement results. The presence of cement mediation can reduce the adaptation of metal-porcelain restoration when seated to the teeth resulting the gapofrestoration margin with poor tooth finishing line. Some researchers also reported the marginal gap value of restoration after being cemented was significantly greater than before..

In this study, fine diamond bur has the highest surface roughness in line with the largest margin gap (margin adaptation) also compared to tungsten carbide finishing instruments, whitestone, and UDTs. Ayad research, et al (2009) which stated that marginal adaptation is better in carbide tungsten finishing bur than diamondbur. Horne, et al (2011) and Ellis, et al (2011) stated that marginal adaptation of UDTs is better than fine diamondsbur.

Ultrasonic instruments have oscillation movements compared to the rotational movements of conventional instruments. The advantage obtained is a better adaptation to the preparation of finishing line. Ultrasonic instruments are useful for beveling enamel and dentins margins especially the area that are hard to reach. Ultrasonic instruments produce excellent finishing line. Restoration can therefore adapt tightly to preparations, lowering marginal leaks and secondary caries and maintaining enamel [8,9]. In addition, precise and smooth preparation margins can improve the quality and accuracy of molds, resulting in proper fitting restoration and long-term success [12].Manova test results between finishing instruments with surface roughness and marginal adaptation obtained a value of 4 effect values namely Pillais Trace (p=0.004), Wilks Lambda (p<0.001), Hottelings Trace (p<0.001), and Roy's Largest Root (p<0.001). The result of the four effect values (Manova Test) shows a value of <0.05, meaning that simultaneously / simultaneously there is an influence of finishing instruments on the surface roughness of the finishing line and marginal adaptation of metal-porcelain restoration. This is in line with all literature reviews from Rosenstiel (2016), Attar (2013), Shillingburg (2012), Horne (2012), Ellis (2011), Ayad (2009) and others that rotary and ultrasonic finishing instruments affect surface roughness so that it will affect the marginal adaptation of fixed restoration.

The test continued with Post Hoc test and obtained significant difference between surface roughness produced by fine diamond instruments compared to UDTs of 0.86 µm (p=0.003 value) and tungsten carbide of 0 ,61 µm (p=0.045), but there was no significant difference in average surface roughness of the finishing line using whitestone 0.06 (p=1,000). Based on marginal adaptation, which differs significantly with fine diamonds only UDTs with an average difference of 14.21 µm (p= value of 0.035), while by using tungsten carbide and whitestone there is no significant difference with fine diamonds with p values of 0.273 and 0.270, respectively. This is similar toHorne's research et al (2011) and Ellis, et al (2011) that the marginal gap generated by UDTs is better than fine diamonds. The smallest surface roughness value of UDTs is in line with the tightest marginal adaptation (the smallest marginal gap) compared to the fine diamond.

Furthermore, Spearman Correlation test was conducted to find out the strength of the relationship between the surface roughness of the finishing line and the marginal adaptation of metal-porcelain restoration based on the finishing instrument, by looking at the correlation value (r). All instruments have positive results for the strength of the surface roughness relationship of the finishing line and the marginal adaptation of metal-porcelain restoration based on the finishing instrument, meaning that the greater the value of surface roughness the absolute marginal discrepancy value is also greater (marginal adaptation of metal-porcelain restoration isbad), but nevertheless significant is the whitestone and fine diamond instruments whose relationship strength is very strong (r=0.9, p value =<0.05). The results are in line with Rosenstiel (2016), Attar (2013), Shillingburg (2012), Horne (2011), Ellis (2011), Ayad (2009), and Laufer (1996) stated that the greater the roughness value of finishing line, the greater the marginal gap of metal-porcelain restoration is (marginal adaptation of metal-porcelain restoration the worse). Ayad, et al (2009) examined the roughness of the rotary surface of diamond instruments, finishing tungsten carbide and tungsten carbide with a profilometer stating that finishing tungsten carbide produces the best smoothness of performance. In 2009, Ayad et al again examined the three bur and found carbide tungsten finishing produced the best marginal adaptation with the smallest marginal discrepancy.

When we observe the work ofmechanism of rotarybur (fine diamond, tungsten carbide, and whitestone finishing) compared to ultrasonics (UDTs finishing kit) then found conclusion the greater surface roughness of finishing line from fine diamond bur causing greater absolute marginal discrepancy of metal-porcelain restoration as well.

The weakness of this study was to use a contact profilometer measuring instrument that the sample had to be cut so as not to hinder the work of the stylus of the profilometer, so that it could not be the same sample to examine the surface roughness of the finishing line and marginal adaptation of metal-porcelain restoration. Another drawback is the difficulty of controlling the thickness of the case and porcelain with manual application, so that with the advancement of technology the use of CAD / CAM can be done for maximum results.

Conclusion

In this study, there was a relationship between the surface roughness of the finishing line by using finishing instruments (fine diamondbur, finishing tungsten carbidebur, whitestonebur and UDTs finishing kit) to marginal adaptations in metal restoration - porcelain. Fine diamond burwhich is often used in everyday clinical turns out to produce the highest roughness, although the marginal gap of all finishing instruments is still acceptable to ADA standards when it is done in the correct protocol.

UDTs finishing instruments (PMS=Perfect Margin Shoulder 1, 2, 3) produce the smallest surface roughness of the finishing line so that the bestmarginal adaptation of metal-porcelain restoration (the smallest marginal gap) than rotary instruments (fine diamondbur, carbide tungsten finishing, and whitestone). UDTs finishing kits are recommended to be used for everyday clinical preparation especially sub gingiva cases as they produce the smallest surfaceroughness value of finishing line and marginal gaps as well as ultrasonic movements not injuring periodonsium tissue.

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