T.C.
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INVESTIGATION OF THE EFFECT OF BUR QUALITY ON COMPUTER AIDED MANUFACTURING DEVICES

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APPROVAL

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DECLARATION

I hereby declare that this thesis is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which has been accepted for the award of any other degree except where due acknowledgment has been made in the text.

21.03.2019

MERVE CİNGİ

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LIST OF SYMBOLS AND ABBREVIATIONS

<	Less than
>	Greater than
3D	Three Dimension
CAD	Computer Aided Design
CAM	Computer Aided Manufacturing
CEREC	Ceramic Reconstruction
Cr-Co	Chrome-cobalt
Gpa	Gigapascal
Max	Maximum
Min	Minimum
Mm	Milimeter
Mpa	Megapascal
p	Probability value
rpm	Revolutions per Minute
sd	Standart Deviation
YTZP	Yttria Stabilized Zirconia
µ	Micro

ABSTRACT

Cingi, M. (2019). Investigation of the Effect of Bur Quality on Computer Aided Manufacturing Devices. Yeditepe University, Institute of Health Science, Department of Prosthetic Dentistry. Msc thesis, Istanbul.

The aim of this study is to evaluate the thickness of ceramic crowns produced after repeated processes without changing the bur with computer aided manufacturing (CAM) system and to evaluate the accuracy of diamond burs. 48 crowns were produced with the same bur until the system warning for a bur change. CEREC MC XL (Sirona Dental Systems GmbH, Bensheim, Germany) was used without changing the bur. The thickness of crowns was measured at three points (middle of occlusal face, mesiobuccal cusp and middle of the buccal face) with a digital micrometer (227-11-820, TRONIC, Torino, Italy). Crowns were divided into 4 groups according to their production order (n=12). The groups were compared in terms of their average thickness, and their deviations from the firs measurement were compared. IBM SPSS Statistics 22 program was used for statistical analysis. The normal distribution of the parameters was evaluated with Skewness and Shapiro Wilks test and the parameters were not normal. The Kruskal Wallis test and Mann Whitney U test were used for the comparison of the parameters between groups. Significance was evaluated at $p < 0.05$. There was no statistically significant difference between the groups in terms of occlusal and mesiobuccal average thickness ($p > 0.05$). There were statistically significant differences between the groups in terms of buccal thickness averages ($p < 0.05$). There was no statistically significant difference between the groups in terms of deviation from the first measurement in the occlusal region ($p > 0.05$). There was a statistically significant difference between the groups in terms of deviation from the first measurement in the mesiobuccal region ($p < 0.05$). There was a statistically significant difference in the amount of deviation from the first measurement in the buccal region between the groups ($p < 0.05$). Increase in thickness was observed in buccal measurements with erosion due to usage of the bur, and deviation from the first value was observed in mesiobuccal and buccal measurements. According to our study, the first 24 crowns were produced properly.

Keywords: CAD/CAM, Milling accuracy, CAD/CAM manufacturing accuracy

ABSTRACT (Turkish)

Cingi, M. (2019). Bilgisayar Destekli Üretim Cihazlarında Frez Kalitesinin Etkisinin Araştırılması, Yeditepe Üniversitesi Sağlık Bilimleri Enstitüsü, Protetik Diş Tedavisi Anabilim Dalı Master Tezi, İstanbul.

Bu çalışmanın amacı bilgisayar destekli üretim (CAM) sistemi kullanarak, frezin tekrar kullanımı ile üretilen seramik kuronların kalınlığını ölçerek elmas frezin kullanımına bağlı hassasiyetini değerlendirmektir**.** Frez değişikliği yapmadan CEREC MC XL (Sirona Dental Systems GmbH, Bensheim, Almanya) kullanılarak sistem frez değişimi uyarısı verene kadar aynı frezle 48 tane kuron üretilmiştir. İç ve dış yüzeyin işlenmesinde toplam 2 tane frez kullanılmıştır. Üretim öncesi belirlenen üç noktadan (oklüzal yüzün orta noktası, mesiobukkal tüberkül ve bukkal yüzün orta noktası) üretim sonrasında dijital mikrometre (227-11-820, TRONIC, Torino, İtalya) kullanılarak ölçüm yapılmıştır, kuronların kalınlıkları hesaplanmıştır. Kuronlar üretim sırasına göre 12'şerli 4 gruba ayrılmıştır. Gruplar kendi aralarında öncelikle kalınlık ortalamaları açısından karşılaştırılmış, daha sonra ilk ölçümden sapmaları karşılaştırılmıştır. Çalışmada elde edilen bulgular değerlendirilirken, istatistiksel analizler için IBM SPSS Statistics 22 programı kullanılmıştır. Çalışma verileri değerlendirilirken parametrelerin normal dağılıma uygunluğu Skewness ve Shapiro Wilks testi ile değerlendirildi ve parametrelerin normal dağılım göstermediği saptanmıştır. Parametrelerin gruplar arası karşılaştırmalarında Kruskal Wallis testi ve farklılığa neden olan grubun tespitinde Mann Whitney U test kullanılmıştır. Anlamlılık $p<0.05$ düzeyinde değerlendirilmiştir. Gruplar arasında okluzal ve mesiobukkal kalınlık ortalamaları açısından istatistiksel olarak anlamlı bir farklılık bulunmamaktadır ($p>0.05$), bukkal kalınlık ortalamaları açısından istatistiksel olarak anlamlı farklılık bulunmaktadır ($p<0.05$). Gruplar arasında oklüzal bölgede ilk ölçümden sapma miktarları açısından istatistiksel olarak anlamlı bir farklılık bulunmamaktadır, mesiobukkal bölgede ilk ölçümden sapma miktarları açısından istatistiksel olarak anlamlı farklılık bulunmaktadır ($p<0.05$), bukkal bölgede ilk ölçümden sapma miktarları açısından istatistiksel olarak anlamlı farklılık bulunmaktadır ($p<0.05$). Kullanıma bağlı frezin aşınmasıyla bukkal ölçümlerde kalınlık artışı gözlenmiş, mesiobukkal ve bukkal ölçümlerde ilk değerden sapma gözlenmiştir. Çalışmamıza göre ilk 24 kuronun en iyi şekilde üretildiği gözlemlenmiştir.

Anahtar Kelimeler: CAD/CAM, Frez hassasiyeti, CAD/CAM üretim hassasiyeti

1.INTRODUCTION AND PURPOSE

Dentists; improves oral function of patients with fillings, crowns, bridges, inlays, onlays, complete and removable dentures, and supports the protection of teeth (1). Because of the increase in expectations about the aesthetics and durability of the materials used in dentistry; recent, high-strength ceramics have been developed in order to be used in the construction of restorations. New production systems and technologies were needed because the materials developed were not sufficiently compatible with traditional methods. As a result of that, Computer aided design and computer aided manufacturing are the most important technologies developed for this purpose (2).

CAD (Computer Aided Design); means that designing and developing an object with using computer systems. The 3D model is created in digital environment. On the other hand, CAM (Computer Aided Manufacturing); computer support in accordance with the desired data production (3).

CAD/CAM systems are both manufactured by the use of newer and better materials was facilitated both working methods. When developing CAD/CAM systems; to reduce the use of traditional impression methods as much as possible, to perform the computer aided design of the restoration according to the natural morphology, function and preparation of the tooth, to produce the restoration in one session, to improve the quality of restoration (marginal adaptation, mechanical resistance) and to provide better aesthetics (4). In addition to this, it is aimed to increase the comfort of patient.

During the tooth preparation, a reduction in the diamond particles was observed due to the use of the diamond bur. The reduction in the cutting efficiency of the bur and the duration of the tooth preparation were observed with the reduction of the diamond particles. Many researchers have reached that after prolonged or repeated use, the cutting efficiency of the burs was significantly reduced (5,6,7). Regardless of the bur model, as the number of usages increased, the cutting efficiency decreased (8). They claimed that the rate of reduction in diamond particles was the highest after the first use of the bur (8).

In computer aided manufacturing, the production time does not change depending on the number of uses of the bur and there is no increase in time.

The aim of this study is to evaluate the thickness of ceramic crowns produced after repeated processes without changing the bur with computer aided manufacturing (CAM) system and to evaluate the accuracy of diamond burs.

2. LITERATURE REVIEW

Computer aided design (CAD) and computer aided manufacturing (CAM) have become an indispensable part of dentistry in the last 30 years. These systems, which are used in orthodontic treatment, inlay, onlay, crown, bridge, implant abutments, full mouth restorations, are a technology that can be used by both dental technicians and dentists (9). CAD/CAM systems can also be used in the design of hybrid prosthetic infrastructure, maxillofacial prostheses and in their production (10).

When developing CAD/CAM systems, it is aimed to bring 3 innovations firstly (11);

• First; to produce the restoration faster and to provide standardization in production.

• Second; to produce more aesthetic restorations with a more natural appearance.

• Third; especially to produce high-strength restorations that can withstand pressure from the posterior teeth.

CAD/CAM systems are becoming increasingly popular in dentistry. More than 30,000 dentists worldwide use their own scaning and milling machines, and more than 15,000 CEREC restorations have been produced (9). In this age we are used to doing every job at a fast pace, we now need to be able to have a faster dental treatment according to the expectations of the patients. Dentists are now moving away from traditional methods to save time with the renewal of technology (12).

2.1. Development of CAD/CAM Systems

In the early 1960s, computer aided design and manufacturing was developed for use in the aviation and automotive industries. It was first used in dentistry in 1970 (11). The geometries of the objects produced in the first industrial applications are relatively simple compared to the expected dental restorations. However, it was thought that it could be produced with these systems; barely, the computing power of computers is limited and the size of the devices is large for dentistry (13).

It was thought that CAD/CAM devices used in dentistry in the 1980's were simpler in terms of design and production than industrial devices. In order to prefer CAD/CAM devices used in dentistry, the cost must be close to the traditional methods, or the production time should be close to the traditional methods. The morphology of the tooth to be restored is designed to be compatible with the adjacent and opposite teeth. The marginal finish line of the prepared tooth should be determined well and production should be done accordingly. High-precision software is required to perform these. The morphology of crowns and bridges, the adjustment of the path of insertion, the numerical representation of the processing of the ceramic is more complex than the industrial production. In addition, CAD/CAM devices should be smaller than those used in industry in order to be able to use dentists easily in their clinics. Considering all these reasons, it can be said that the production of CAD/CAM used in dentistry is not as easy as it is thought (1).

The development of CAD/CAM used in dentistry has been through the work of many names who are Dr. François Duret, Werner Moermann, Dianne Rekow and Matts Andersson. Dr. Duret, a French citizen, developed the CAD/CAM system used in dentistry in early 1971. With this system, it is the first person who produces crown with milling machine by resembling the teeth morphology to other teeth. He produced this crown for his wife to use posterior in 1983. Production took less than 1 hour. He introduced this system in 1985 at the Congress of the French Dental Association (11). Dr. Duret further developed the system of Sopha Bioconcept (Sopha Bioconcept, Inc. Los Angeles, CA), but this system is not currently used (14).

Dr. Moermann, a Swiss citizen, developed the first commercial CAD/CAM system together with an optical scanner device by Dr. Marco Bradestini, an engineer. In 1985 they produced the first inlay using an optical scanner and milling machine. They have given this system the name CEREC, which is an abbreviation of computer aided ceramic reconstruction. An American citizen, Dr. Rekow worked on a new CAD/CAM system in the 1980's. She has worked on obtaining data with a high-resolution scanner and producing restoration with a 5-axis device. Dr. Andersson, a Swedish citizen, developed the Procera (Nobel BioCare, Zurich, Switzerland) system in 1983. This system can produce crowns with high precision. Dr. Andersson was the first person to use CAD/CAM in the production of composite veneer restorations. In addition, inlay, onlay, crown and veneer can be produced by the developed system (11).

CAD/CAM systems currently used for bridge, implant abutment production, orthodontic treatments. For example Invisalign plates (Align Technology, Inc, Santa Clara, CA, USA) can be produced with CAD/CAM systems (11)

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2.2 Overview of CAD/CAM Devices

CAD (Computer Aided Design); means designing and developing an object using computer systems. The 3D model is created in digital environment. CAM (Computer Aided Manufacturing); computer support in accordance with the desired data production (3).

The basis of CAD/CAM systems are based on 3 structures;

First; It is the scanner that allows the opposite or adjacent teeth to be scanned intraoral or extraoral. In most CAD/CAM systems, the scanner is part of the system. Scanners only work with the appropriate CAD software (15). Scanners are divided into 2 as optical and mechanical scanners (4).

• Optical scanner: Works with the triangulation method to obtain a 3D image of objects. Because it is sensitive to most movements, even the slightest movement of the patient during data collection can cause erroneous data to occur. Laser projection, optical scanning using white or color light. The receiver unit and the light source are placed at the appropriate angle (4). The most important advantage of optical scanners is high-resolution and rapid data collection (15).

• Mechanical scanner: Scan through the pin, sphere or needle tip. The 3D measurement of the model to be used is done mechanically (16).

Second; It is the design software that allows the user to design his own by creating a modification of ready templates and ready templates for restoration production. A computer is used for planning and designing the restoration in three dimensions. There are many design programs that help to make personal design and production. The design program of each CAD/CAM system is unique. When the design is finished, the virtual model is converted to a different format with the CAD software and sent to the CAM and the production is started (15).

Third; milling unit which is connected to the computer system. The appropriate material block is selected for restoration production, this block is milled to produce restoration. If the restoration is necessary after the production; coloring, final polish, porcelain applications and some corrections can be done by the technician (4).

Dr. Duret explored this process and developed it practically. In CAD/CAM systems, it is not as easy to view all the limits of the prepared tooth due to the presence of saliva, adjacent teeth and gums. This situation is among the reasons limiting the sensitivity of the system. The physician can take a impression by using traditional method and prepare a model. After this model is prepared, CAD/CAM process is started by scanning the model (1). In restoration production, materials such as feldpatic, leucite, lithium disilicate or composite blocks can be used (17). After the restoration, the restoration is examined, necessary corrections are made, polished and traditional roughening methods are used (11). It is concluded that there is no significant difference between the restorations in clinical and laboratory after 5 years of use. From this, it can be said that the restorations produced in the clinic are as good as those produced in the laboratory (18).

CAD/CAM systems are examined in 3 groups according to production methods (19);

• Direct clinical systems: intraoral scanning of the prepared tooth and restoration production in the clinic. CEREC and E4D Dentist systems are in this group.

• Systems used in laboratories: scanning is carried out on impressions or gypsum model. In these systems, the infrastructure is generally produced, the technician makes the restoration to the desired shape by adding porcelain on the infrastructure. In this group of CEREC in Lab, Cercon, DCS Preci-fit and Everest systems.

• Production-based systems: the scanning process of the model is carried out in the laboratory. This scanning data is then sent to the main production center via the internet. All substructures are produced in the same center to ensure quality control. After the infrastructure is prepared, it is sent back to the laboratory and porcelain is added. Lava and Procera systems are in this group.

2.3. Advantages of CAD/CAM Systems

Reduction of the number of appointments is one of the most important advantages for the patient and the physician (20). Other advantages of these systems are;

• Preparation of the materials to be used for impression, the time spent in the selection of the impression tray, disinfection of the impression tray, dispatch of the impression to the laboratory, the fee paid for the dispatch, the cost of the impression and the impression tray disappeared (21).

• The impression taken by scanning can be saved and stored in digital media for later use (21).

• Experienced in traditional methods; problems such as the lack of sufficient impression of the tray, the tray not sitting properly, the impression removed from the tray, polymerization shrinkage, incorrect recording of the closure, air bubbles in the model, expansion of the model cast, problems such as the system is eliminated with these systems (21).

• It provides great convenience for patients and physicians in patients with gag reflex (21).

• Stages in traditional methods; impression disinfection, model preparation, trimming of the model and stump preparation, waxing and casting processes are eliminated. The addition and processing of porcelain has also disappeared in some cases (21).

• Restoration is achieved without the use of facial arches. The loss of time and discomfort caused by the patient disappeared when placing and adjusting the face arch (21).

• When the impression is taken by the scanning process, the physician can check the area he/she is scanning from the screen. You can complete the missing locations with scanning device again. If the work area is small, it is sufficient to scan only the working area with the opposite arch. Corrections can be made before starting the production process (11).

• Usually there is no need for temporary restoration; because permanent restorations are produced in a short time. It saves material and time spent on preparation of temporary restoration (22).

• Aesthetic and natural looking restorations can be produced with these systems (11).

• The previously produced restoration can also be reproduced without the need to repeat the measurement. Standardization in production is provided (23).

• Possible cross-contamination has been eliminated by the use of these systems (24).

• They can be used easily in implant applications. The planning and digitization of the implant position, the design and manufacture of implant based restoration can be performed with these systems (25).

• The presence of these state-of-the-art devices in the clinic positively affects patients and increases the reputation of the physician (19).

2.4. Disadvantages of CAD/CAM Systems

The high cost is one of the most important disadvantages of these systems. However, this cost can be financed in clinics or laboratories where continuous restoration is produced (14). Other disadvantages of these systems;

• The process of learning and using these systems is long. The longer the process, the more disappointing the physician. However, CAD/CAM systems can be used more easily depending on the continuous use (20).

• On many patient we require gingival retraction. Especially in teeth with deep subgingival margins, it is difficult to obtain digital impression (26).

• Aesthetic expectations cannot be met in every patient. This problem is thought to be solved by further development of polychromatic blocks (23).

• The use of full arc impression accuracy is under development. In a study on in vitro model, the accuracy of traditional and digital impression methods were compared. At full arc, more deviation was observed in digital impression systems (27).

• The use in edentulous patients for under development. In one study; Anatomical structures of patients with inadequate anatomical structures, a good fit to the prosthesis is difficult to produce, it is revealed that the data cannot be transferred to the system (28).

2.5. CAD/CAM Systems Used in Clinic

There are 4 digital scanners that are frequently used in the clinic.

• CEREC AC (Sirona, Charlotte, NC, USA)
• E4D Dentist (D4D Technologies, Richardson, TX, USA)
• iTero (Cadent, Carlstadt, NJ, USA)
• Lava COS (3M ESPE, St Paul, MN, USA)

With digital impression; choosing appropriate tray, preparation of impression materials, mixing, waiting for hardening, disinfecting after hardening, sending the impression to the laboratory, preparing a model in the laboratory, and many other stages and time loss have disappeared. iTero and Lava Cos devices only have digital scanning. CAD/CAM can be done with CEREC and E4D devices, so design and production can be performed in clinic (11).

2.5.1 CEREC System

The CEREC system was released in 1987. It is the first CAD/CAM system, it is the first system that combines the digital scanning and milling unit. With this system, restoration is produced in a single session using appropriate block. When the system is used for the first time, only inlay and onlay can be produced. Between 2007 and 2012, CEREC BlueCam (Sirona, Charlotte, NC, USA) was used as a scanner system. In order to record all areas easily, the teeth were coated with special titanium dioxide powder and the images were taken with blue light diodes (LED). It was used in crown, bridge, all mouth restorations and veneer production (11). In 2012, a new system, CEREC Omnicam, has been introduced, with the use of powder seen as its major disadvantage affecting image quality. When using CEREC Omnicam, it is not necessary to use powder, sensitive image acquisition and natural color capture are the most important advantages (29).

The received images can be tracked on the screen that the scanner is connected to and can be examined in detail when finished. CEREC designs a similar restoration to existing teeth with the biogeneric feature and places it on the prepared tooth. Thus, it provides restoration production in a morphology similar to the individuals natural teeth or existing restorations. Physician can make corrections on this design. Contour changes can be made, virtual etching or insertion can be made on the design, contact points are checked, the frequency of the contact points can be changed. Many other changes can be made depending on the actuality of the software (19).

4.4 software was released in 2015, it is more comfortable to use than previous software. It can design all restorations that need to be done in the patient. When the design process is finished, the selected block in the desired color and size is placed on the CEREC MC XL and this block is milled to produce a single session restoration. High resistance ceramics, such as feldspathic ceramics, Nano-ceramics, lithium disilicate, leucite-reinforced glass ceramics can be used in this system. Blocks used for temporary restoration production are also available (4).

2.5.2 E4D Dentist System

The E4D Dentist (D4D Technologies, Richardson, TX, USA) system was introduced in 2005. Performs scanning with intraoral laser scanner without the use of powder. In order for the software to generate the correct morphology, images are taken from several angles and data points are increased (19). After the images are taken, they are examined on the screen. Soft and hard tissue differentiation, circumference of crowns, sharpness of intraoral environment can be seen easily. It has the ability to make custom design. Design of 16 members can be performed at the same time (4).

The most important advantage of this system is the company's free software update online. However, material diversity is not much, which is the disadvantage of this system. Lithium disilicate, leucite reinforced ceramic and nanoceramic blocks are available. There are also blocks used for temporary restoration production (4).

2.6. CAD/CAM Systems Used in Laboratory

Scanning is performed on the impression or gypsum model. In these systems, the infrastructure is generally produced, the technician makes the restoration to the desired shape by adding porcelain on the infrastructure.

2.6.1. CEREC inLab System

This system was released in 2004. Developed for laboratory use. The image of the model is transferred to the system using the laser scanner. This system consists of scanner, computer unit, inLab three-dimensional scanner and design software. The milling unit and sintering device of the system are also available (4). It is the process of sintering heat treatment, where the part of the pressed part is bonded to each other at high temperature. Substructure produced with these systems, precision retaining prosthesis, removable partial prosthesis, infrastructure of metal ceramic restorations, zircon crown, personalized implant abutments, bars with implant supported overdenture prosthesis and implants sintering device can be used (30). With its biogeneric feature, it designs similar restorations to existing teeth or restorations. Thus, the individual design and production is done, standard morphology patterns are not used (4).

When the design process is finished, milling is performed with inLab MC XL, restoration is produced. The InLab MC XL milling machine works with a precision of ± 25 μ, and can produce 10 member bridges. It can produce approximately 40-60 membered restorations in one day (31).

Zirconia bridge infrastructure mills the porcelain to be used in the superstructure. This makes the two parts easy to assemble and use together. This is an important feature of the CEREC inLab system. In this way, the manual porcelain masonry process is completely compatible with the substructure, leaving the morphology to the previously designed superstructure production in CAD software. Blocks of Sirona, Ivoclar Vivadent, Vident and 3M Espe can be used in CEREC inLab systems (31).

2.6.2. DCS Preci-fit System

This system was first announced in 1990 and started to be used. The most important features of the DCS Preci-fit system are; To be able to mill metal, glass ceramics, reinforced ceramics, to produce the substructures of restorations from titanium (DC Titan) and full sintered blocks (DC Zircon). There are very few CAD/CAM systems with these features (14). System includes laser scanner and milling unit, bridges body shapes and connectors are designed to automatically design (4).

2.6.3. Cercon System

This system was launched in 2002 by Dentsply. Only the CAM system is available during the first years. 3D optical scanner and CAD design software was added in 2005 and started to be used as CAD/CAM system. The scanning sensitivity is specified as 10 microns. Each member can be scanned in 20 seconds with an experienced user. The boundaries of the restoration are automatically determined and edited. Semi-sintered zirconia blocks up to 9 members can be milled (4).

2.6.4. Everest System

The production of the Everest system was carried out by Kavo. The system has a scanner, a computer, a milling unit and a sintering unit. The gypsum model is placed on a rotary table and the image is scanned by a CCD (Charge Coupled Device) camera. CCD cameras have a wide dynamic range, high performance even in low light conditions, not affected by vibration, high sensitivity and resolution.

The digitization of the scanned model takes place and is displayed on the computer. The design of 1 member can be completed in about 5 minutes. After the design process is finished, production starts. The milling unit is a 5 axis milling machine. With these systems, crown, bridge, inlay and onlay production can be realized (4).

2.6.5. Zeno Tec System

Manufactured in 2005 by Wieland. This system consists of three-dimensional laser scanner, milling machine and sintering furnace. Cr-Co and titanium substructures can mill the zirconia blocks. The system has various sizes of scanner and milling machines suitable for laboratories (4).

2.6.6. Katana System

It was released by Noritake Dental in Japan. The system includes scanner device, 4 and 5 axis milling devices and sintering furnace. With this system, only non-sintered Y-TZP blocks can be milled. The production of a 3-member fixed partial prosthesis is approximately 30-45 minutes (32). In this system, there is usually no need for additional processing to be done in restoration. Color Y-TZP blocks are available with 4 different color options. This is the most important advantages of this system. After the infrastructure production is completed, restoration is completed with CZR Press or Noritake CZR ceramics (4).

2.7. Production Based CAD/CAM Systems

In these systems, the scanning process of the model is carried out in the laboratory. This scanning data is then sent to the main production center via the internet. All substructures are produced in the same center to ensure quality control. After the infrastructure is prepared, it is sent back to the laboratory and porcelain is added (33).

2.7.1. Procera System

These systems were produced in 1994 by Nobel Biocare. Scanning of the model with the compact scanning device in the laboratory is performed. The data obtained are sent to the production center in Sweden or the USA (34). Substructures prepared and sintered are sent back. Porcelain application and finishing is done by the technician (35).

Procera AllCeram system can be produced from pure and high durability, sintered aluminum oxide substructurers, abutments and veneers with high precision (35). With the Procera AllZirkon system, substructures of crowns and bridges, abutments can be produced from zirconium oxide. Titanium substructures, abutments, implant based titanium bridges can be produced with Procera AllTitan. Full ceramic crown production is also possible with these systems (36,37).

2.7.2. Lava System

Manufactured in 2002 by 3M ESPE. System includes optical scanner, milling units and sintering furnace. Substructures of crowns and bridges can be prepared at production centers. The edges of the restoration and the future part of the body are determined automatically in the system. The design of the restoration is designed to be 20-25% larger than it should be. The aim is to compensate for sintering shrinkage. When the design process is over, semi-sintered zirconia blocks are milled and restoration is produced. Single member infrastructure production takes approximately 15 minutes, 3-member bridge production lasts 45-50 minutes (4).

After the production process is finished, the restoration can be colored by adding the colorant solution. There are 7 different colors. It is aimed to increase the aesthetic harmony between infrastructure and superstructure by coloring process (38).

2.8. Diamond Burs

For more than 100 years, dental burs have been used by dentists. The burs used in the early days are made of steel and are made of tungsten carbide. Diamond burs were raised at the end of the 19th century (39).

It was seen that carbon steel burs was insufficient in tooth preparation before 1890 and stones and discs produced from silicon carbide were started to be used. The first dental diamond bur was made in 1897 by Willman and Schroeder, German citizens. The production of these burs was made by compressing the diamond powder into the gaps on the surface of the soft iron or copper (39).

In 1899, Claudius Ash and Sons created a catalog and listed diamond burs and mentioned that they could be used in tooth preparation. They mentioned that we could work at high speed with the burs and that it should be worked hydrated (39). In 1913, it was mentioned that the enamel could be removed more easily by a narrow bur with diamond particles (39). Modern diamond burs manufactured in 1932 by Dr. Drendel who works as an industrialist in Germany. It has developed the diamond particles by gluing the gaps on stainless steel (39).

In 1939, diamond burs were introduced in Europe, and different shapes were introduced in the United States. Diamond burs were not used until 1946 because the cost was high and the existing shapes and dimensions were not suitable for practical use. Due to the difficulty of finding steel, silicon carbide and other abrasive materials during the war, interest in diamond burs has increased (41). In the post-war years, the public's awareness of oral hygiene increased, and the demands for treatment with advanced materials increased. This increase in demand led dentists to use new materials and to use various types and sizes of diamond burs in dental treatments (39).

In 1957, the air turbine was operated at high speeds of 200,000 to 300,000 rpm and mass production was started. This is considered the widespread acceptance of the diamond bur. With the introduction of these devices, the cooperation of dentists and manufacturers increased and the production of diamond burs, which can be used with less pressure and which can be worked more efficiently, started in this way (42).

Dental bur design is based on the principles of cutting tool in engineering. However, dental applications and applications in engineering are carried out with different methods and speed. In cutting operations in engineering, the cutting tool (counter tooth in dentistry) is fixed. The part to be cut is moved. In dentistry, the part to be cut, ie the tooth is fixed, the hand tool with which the cutting tool is attached is moved. Cutting and drilling operations in engineering are slower than in dentistry. When working with 5,000 - 10,000 rpm in engineering, there is a wide speed range of 25,000 - 450,000 rpm in dentistry (39).

Dental diamond burs; stainless steel handle, diamond particles and binding layer (43). They consist of one or more layers of diamond particles. The part of the handpiece is the handle. High strength alloys such as stainless steel are used in the production of the handle (39). The production of modern diamond burs is similar to the original Drendel system. The diamond particles are locked into the stainless steel handle with a nickel or nickel-chrome matrix (43). Synthetic or natural diamond particles are placed into the cutting edge (39). According to the size and shape of the product, the gap of the diamond particles is adjusted. The gaps are effective in numbering and identification of the burs (39).

Diamond burs can be used in all areas of dentistry. It is used even in surgical procedures. As diamond burs are used for a long time, they are more preferred because they are more resistant to wear and tear and create less heat during use (39).

Although they have been used for a long time, there is not much information about diamond burs, there is not much work about design methods and changes in bur after use in clinic.

The production of CAD/CAM restorations starts with scanning processes, images are transferred to the computer, design is made and the latest production is started (45). In dentistry, abrasion is performed on the surface with burs with hard particles at the tip (46). Diamond burs are particularly preferred for this process; however, they may form micro cracks after some roughness on the ceramic surface in use on the ceramic surface (47).

The number and size of the diamond particles to be used are important in terms of the surface properties of the material to be scraped (47,48). The burs with more diamond particles make more abrasions; but they can form deep marks on the surface. Fewer diamond particles result in less damage to the surface (49). The inner surface of the restorations is the most difficult stage in the CAD/CAM process. Surface defects can occur, stress on the surface and material strength can be affected (48). When evaluated in terms of internal and marginal fit, it is observed that the adaptation of CAD/CAM restorations is good (50,51).

Apart from the manufacturer's information, there is not an adequate source for the amount of restoration that can be produced without affecting the resistance and structure of the restoration with the same set burs used in CAD/CAM (52).

2.9. Block Materials Used in CAD / CAM Systems

The increase in the use of CAD/CAM systems has led to an increase in aesthetic and functional expectations. The increase in expectations has led to the development of different compositions, materials with different structure and physical properties. Blocks used in production processes may vary depending on the restoration, restoration of the mouth, patient's wishes, socioeconomic status of the patient and the physician's wishes (53).

Materials used in CAD/CAM systems (54,55);

- Feldspatic ceramics
- Sintered oxide ceramics
- Oxide ceramics
- Glass infiltrating oxide ceramics
- Leucite reinforced glass ceramics
- Lithium disilicate reinforced glass ceramics
- Zirconia reinforced lithium disilicate ceramics
- Nanoceramics
- Hybrid ceramics
- Composites
- Polymer
- Metals

The blocks used in our study are feldspatic ceramics. The first blocks used in CAD/CAM systems in dentistry are feldspatic ceramic blocks. Feldspatik ceramic blocks were used and followed up for 10 years, with a very high success rate of 90.4% (56).

There are feldspar particles at a size of 30% in the glass matrix and 3-4 micrometers distributed homogeneously. The modulus of elasticity is 45-63 Gpa and the breaking resistance is 150 MPa (53).

Feldspatik ceramic blocks are three types as monochromatic blocks, dichromatic blocks and polychromatic blocks. In developing monochromatic blocks, dichromatic blocks and polychromatic blocks were also considered and developed. Dichromatic blocks are composed of a spherical dentine core and a translucent enamel layer. The color transition in these blocks was prepared in the form of a 3D arc to imitate the dentine and enamel. Because polychromatic blocks have different light permeability and color saturation, they may look like natural tooth tissue. Thus, it is ensured that the restoration is compatible with the existing natural teeth by mimicking the optical properties of the tooth (57).

Inlay, onlay, laminate veneer, crown production is possible with these blocks (58). Due to the high content of glass, it can be roughened using hydrofluoric acid. Adhesive cementation showed higher success rates than oxide ceramics. They can be mechanically polished. With these blocks, restoration production can be performed easily in one session (59,60).

3. MATERIAL AND METHOD

3.1. Choosing a Model to Use

Frasaco AG-3 (Frasaco GmbH, Tettnang Germany) model was used and a second molar tooth (number 37) prepared (Figure 1). As a supragingival preparation and the chamfer finish line has been designed in order to be more comfortable in digital scanning.

Figure 1: Frasaco AG-3 model and prepared 37 teeth

3.2. Choosing the System to Use

The CEREC Premium version 4.4 and the CEREC MC XL were used in the design of the crown for the production of the crown to be produced in CEREC AC Omnicam (CEREC 3D, Sirona Dental Systems GmbH, Bensheim, Germany). CEREC Blocs C (Feldspatic ceramic) was used for the production of crowns (Figure 2). CEREC Step Bur 12S and CEREC Cylinder Pointed Bur 12S, which are compatible with CEREC MC XL, are used as diamond burs (Figure 2).

Figure 2: CEREC Cylinder Pointed Bur 12S, CEREC Blocs and CEREC Step Bur 12S

3.3. Design and Production Stages

The model was scanned with CEREC AC Omnicam and the crown was designed after the images were transferred to the computer (Figure 3). In order to be comfortable to measure, the crown thickness is adjusted to 1 mm throughout the crown. A recess is formed şn the middle of the buccal and occlusal face and mesiobuccal cusp in order to make the measurement location specific and comfortable to measure.

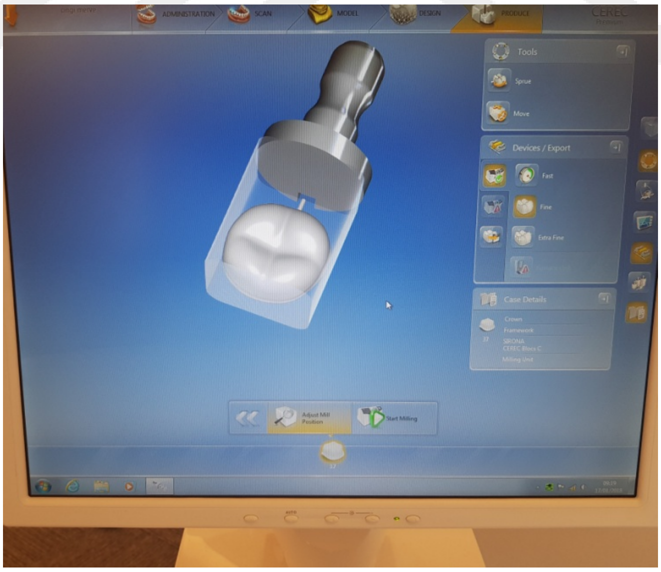

Figure 3: It is ready for production after the design of the crown. The buccal face of the remaining crown on the tij side is the lingual face of the crown close to the end of the block.

The new CEREC MC XL is equipped with new burs to be used and the devices water has been renewed.

Figure 4: Display of the screen during refresh of the burs before using the device

According to the manufacturer's information, the production accuracy can be set as fast, fine and extra fine. Depending on the sensitivity, the production time also varies. Fast setting can be used for jobs that need to be done very quickly. In a fine setting, a more precise production can be made, if production sensitivity is very important in the job, for example, if the occlusal facial morphology is desired to be more detailed, a extra fine setting can be preferred.

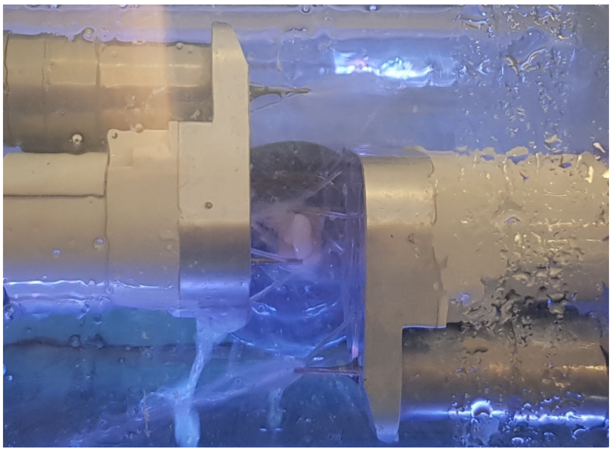

Figure 5: It is seen from the upper part of the block that the milling process is started from the lingual.

In this study, it was preferred that a very complex morphology was not designed on the occlusal side, and it was preferred to produce in a fine setting as no occlusal percentages were needed. After the installation of a burs (CEREC Step Bur 12S and CEREC Cylinder Pointed Bur 12S) to be used for the processing of the inner and outer surfaces, the system was produced until the system gave a change of the bur. The production process started from the lingual of the crown and the last buccal face was formed and the tij was cut off (Figure 5). The operation was terminated when the system gave a warning. The production of each crown lasted 12 minutes. After producing 48 crowns with the same bur, the device warned of a change of bur and the operation was terminated.

3.4. Post-Production Operations

The crowns produced are numbered according to the order of production. The thickness of the crowns were measured and the measurement was repeated 3 times. The averages of these 3 measurements were taken and considered as the measurement result. The fine-tipped digital micrometer (227-11-820, TRONIC, Torino, Italy) was used for measurement (Figure 6). Measurements were made at 3 points (middle of occlusal face, mesiobuccal cusp and middle of buccal face).

Figure 6: Measuring by micrometer

48 crowns were measured in sequence. The crowns were divided into 4 groups according to their order of production, and the results were compared. The thickness averages of the groups and the deviations from the first measurement were examined. The first group is the first 12th crowns and the second group is 13-24th crowns, third group 25-36th crowns and fourth group are set as 37-48th crowns.

3.5. Statistical Reviews

While evaluating the findings obtained in the study, IBM SPSS Statistics 22 program was used for statistical analysis. The normal distribution of the parameters was evaluated by Skewness and Shapiro Wilks test and it was found that the parameters did not show normal distribution. The Kruskal-Wallis test and Mann-Whitney U test were used for the comparison of the parameters between groups. Significance was evaluated at $p < 0.05$.

4. RESULTS

The crowns were measured in order of production. The results of measurements of occlusal, mesiobuccal and buccal thickness are shown in Table 1 and Table 2.

Table 1: Results of the measurements of occlusal and mesiobuckal thickness of the groups according to the order of production of the crowns (Group 1 crowns 1-12 respectively from top to bottom, group 2 from top to bottom respectively 13-24 crowns, group 3 from top to bottom respectively 25-36 crowns, group 4 from top to bottom respectively 37-48 crowns)

occlusal				mesiobuccal			
Group 1	Group 2	Group 3	Group 4	Group 1	Group 2	Group 3	Group 4
1,135	1,145	1,145	1,16	0,955	0,935	0,955	0,97
1,135	1,135	1,125	1,15	0,925	0,945	0,935	0,975
1,135	1,14	1,125	1,14	0,945	0,945	0,935	0,965
1,135	1,135	1,135	1,16	0,95	0,97	0,975	0,985
1,15	1,125	1,16	1,125	0,965	0,975	0,97	0,955
1,135	1,14	1,145	1,135	0,965	0,965	0,975	0,96
1,145	1,125	1,155	1,135	0,96	0,965	0,975	0,965
1,145	1,145	1,13	1,155	0,965	0,945	0,94	0,985
1,135	1,14	1,145	1,235	0,975	0,945	0,945	1,125
1,145	1,15	1,155	1,15	0,975	0,985	0,975	0,98
1,135	1,125	1,15	1,135	0,965	0,935	0,965	0,96
1,135	1,135	1,125	1,17	0,945	0,955	0,955	1,005

Evaluation of the thickness measurements of the groups is shown in Figure 7, Figure 8 and Figure 9.

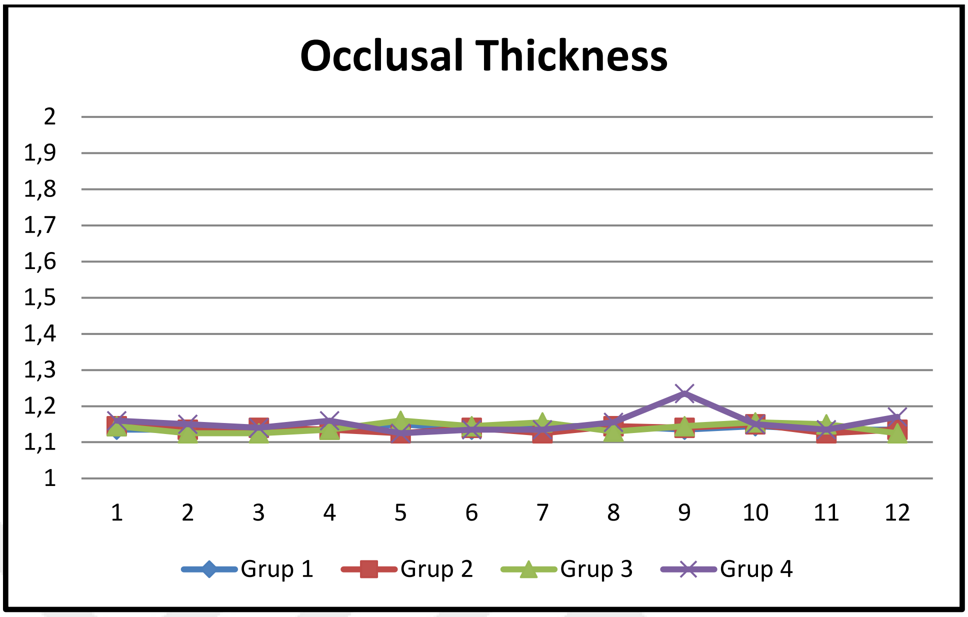

Figure 7: Evaluation of the occlusal thickness measurements of the groups

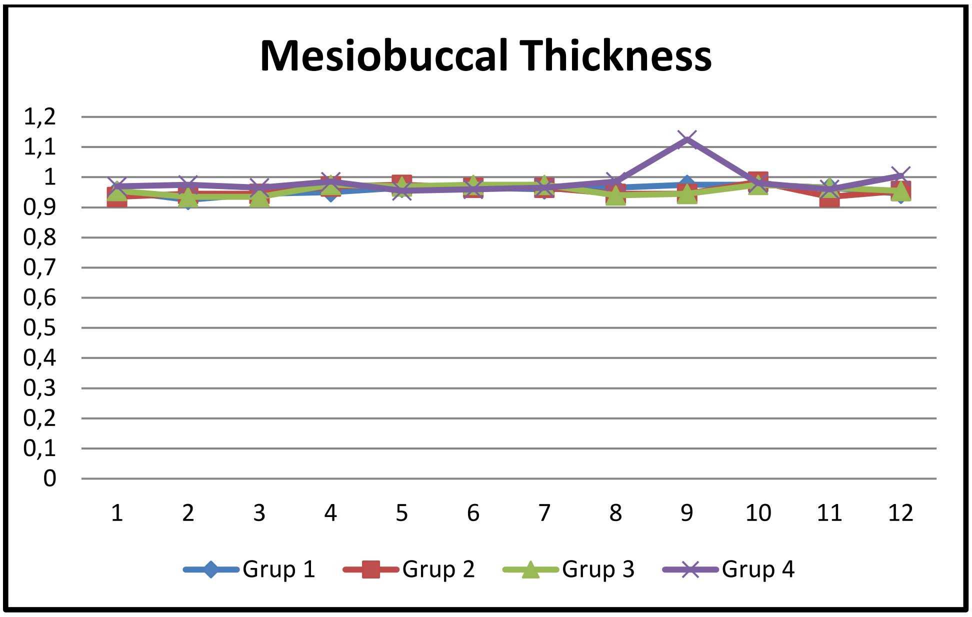

Figure 8: Evaluation of mesiobuccal thickness measurements of groups

Table 2: Buccal measurement results of groups according to the order of production of the crowns (Group 1 crowns 1-12 respectively from top to bottom, group 2 from top to bottom respectively 13-24 crowns, group 3 from top to bottom respectively 25-36 crowns, group 4 from top to bottom respectively 37-48 crowns.)

Buccal			
Group 1	Group 2	Group 3	Group 4
1,185	1,175	1,195	1,2
1,18	1,175	1,19	1,12
1,19	1,18	1,195	1,2
1,175	1,175	1,195	1,205
1,18	1,185	1,205	1,21
1,17	1,185	1,195	1,21
1,18	1,18	1,2	1,2
1,17	1,185	1,2	1,205
1,17	1,185	1,195	1,215
1,18	1,185	1,195	1,215
1,17	1,185	1,2	1,215
1,185	1,19	1,205	1,215

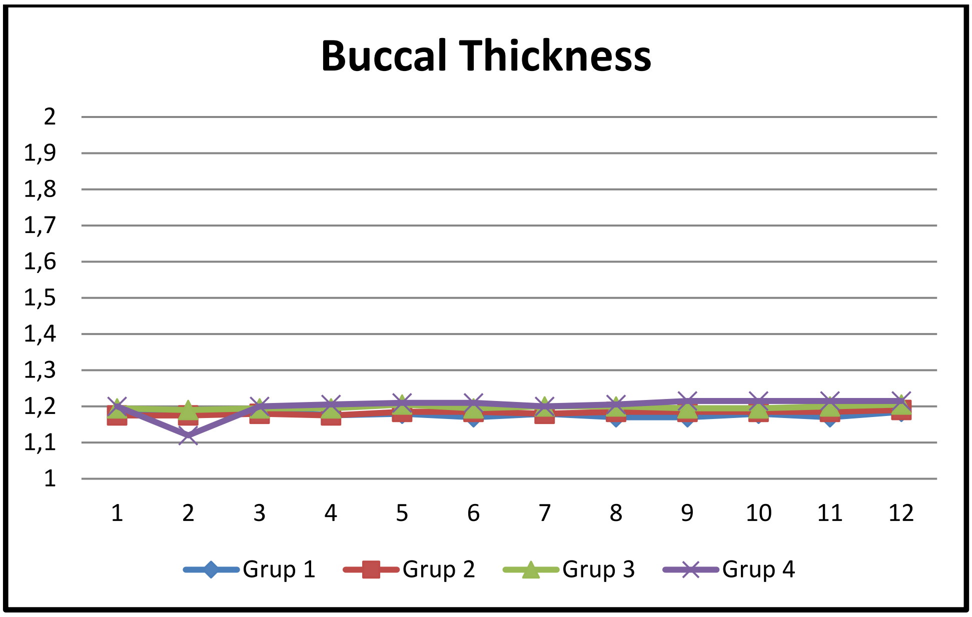

Figure 9: Evaluation of buccal thickness measurements of groups

Table 3: Evaluation of groups in terms of occlusal, mesiobuccal and buccal thicknesses

	Group 1	Group 2	Group 3	Group 4	
	Mean±Sd (median) (Min-Max)	**Mean±Sd (median) (Min-max)**	**Mean±Sd (median) (Min-Max)**	**Mean±Sd (median) (Min-Max)**	**p**
Occlusal	1,14±0 (1,14) (1,14-1,15)	1,14±0,01 (1,14) (1,13-1,15)	1,15±0,01 (1,15) (1,13-1,16)	1,16±0,03 (1,15) (1,13-1,24)	0,162
Mesiobuccal	0,96±0,01 (0,96) (0,93-0,98)	0,96±0,02 (0,95) (0,94-0,99)	0,96±0,02 (0,96) (0,94-0,98)	0,99±0,05 (0,97) (0,96-1,13)	0,061
Buccal	1,18±0,01 (1,18) (1,17-1,19)	1,19±0,01 (1,19) (1,18-1,19)	1,2±0,01 (1,2) (1,19-1,21)	1,2±0,03 (1,21) (1,12-1,22)	0,000*

Kruskal Wallis Test ** p<0.05*

There was no statistically significant difference between the groups in terms of occlusal thickness averages (p> 0.05).

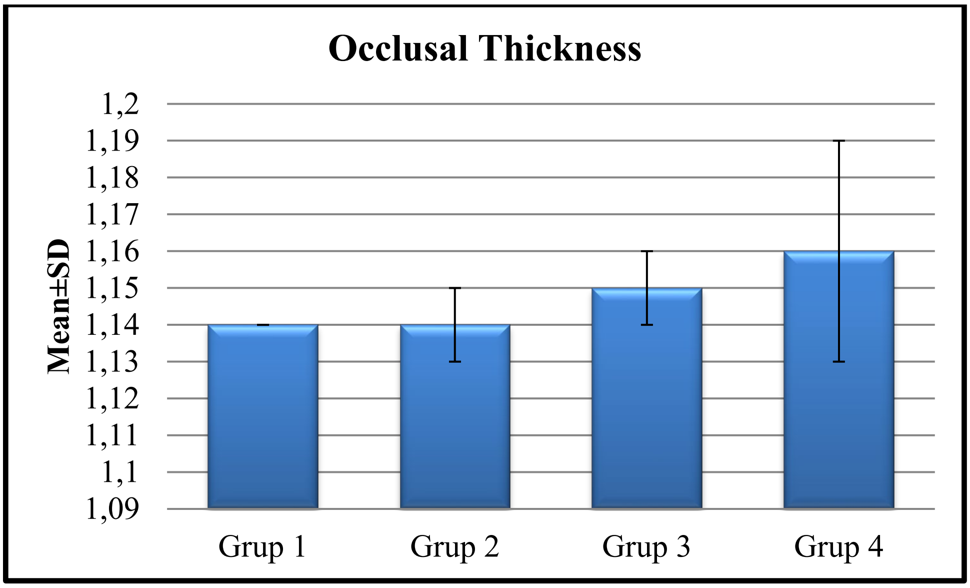

Figure 10: Mean occlusal thickness of the groups

There was no statistically significant difference between the groups in terms of the mean mesiobuckal thickness (p> 0.05).

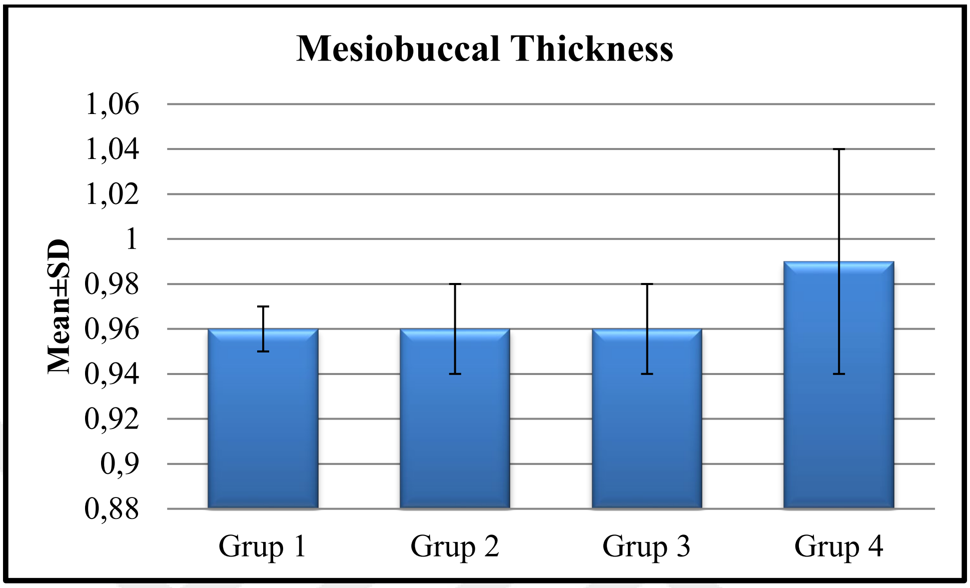

Figure 11: Mean mesiobuccal thickness of groups

There were statistically significant differences between the groups in terms of buccal thickness averages (p <0.05).

As a result of the paired comparisons to determine which groups the meaningfulness comes from; the mean thickness of Group 1 was significantly lower than Group 2, Group 3 and Group 4 (p1: 0.033; p2: 0.000; p3: 0.000; p <0.05). The mean thickness of Group 2 was significantly lower than Group 3 and Group 4 (p1: 0.000; p2: 0.000; p <0.05). The mean thickness of Group 3 was significantly lower than Group 4 (p1: 0.023; p <0.05).

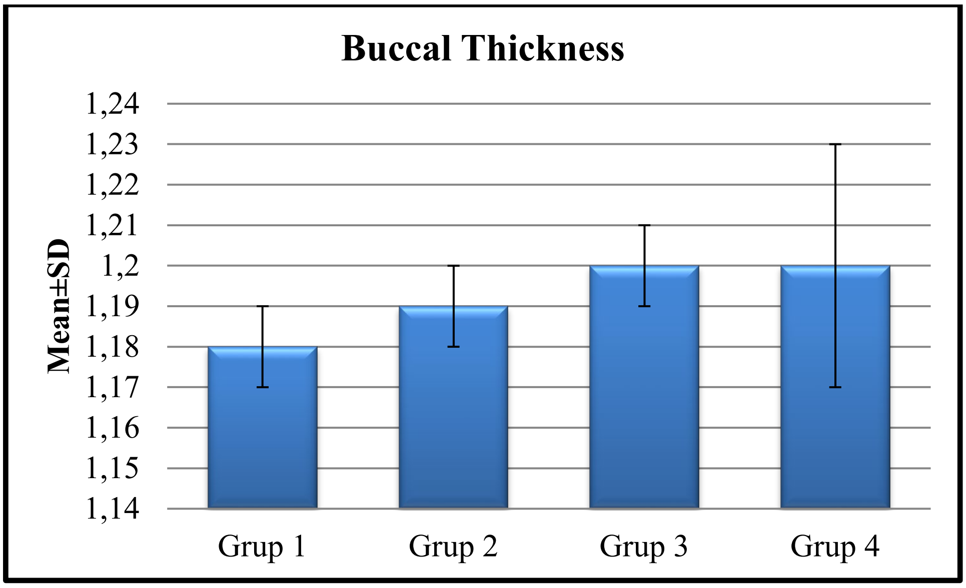

Figure 12: Mean buccal thickness of the groups

Table 4: Evaluation of the groups in terms of deviation amounts from the first measurement

Deviation amounts from the first measurement	**Group 1** Mean±Sd (median) (Min/Max)	**Group 2** Mean±Sd (median) (Min/Max)	**Group 3** Mean±Sd (median) (Min/Max)	**Group 4** Mean±Sd (median) (Min/Max)	**p**
Occlusal	0±0 (0) (0/0,01)	0±0,01 (0) (-0,01/0,01)	0,01±0,01 (0,01) (-0,01/0,02)	0,02±0,03 (0,01) (-0,01/0,1)	0,162
Mesiobuccal	0±0,01 (0,01) (-0,03/0,02)	0±0,02 (-0,005) (-0,02/0,03)	0±0,02 (0,005) (-0,02/0,02)	0,03±0,05 (0,02) (0/0,17)	0,021*
Buccal	-0,01±0,01 (-0,01) (-0,02/0)	0±0,01 (0) (-0,01/0)	0,01±0,01 (0,01) (0/0,02)	0,01±0,02 (0,02) (-0,06/0,03)	0,000*

Kruskal Wallis Test   * $p<0.05$

There was no statistically significant difference between the groups in terms of deviation from the first measurement in the occlusal region (p> 0.05).

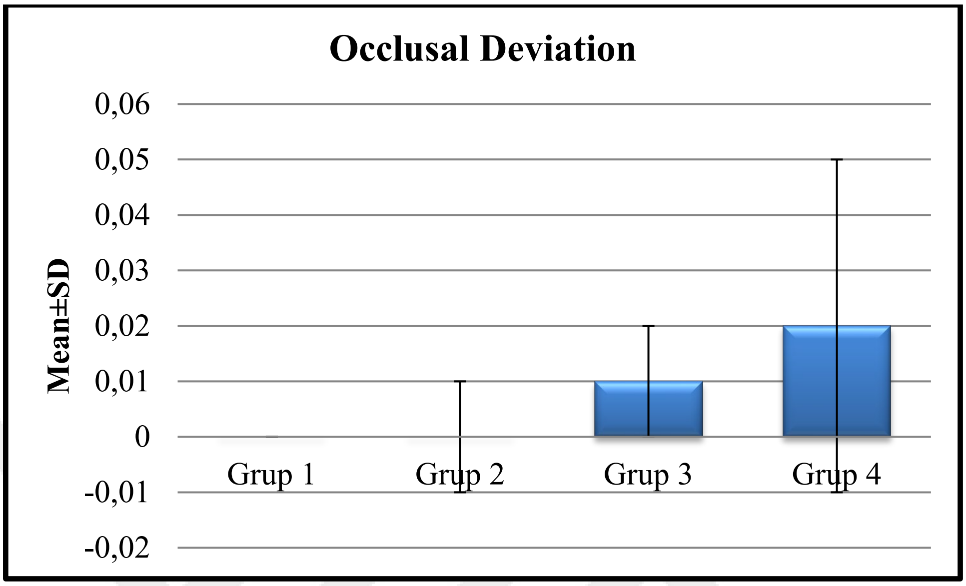

Figure 13: Mean deviation of the groups from the first measurement in the occlusal

There was a statistically significant difference in the amount of deviation from the first measurement in the mesiobuccal region between the groups (p <0.05).

As a result of the paired comparisons to determine which groups the meaningfulness comes from; the mean deviation of Group 4 was significantly higher than Group 1, Group 2 and Group 3 (p1: 0.008; p2: 0.008; p3: 0.025; p <0.05). There were no statistically significant differences between the groups in terms of deviation from the first measurement in Group 1, Group 2 and Group 3 (p> 0.05).

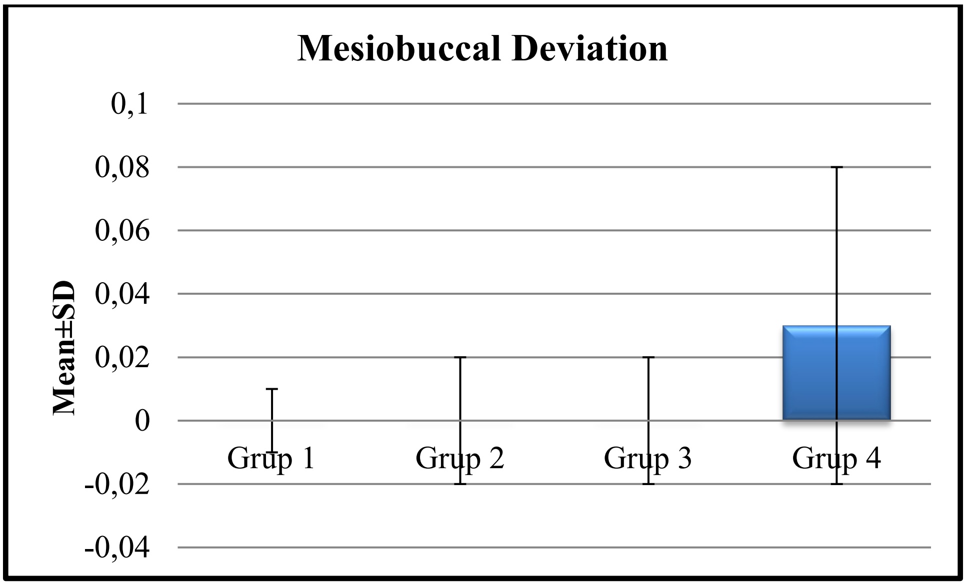

Figure 14: Mean deviation of the groups from the first measurement in mesiobuccal

There were statistically significant differences between the groups in buccal region in terms of deviation from initial measurement (p <0.05).

As a result of the paired comparisons to determine which groups the meaningfulness comes from; The mean deviation of Group 2 was significantly lower than Group 1, Group 3 and Group 4 (p1: 0.033; p2: 0.000; p3: 0.000; p <0.05). There was a decline deviation from the first measurement in Group 1, which was significantly different from Group 3 and Group 4 (p1: 0.000; p2: 0.000; p <0.05). The mean deviation of Group 3 was significantly lower than Group 4 (p1: 0.023; p <0.05).

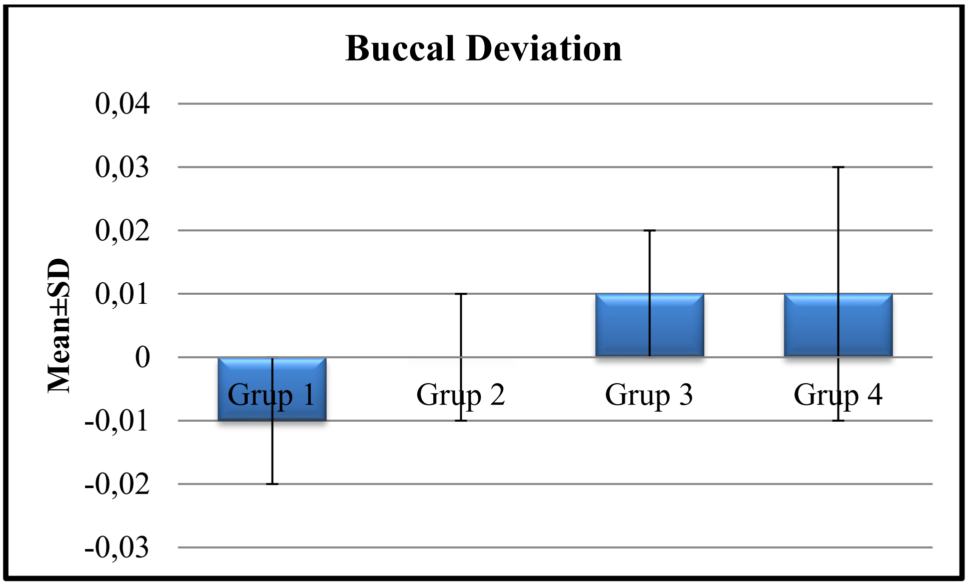

Figure 15: Mean deviation of the groups from the first measurement in buccal

5. DISCUSSION

In these days when we are used to living at a fast pace, we expect both our business to be done very quickly and to be able to satisfy our expectations and to be good enough to satisfy us. This idea also applies to dental treatments. Patients both have limited time and aesthetic expectations of the teeth that can meet the expectations very well they are talking about. We want dentists to do a better job both in terms of the number of appointments and to perform better functions and aesthetics. In the same way, technicians want to do a better job in a shorter time without the need for long processes like traditional methods.

As ceramic is the best material that can replace natural teeth in terms of aesthetics, it is preferable to use more ceramics. It is a fragile material if it restricts us. As computer aided design and production systems become widespread in dentistry, we can work with more materials and restorations can be made according to the aesthetic and mechanical properties we want (23). These systems allow us to keep up with our fast pace and make restorations in a short time. Mostly the same day, the measure can be taken and restoration can be produced.

Although CAD/CAM systems have been used in dentistry for many years, they have still not fully prevented traditional methods; continues to be development and improvement. The biggest disadvantage is the cost. Most research is on marginal adaptation of the crowns. There is not much work on precision of the burs. The reason we have done this study is that we think that the bur we use during the tooth preparation is wear in time and that the duration of our preparation is prolonged or we cannot get enough yield when we want to prepare it in the same period. In CAD/CAM systems, the preparation takes a certain amount of time and the production time does not change depending on the use time of the bur. By doing this study we wanted to see how the bur affects the production depending on the number of uses.

Diamond bur used in tooth preparation in the work of abrasive wear; the removal of the diamond pieces, the wear of diamonds, diamonds filled with residues and clogging or depending on the wear of the diamond binding material is shown (43).

Grajower et al. (61) found a correlation between the density of the diamond particles and the wear mechanism. They said that the application of cooling fluids during etching may help to prevent clogging (the stuffing of the residues between the diamond pieces). Siegel and von Fraunhofer (62) concluded that the build-up has a worse effect on the cutting efficiency compared to abrasion on the cutting surface or loss of diamond particles.

Zhou et al. (63) according to his work the actual wear mechanism, depending on the removal of diamond pieces. Freedman (43) pointed out the removal of the diamond fragments as the only wear mechanism of the diamond bur in two study examining the burs and mentioned how good the sticking of the diamond to the stainless steel would preserve the function of the bur. Benn-Hannan et al. (64) found diamond abrasion as the dominant wear mechanism in all types of burs.

Regev et al. (43) found the wear of diamond particles as the dominant wear mechanism. The effect of clogging and separation of the diamond pieces is minimal and no damage to the binding layer has been detected (43). Bae et al. (8) concluded that the cutting efficiency decreases as the number of uses increases, regardless of the type of the bur. They claimed that this decrease was the highest after the first use.

Emir et al. (65) concluded that diamond burs exhibited wear with repeated use in the clinic; this means that the surface roughness of the bur is reduced and thus the reduction in cutting efficiency. Therefore, especially after the use in prosthetic procedures, they recommended the replacement of diamond bur after every 5 teeth preparation.

Pilcher et al. (66) compared the use of single-use burs with multiple-use diamond burs and found that both of them had the same efficiency. With continuous use, cutting rates are reduced for all diamond burs. Wear and loss of diamond particles and binding material can lead to a reduction in cutting rates (67). In this study, 20 of them used 20 cutters and said that the performance after use is unknown (66). The cutting efficiency of the multi-use diamond burs is dependent on the residual build-up or the sterilization method (68). Therefore, if a diamond bur is not thoroughly cleaned of residues or if several patients have been repeatedly used and sterilized several times, there may no longer be an efficient cutting tool (66).

Nakamura et al. (69) compared two different diamond burs, one of which is normal. They stated that they observed wear and decrease in the diamond parts in both working time and the cutting efficiency of the cutter decreased according to the usage time.

There are not many studies on CAD/CAM burs. Yara et al. (69) compared two CAD/CAM systems (GN- I, GC Corp. Tokyo Japan and Cadim, Advance, Tokyo, Japan) to examine bur durability, and on one systems diamond bur after 21 crown production (GN- I, GC Corp.) found a significant reduction in diamond particles. They have an increase in surface roughness due to reduction in diamond particles. In the other system, no significant difference was observed between the two systems and the difference between the use of their own brand of ceramic blocks, they thought they were due to hardness. After the 11th crown, it was observed that the surface roughness increased with GN and bur marks were observed on the crown surface. The correlation between mean surface roughness and number of diamond particles was found to be significant (70).

Tomita et al.(52) using CAD/CAM (Cadim, Advance, Japonya), they produced 51 crowns in succession with the same diamond bur and they examined the change in the diamond particles and the surfaces of the crowns produced. They measured the inner and outer surfaces of the crowns with a three-dimensional coordinate measuring machine. There was no significant difference in the production accuracy of 51 crowns produced from ceramics.

At all measurement points, the inner surface is manufactured to be larger than the first produced crown (cement cavity is increased), the outer surface is smaller than the first crown (smaller crown). It has been observed that the occlusal surface decreases as the cavity gap increases with repeated production. They thought that this was due to a decrease in the diamond particles. After the 11th crown, it was observed that the decrease in the diamond particles on the bur increased gradually. They also stated that the surface roughness increased from the 21st crown and that they saw lines on the crown surface (52).

Corazza et al. (45) investigated the effects of use-related distortion of CAD/CAM diamond burs on surface roughness (Ra) and resistance of YTZP based ceramic substructures coated with feldspatic porcelain. 30 crowns were produced, cracks on the surface of the crowns were observed. They used digital calipers similar to our study in measuring the outer surface of the crowns. They used Step Bur and Cylinder Pointed Bur as we used in this study using CEREC in Lab and no significant wear was observed between the first and last uses on the burs.

Corazza et al. (45) in a study similar to their study again CEREC in Lab was used. Addison et al. (46) reported that while the feldspatic ceramic discs were etched while the manufacturer said that 50 crowns could be produced with the same bur, the burs were broken and abraded during the production of the 15th crown when both were scraped. Corazza et al. (45) reported that the difference between the study and the other studies (46,52) was due to the fact that they had previously used sintered zirconia. Previously, the use of sintered zirconia has been found to make milling easier. Therefore, we may think that there is no abrasion on the bur. From this, it can be said that the lifetime of the bur varies greatly depending on the material used and the size of the restoration to be produced (71).

In our study, the measurement of three-dimensional measurement devices with error of the company with the suggestion of the measurement was made with digital micrometer. The company said that the system will give a warning to change the bur when its work life is over, and 60-80 crowns can be produced with 1 set bur, this number may vary according to the material. In addition, CEREC Blocs with CEREC Premium version 4.4 stated that generally 50 crowns were produced for other feldspatic and glass ceramics, the system gave a warning at that time, but the burs had been abraded before, and therefore, they not recommended milling after 25 crown production. In our study, 48 crowns were produced until the device gave a bur change warning. The produced crowns were measured from the points previously determined from occlusal, mesiobuccal and buccal. The thickness of the first crown was compared with the thickness of the other crowns. There was no statistically significant difference in occlusal and mesial thickness ($p > 0.05$). The mean thickness of the group 1 in the average of buccal thickness; was significantly lower than group 2 ,group 3 and group 4. The mean deviation of Group 2 from the first measurement was significantly lower than group 1, group 3 and group 4. Deviation was observed to increase after Group 2. It was found that the thickness averages increased between the groups.

Depending on the usage, the difference of the thickness of the buccal percentage was found to be significant with the erosion of the bur. When deviated from the first value, a significant deviation was determined in the mesiobuccal measurements after the 36th crown. Deviation amount of the 13-14th crowns was determined to be the least. There is no difference in occlusal surface thickness and deviation from first measurement. While the mean averages of occlusal face and cusps do not change significantly, it can be said that buccal thickness increases with erosion on bur. Considering the amount of deviation from the initial value; When the production is made using CEREC Blocs, it is observed that the first 24 crowns are produced in the best way. It is thought that the number and quality of the crown produced can vary depending on the size of the crown. In our study, 1 mm thick crown was produced considering the ease of measurement and standardization. As in similar studies, the bur can be examined depending on the crown production, and its wear can be observed; but since the firm accepted that the bur was previously worn without giving a change of the burs, The bur has not been examined in our study and the change in crown thickness has been investigated. With the development of technology, it is thought that the quality will be increased by further developing the software and hardware.

6. CONCLUSİON

When the turbine burs were examined, it was observed that the time of the preparation was prolonged and the productivity decreased with the reduction of the diamond particles. In addition, it has been reported in the clinical setting that it is effective on the factors such as the force applied by the dentist, the type of hard tissue of the tooth and the viability of the tooth. In studies with CAD/CAM, it was reported that the time did not change and productivity decreased and the surface roughness increased with the decrease of diamond particles.

In this study, 48 crowns were produced with the same bur until the device was given a change of the bur change. The thickness of the crowns produced from the occlusal, mesiobuccal cusp and buccal was measured. The crowns produced were divided into 4 groups according to their order of production and the comparisons were made accordingly. The groups were examined in terms of their thickness averages and deviations from the data of the first crown produced.

Within the scope of this thesis study, the results obtained in the light of the data of the study can be listed as follows;

1. There was no statistically significant difference between the groups in terms of occlusal thickness averages ($p > 0.05$).

2. There was no statistically significant difference between the groups in terms of mesiobuckal thickness averages ($p > 0.05$).

3. There was a statistically significant difference between the groups in terms of buccal thickness averages ($p < 0.05$). When the groups were compared among each other, the average thickness was increased.

4. There was no statistically significant difference between the groups in terms of deviation from the first measurement in the occlusal region ($p > 0.05$).

5. There was a statistically significant difference in the amount of deviation from the first measurement in the mesiobuccal region between the groups (p: 0.021; $p < 0.05$). The mean deviation of Group 4 was significantly higher than Group 1, Group 2 and Group 3 (p1:0.008; p2:0.008; p3:0.025; $p < 0.05$). The deviation from the first measurement increased after the 36th crown.

6. There was a statistically significant difference in the amount of deviation from the first measurement in the buccal region between the groups (p: 0.000; $p < 0.05$). As a result of the paired comparisons to determine which groups the meaningfulness comes from; the mean deviation of Group 2 was significantly lower than Group 1, Group 3 and Group 4 (p1:0.033; p2:0.000; p3:0.000; $p < 0.05$). There was a decline deviation from the first measurement in Group 1, which was significantly different from Group 3 and Group 4 (p1:0.000; p2:0.000; $p < 0.05$). The mean deviation of Group 3 was significantly lower than Group 4 (p1: 0.023; $p < 0.05$). The deviation from the first measurement is the lowest in the 13th-24th crowns produced.

7. Depending on the usage, it was found that there was a significant difference in the thickness average on the buccal surface with the wear of the bur. If it is examined according to the deviation from the first measurement; a significant deviation was determined in the mesiobuccal measurements after the 36th crown. In the first 12 crowns there was determined declined deviation from first measurement on the buccal face. 13.-24th deviation amount of the crowns were determined to be the least. There is no difference in occlusal surface thickness and deviation from first measurement. Considering the amount of deviation from the initial measurement; when the production is made using CEREC Blocs, it is observed that the first 24 crowns are produced in the best way.

8 Although there was no significant difference in the thickness of the occlusal and mesiobuccal measurements, there was a significant difference in the buccal; starting the milling process from lingual, it is thought that the wear starts at the bur until it

reaches the buccal face. The points measured in the occlusal and mesial are formed by the tip of the bur and the buccal face is formed by the side surfaces of the bur.

Based on this; considering that the side surface of the bur is used in the milling of the block outside the crown until the face of the buccal face, the side surface of the bur is more worn, so it is thought that there is a significant difference in the thickness of the buccal percentage.

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8. CURRICULUM VITAE

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Work Experience (Sort from present to past)

Position	**Institute**	**Duration (Year - Year)**
		-
		-

Computer Skills

Program	**Level**

***Excellent , good, average or basic**

Scientific works

The articles published in the journals indexed by SCI, SSCI, AHCI
