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RESEARCH ARTICLE

EVALUATION OF THE EFFECT OF PREPARATION TAPER, FINISH LINE AND MARGINAL CONFIGURATION ON EXTRA ORAL SCANNING IN CAD/CAM- AN IN-VITRO STUDY.

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Abstract

Purpose of the study: Manyauthors and some of the clinicians are of the opinionthat tooth preparation is not the same for CAD-CAM restoration. There are some manufactures who also recommend preparation taper higher degree. Based on the above notion this study was conducted whether the tooth preparation has got any bearing in the scannability of gypsum models.

Aims and objectives: Theaim of the study is to scan the gypsum models using extraoral scanners. The objective of this study is to evaluate the following features of tooth preparation has any effect on scannability

1. Different preparation taper
2. Shoulder or chamfer margin
3. Plane of marginal placement

Materials and methods: Six standard metal dies were prepared with a crown length 8mm, diameter 5mm out of which

1. Three dies with 3^0, 8^0, 12^0taper each with shoulder margin
2. Two dies with shoulder and chamfer finish line
3. One with marginal geometry in different planes

Each die was duplicated 10 times and a total 60 models were obtained. The stone cast models were duplicated from the individual metal dies were scanned using extra oral model scanner INTELLIDENTIA.

Results: As far as extraoral scanning is concerned, there is no significant difference in scanning regarding preparation taper, finish line and marginal configuration.

Conclusion: Currently extraoral scanners are capable of producing virtual model images irrespective of preparation taper, Finish line and marginal geometry

Introduction:-

Automated restoration in the form of Computer Aided Designing and Computer Aided Manufacturing has become popular these days because of the quick, precise and bulk fabrication of restoration. CAD–CAM system has got 3 components

1. A digitalisation tool/scanner that produces digital data
2. Software to produce virtual images
3. Milling system to produce the restoration

Scanners have a digitalization tool that scans the prepared tooth and transform them into digital data sets.[1]
Scanners are of two types: intra-oral and extra -oral scanners. Extra oral scanners are the most commonly used scanners for large scale production and cost effective. Both operates on the optical properties of light. The extraoral scanners can be classified based on the source of light that it uses. They are Laser scanners and white light scanner [2]. Laser scanners analyses line pattern and it produces speckle effect. White light scanners analyses multiple stripe pattern for obtaining three-dimensional data [3]. The speed of laser is 10-500 kHz/s and that of white light is 3 mHz/s. In this study white light was employed from a professional CAD-CAM laboratory.

Aims & Objectives:

Aim

The aim of the study is to scan the gypum models using extraoral scanners.

Objectives:

The objective of this study is to evaluate whether the following feature of tooth preparation has any effect on scannability

1. Different preparation taper.
2. Shoulder or chamfer margin.
3. Plane of marginal placement.

MATERIALS AND METHODS:

Six standard metal dies wwere prepared with the described preparation geometry of length 8mm, width 5mm out of which**(Fig 1)**

- Three with varying degrees of 3^0, 8^0 and 12^0 taper of preparation taper each,
- Two dies with shoulder and chamfer finish line &
- One with marginal geometry in different planes.

Stone cast models were fabricated after duplicating the metal dies with putty impression material. A total of 60 samples of stone cast models were prepared of 10 each**(Fig 2)** and were scanned in INTELLIDENTA model scanner**(Fig 3)**.

PROCEDURE

All the models from each specified die were scanned using the white light scanner INTELLIDENTA. A total of 8 models can be scanned at a time with an average time of 11/2 minute.Scanning data were exported to STL file format through proprietary conversion. The STL FILE viewer is used to open up the scanned images and compared.
The scanned models with varying taper shown in **(Fig4,5,6)**
The scanned models with two different finish lines shown in **(Fig 7,8)**
The scanned models with varying marginal geometry is shown in **(Fig9)**

Figure 1: Metal Master Die

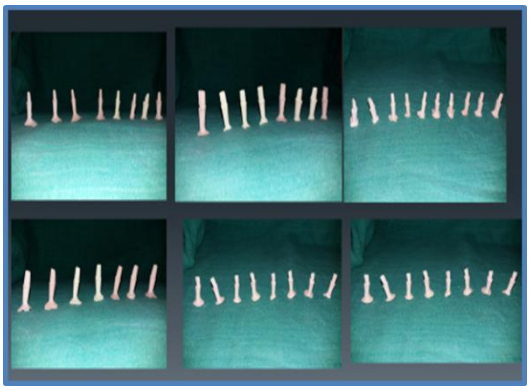

Figure2: Stone Cast Models

Figure 3: INTELLIDENTA model scanner with Scan Models

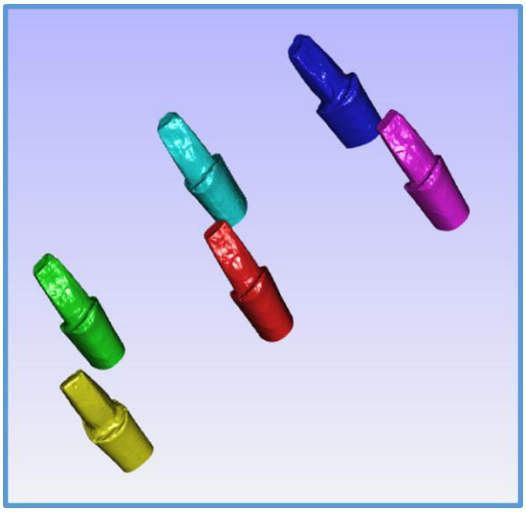

Figure 4: Scanned models with 3 degree taper

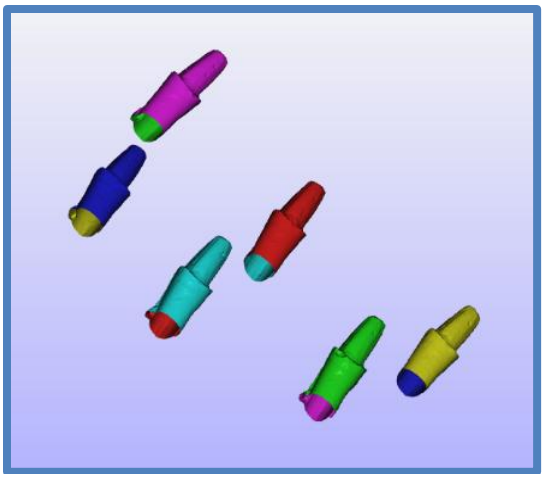

Figure 5: Scanned models with 8 degree taper

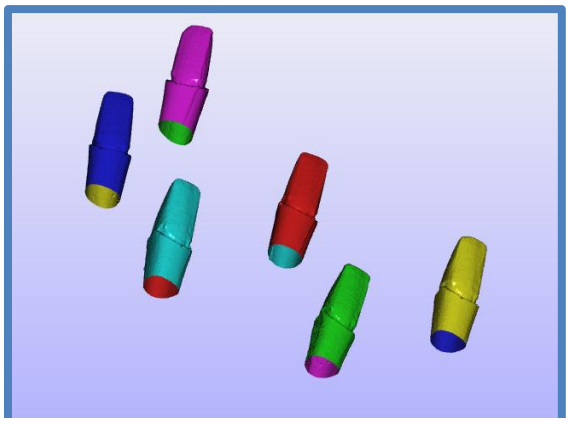

Figure 6: Scanned models with 12 degree taper

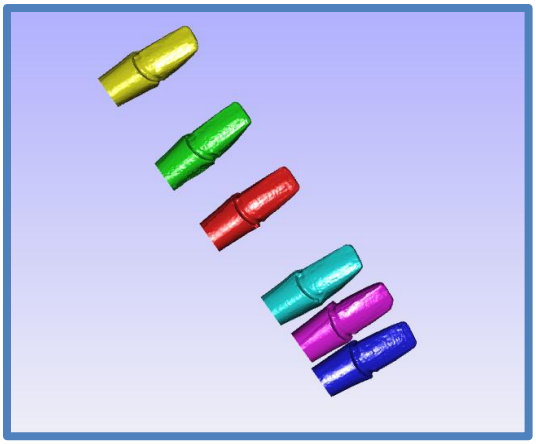

Figure 7: Scanned models with Chamfer finish lines

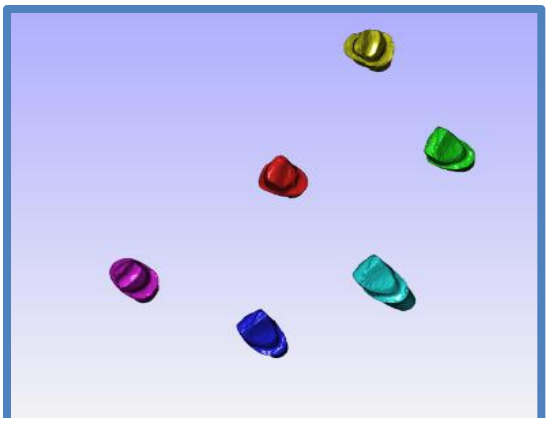

Figure 8: Scanned models with Shoulder finish lines

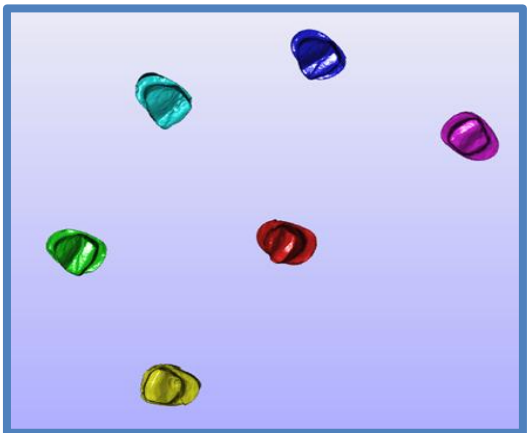

Figure 9:Scanned models with varying marginal geometry

Statistical analysis:

Similar to FEA**(Finite Element Analysis)** study the scanning efficacy does not require statistical analysis as it is self -explanatory.The scanned image is compared directly with the prepared tooth and the successibility of scanning is determined.

Result:

As far as extra oral scanning is concerned,there is no significant difference in scanning regarding preparation taper, finish line and marginal configuration.The magnetic table in the extra oral scanner allows 360 degrees movement of the individual model to allow the white light to pass in all the direction. Fitting of the copings depend on the size of tooling bur used for milling the block.

Discussion:

In the present study, white light extraoral scanner is used to analyse the effect of scannability on the preparation taper, finish line and the plane of marginal placement.

Many clinicians and manufacturers like E4D are of the opinion that little more taper is required for the CAD-CAM scanning. The purpose of this study was to determine whether the extraoral scanners can scan various degrees of preparation taper equally and different types of finish line margin without any difficulty.

Principle of Dental Scanner

When the White light is projected on the object, the reflected patterns are registered in the digital camera which is present in the receptor unit. The relationship between the light sources and the receptor unit is represented by a definite angle. This is based on the principle of **Phase shifting optical triangulation.** [4]

When light is focussed on a parallel object the light projected and the light reflected travel in the same linear pathway.[5]So the scanning requires a steep slope which can be achieved by using a higher degree of taper while scanning tooth preparations.

In this study, when the models with 3º,8 ºand 12ºtaper was placed in the scanning machine the virtual image produced after the white light reflection was same and there was no significant difference in the scanned image.
Even though slight manual adjustment is required for preparation taper with lesser degree taper it was not so very significant.

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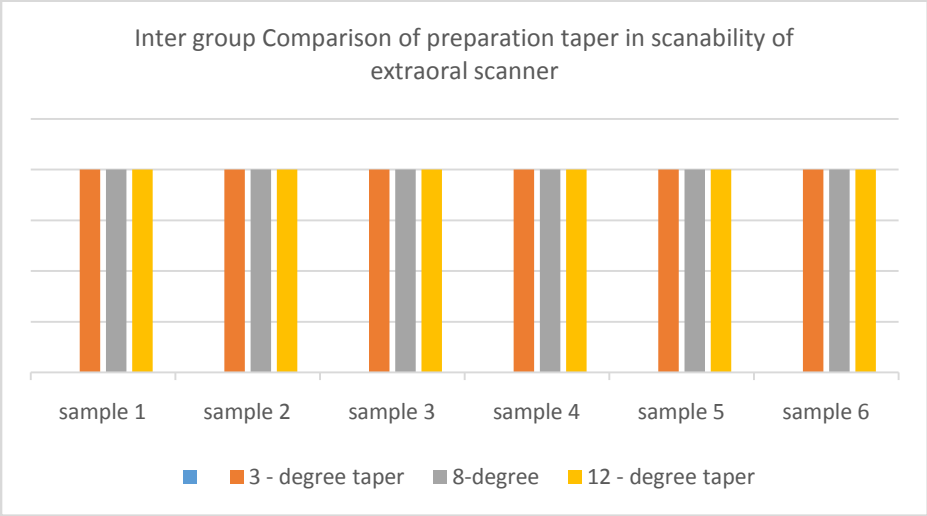
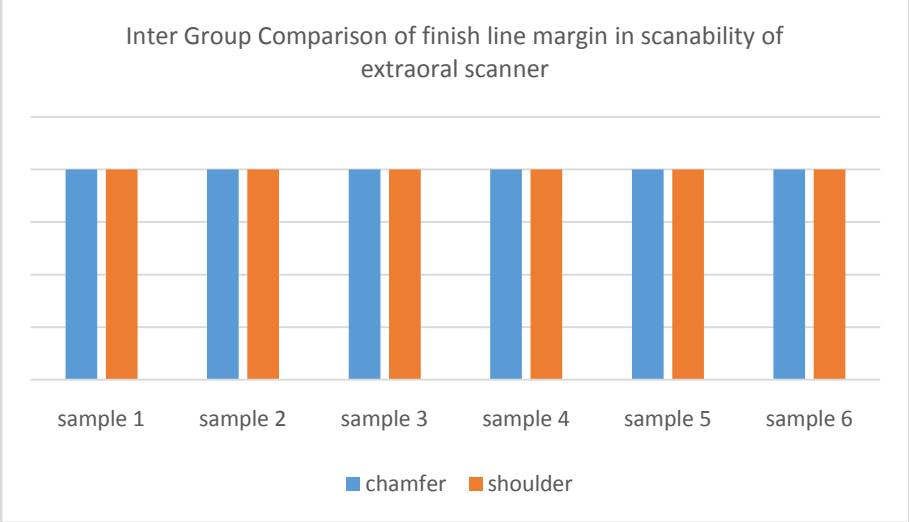
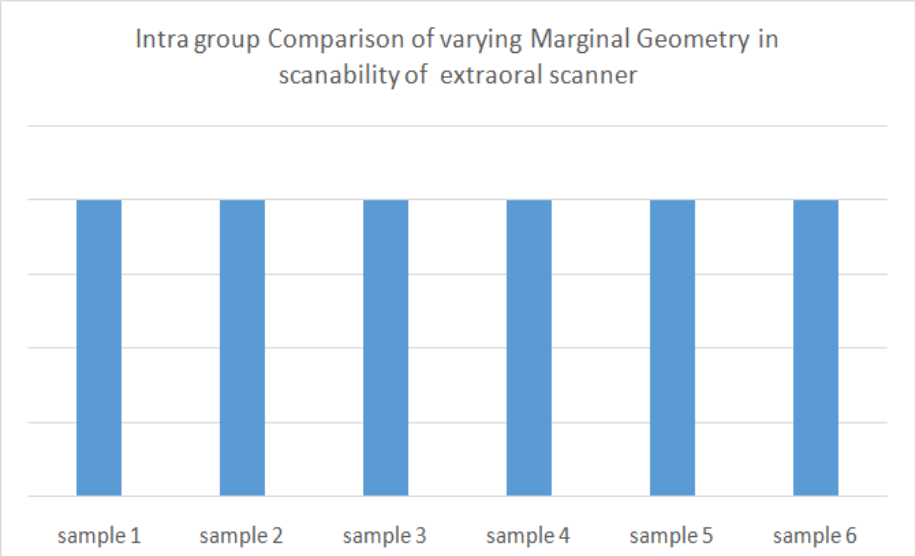


Graph1: Inter group Comparison of preparation taper in scanability of extraoral scanner.



Graph2: Inter groupComparison of finish line margin in scanability of extraoral scanner.

When the models with chamfer and shoulder finish line was placed in the scanning machine there was some difficulty in scanning the chamfer finish line margin when compared to the shoulder finish line. Some manufacturers recommend only shoulder finish line. But the modern day extra oral scanners can scan both the finish lines efficiently.



Graph3: Intra group Comparison of varying Marginal Geometry in scannability of extraoral scanner.

When the models of varying marginal geometry were scanned the planes which goes deep into the sulcus were scanned with little difficulty and requires some manual adjustment when compared to that of the planes which are not so deep.

The reason behind this may be due to the uneven distribution of the titanium dioxide powder which is used for coating the models for scanning. The source of the white light which is used for scanning is projected from the sides of the scanner. The reflection of the light may not be sufficient to produce the virtual image. The software resistance which is present due to which the images has to be manually manipulated. But the difficulty in scanning and the difference in the virtual image formation is very minimal and is not considered significant.

The white light extra oral scanner INTELLIDENTA which is used in this study can scan the various preparation taper 3^0,8^0,12^0without any significant difference. The difference in high degree taper may be attributed to the intra oral scanners due to limited space available, humid intra oral environment and salivary flow.

Regarding the finish line margin, shoulder margins and chamfer margins can be equally scanned and the marginal geometry in different planes can be manually adjusted. But the shoulder margins are better scanned.

The marginal geometry of the tooth preparation affects the fitting of the milled copings. If the preparation geometry is not uniform the fitting might not be proper. But the scanning with extra oral model scanners does not have any significant difference in scanning different planes[6].

Conclusion:

Within the limitation of this study the tooth preparation could be the same for CAD-CAM and conventional crown fabrication irrespective of preparation taper, finish line and marginal geometry. Extra oral scanners can scan any degree of preparation taper, finish line and plane of marginal geometry. Probably there might be some difference in the taper and sub-gingival margin placement when intra oral scanners are used. The optical properties are monolithic in case of stone models which are scanned by extra oral scanners.

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