A COMPARATIVE EVALUATION OF OCCLUSAL CONTACTS AND OCCLUSAL ADJUSTMENTS MADE USING A VIRTUAL ARTICULATOR AND FUNCTIONAL GENERATED PATHWAYS TECHNIQUE IN A PROVISIONAL RESTORATION

Dissertation

Submitted to the

BABU BANARASI DAS UNIVERSITY, LUCKNOW, UTTAR PRADESH In the partial fulfillment of the requirement for the degree

Of

MASTER OF DENTAL SURGERY

In

PROSTHODONTICS AND CROWN & BRIDGE

By

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BABU BANARASI DAS COLLEGE OF DENTAL SCIENCES, LUCKNOW

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BATCH: 2019-2022

ENROLLMENT NO: 1190329005

DECLARATION BY CANDIDATE

I hereby declare that the dissertation entitled " **A COMPARATIVE EVALUATION OF OCCLUSAL CONTACTS AND OCCLUSAL ADJUSTMENTS MADE USING A VIRTUAL ARTICULATOR AND FUNCTIONAL GENERATED PATHWAYS TECHNIQUE IN A PROVISIONAL RESTORATION**" is a bonafide and genuine research work carried out by me under the guidance of **Dr AMRIT TANDAN** Professor, Department of Prosthodontics and Crown & Bridge. Babu Banarasi Das College of Dental Sciences, Lucknow, Uttar Pradesh.

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Place: Lucknow

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CERTIFICATE

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ACKNOWLEDGEMENT

"No one who achieves success does so without acknowledging the help of others."

My mentor, **Dr Amrit Tandan**, M.D.S. Professor, Department of Prosthodontics, Babu Banarasi Das College of Dental Sciences, Lucknow deserves the highest praise. He patiently supplied me with the vision and motivation needed to finish my dissertation. His extensive expertise shed a light on this research project and helped me to think out of the box by exploring unseen aspects of this thesis. I will be eternally grateful for his scholarly guidance.

It brings me great pleasure to express my profound gratitude to my esteemed Professor, **Dr Swati Gupta**, a woman endowed with remarkable foresight and the ability to attain excellence via a wealth of knowledge. Thank you, ma'am, for always being an inspiration and believing in me even when I didn't believe in myself.

It brings me great pleasure to express my gratitude to my respected Principal, **Dr Puneet Ahuja**, for his permission and advice over the course of this project.

I am grateful to the Readers **Dr Manoj Upadhayay**, **Dr Garima Agarwal**, and **Dr Virag Srivastava** for their insightful feedback that pushed me to sharpen my thinking and brought my work to another level. I would like to extend my gratitude to Senior Lecturers **Dr Anant Agarwal**, **Dr Arun Tiwari**, **Dr Divyjot**, **Dr Ruquaya Bashir**, and **Dr Amrita Upadhyay**, **Dr Neha Jaiswal and Dr Kausthiki** for their unwavering support and excellent ideas whenever I sought them.

I would like to express my gratitude to my colleagues, **Dr Bhumika Singh Chauhan**, **Dr Rehana Bano, Dr Arushi Agarwal** for always cheering me up and helping me in the clinical procedures by being there. I thank my juniors **Dr Rusa**, **Dr Khirod**, **Dr Namra**, **Dr Roopali, Dr Rakhi** for their support and assistance in the most critical moments.

From the bottom of my heart, I am grateful to my mother, **Dr Rajyalakshmi Matety** and my father, **(Col) Dr Ashok Rao Matety** for their blessings and for always believing in me.

I am eternally grateful to my brother, **Arvind Matety** and my sister-in-law **Ramya Matety** for their unwavering love and sympathetic ear. I owe my gratitude to my best friend **Dr Ritika Sethi** for her unwavering love, support, and encouragement, as well as her best wishes.

BEST REGARDS

-Dr Matety Ashwin

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LIST OF ABBREVIATIONS

S.No.	Abbreviations	Full Form
1.	et al.	et alia (and others)
2.	FGP	Functionally Generated Path
3.	VA	Virtual Articulator
4.	i.e	That is

LIST OF ANNEXURES

ABSTRACT

Background:

One of the most common prosthodontic treatments rendered to patients is placement of crown. As the lower first molar is the first posterior teeth to erupt in the oral cavity (i.e., 6 years), it is more prone to caries and a root canal treatment might be necessary followed by placement of a crown. The success of a crown is determined by many factors, out of which one such factor being occlusion.

Aim:

To compare and adjust the number of occlusal contacts in a provisional restoration in centric occlusion using a virtual articulator and functionally generated path technique.

Materials and Methodology:

The present study was carried out in BBD college of Dental Sciences, Lucknow with a sample size of 10. A clinic evaluation of the provisional prosthesis fabricated on lower 1st molar using FGP technique and VA was done. The number of occlusal contacts and number of occlusal adjustments according to the reference tooth and patient compliance made were noted down.

Results:

After 1st & 2nd adjustment, mean number of markings were significantly more among VA group as compared to FGP group but after 3rd & 4th adjustment for centric, mean number of markings did not differ significantly. After 1st & 2nd adjustment, mean number of markings did not differ significantly among FGP & VA group. Mean number of adjustments done were significantly high among Centric type among both FGP & VA groups. Mean number of adjustments, both centric & eccentric, done were significantly high among FGP group as compared to VA group.

Conclusion:

With the era of modern dentistry new methods such as articulation through a virtual articulator has developed better results in terms of occlusal adjustments both in centric and eccentric contacts. By the present study virtual articulator has been

deemed better in terms of both patient compliance as well as operator's ease than FGP in delivering of the prosthesis.

One of the most common prosthodontic treatments rendered to patients is placement of crown. As the lower first molar is the first posterior teeth to erupt in the oral cavity (i.e. 6 years), it is more prone to caries and a root canal treatment might be necessarily followed by placement of a crown. The success of a crown is determined by many factors, out of which one such factor being occlusion.

Occlusion is defined as the static relationship between the incising or masticating surfaces of the maxillary or mandibular teeth or tooth analogues.[1]

Occlusion can be of two types which are static occlusion and dynamic occlusion. Static occlusion is the contacts between the teeth when the mandible is not moving, whereas dynamic occlusion is the occlusion when the mandible performs protrusive and lateral movements. Recording dynamic occlusion is important to reduce the chair side time of the operator and the patient.

Functionally Generated Path technique is one such method to record the dynamic occlusion which was first proposed by Meyers and was termed as chew in technique. In 1933, Meyer described techniques that allowed the dentists to use the patient's mandibular movements to carve an occlusal surface. Functional Generated path is determination of the harmonious relationship between the occlusal path (the functional occlusal path) and the condylar paths at a given vertical dimension [2]. It can also be defined as static representation of the opposing cusps' dynamic eccentric movements from a centric position to achieve optimal articulation and occlusal harmony. The FGP technique records such eccentric movements at the precise occlusal vertical dimension (OVD), as the eccentric movements are influenced by both the anterior and condylar guidance.

Meyer suggested that 'no occlusal adjustment in the mouth should be necessary if the technique is performed properly'. Pankey and Mann modified the principles discussed by Meyer to describe a "functionally generated path" record. FGP is also being used in fabrication of implant-retained fixed partial dentures. FGP is a practical method to achieve harmonious occlusal anatomy of restorations with the anterior determinant/anterior guidance, the posterior determinant/condylar guidance, existing occlusal and cuspal anatomy, and the neuromuscular system.[3]

Dawson and Shillingburg et al note the following prerequisites for use of the FGP:

- Existence of ideal occlusion.
- Absence/elimination of posterior interferences.
- Adequate opposing occlusal surfaces capable of generating a functional path: no significant rotations, no carious lesions, no deficient restorations.

Articulators are mechanical instrument that represents the temporomandibular joints and jaws, to which maxillary and mandibular casts may be attached to simulate some or all mandibular movements [1]. There are many types of articulators used in dentistry such as mean value articulator, semi adjustable articulator and fully adjustable articulators. One of the recent advances in articulators are virtual articulators.

Virtual reality refers to "immersive, interactive, multi-sensory, viewer centered, three-dimensional (3D) computer generated environments and the combination of technologies required to build these environments". In essence, virtual reality is a clone of physical reality creating a virtual environment to replace the real-world environment. Virtual articulators use virtual reality to simulate jaw movements.[4]

The programming and adjustment methods of the virtual articulator were described by Kordass and Gärtner in 1999. First a digital image is obtained of the surfaces of each tooth, of the both dental arches, and of the bite registries. To this effect a three-dimensional laser scanner is used, such as for example the Laser Scan 3D (Willytec, Munich, Germany). This scanner projects a vertical laser beam onto the surface of the object. A digital camera equipped with a charge coupled device (CCD) registers the beam reflected from the object and transmits the digital signals to an electronic processing system. The processed image data are stored as digital matrix brightness values, ready for use by the scanner software and for on-screen visualization and computerized manipulation. [5]

The basic system of the virtual articulator generates an animation of the movements of the mandible based on the input data, and calculates the points of occlusion, which in turn are shown on-screen by means of some type of code. [6]

Ideally, the virtual articulator is equipped with a device for registering the specific mandibular movements of a given patient (such as the JMA), and can integrate the movements recorded in the animation.

There are two types of virtual articulators namely -Completely adjustable and mathematically simulated.[7] The virtual articulator requires digital 3D representations of the jaws and patient specific data on jaw movements and then simulates jaw movements and provides a dynamic visualization of the occlusal contacts.

Virtual articulator can also show the effects of resilience of the soft tissue on the time dependent basis during muscular movements of chewing or eating. That is why it can illustrate the real time dynamics of the occlusion. Other advantages of using virtual articulators over mechanical ones are the reduction in inaccuracies while making interocclusal registration with materials prone to deformation (eg: Bite registration wax) and accurate repositioning of the master cast into bite impression without leaving any space.[8]

The most precise occlusal surface reproduction can be accomplished by using virtual articulators with CAD/CAM systems.

The virtual articulator has been compared with the mechanical articulator in orthognathic surgery, to create ideal maxillary position and for making surgical splints and concluding that the virtual method is more precise than the conventional approach.[9]

Advantages of Virtual Articulator

- Offers best quality of communication between the dentist and dental technician
- Simulating real patient specific data
- Examines both static and dynamic occlusions
- Analyses ganathic and joint conditions

- Acts as a 3D navigator

Limitations of Virtual Articulator

- Not cost effective as it requires the digital sensors, digital scanners, software's, and different types of virtual articulator models mimicking the mechanical ones according to the patient need.

- Knowledge about the CAD/CAM technology, mechanical articulators, designing and modeling of virtual articulators etc and technical skills regarding the understanding of data recorded from scanners, sensors, minor adjustments, incorporating motion parameters etc. [10]

The purpose of this study is to make a detailed comparative evaluation of occlusal points and occlusal adjustments in functionally generated path technique and virtual articulators.

AIM AND OBJECTIVES

AIM

To compare and adjust the number of occlusal contacts in a provisional restoration in centric occlusion using a virtual articulator and functionally generated path technique.

OBJECTIVES

- To assess the number occlusal contacts of a provisional restoration fabricated
  - using a virtual articulator
  - using FGP technique
- To compare the number of occlusal contacts of provisional crown fabricated by using both.
- To compare the number of adjustments required to equalise the contacts in provisional restoration made by both in centric occlusion.

Meyer S (1936) [2] described functional generated path in a complete denture patient for the first time and called it a 'chew in technique'. According to him, the occlusal anatomy of upper dentition can be established by the movements of the mandible.

Victor NJ (1954) [11] used FGP technique in complete denture patients. According to him the same principle, with necessary variations, has been applied in the construction of occlusal correction splints, partial dentures, fixed partial prosthesis, precision partial dentures, full lower dentures made to the patients' natural upper dentitions, and against partial dentures, full upper dentures to patients' own natural or existing partial dentitions. and to immediate single dentures and this technique has produced most gratifying results.

Pankey and Mann (1960) [12] modified the FGP technique described by Meyers utilizing guide castings on the upper cuspids to control the development of a functional occlusion. He also emphasised on use of interocclusal wax functionally generated path records made on functionally generated path tables which made it possible to eliminate all occlusal interferences and establish the functional form of the occlusal surfaces of the restorations.

Zimmermann M (1966) [13] stated that when functionally generated path procedures are carefully followed, a minimum of occlusal adjustments are required when cast restorations for the maxillary posterior teeth are placed in the mouth, but he also pointed out a few problems encountered by both the laboratory and clinician and brought about some modifications for the same.

Kafandaris NM (1981) [14] modified technique presented by Meyers and proposed modifications such as (1) the use of the cast partial denture framework of the ceramometal restoration as the recording base and (2) the use of an interim acrylic resin restoration to compensate for any possible errors before completing the restoration. The technique he proposed could be used for both unilateral and bilateral restorations, including the final part of complete occlusal treatment proposed by Pankey and Mann.

Weingärtner (1998) [15] stated that there is a strong need for a computer model of the jaw - the virtual jaw - to support physicians and surgeons in diagnoses and

preoperative planning. They spoke about 3D simulation of the human mastication apparatus which can be used for the preoperative planning of craniofacial surgeries as well as the education of dentists and surgeons and stated that it consists of three interacting components: A kinematic model which defines the constraints of the articulation, a model for the mastication muscles and a 3D graphical interface.

Kordaß B (2002) [16] stated that the VR articulator is a basic tool that deals primarily with the functional aspects of occlusion which is also regarded as a core tool in many diagnostic and therapeutic procedures and in the CAD/CAM manufacture of dental restorations. The add-on modules will be changing conventional ways of production and communication in dentistry and will begin to replace the mechanical tools.

Bisler A, Bockholt U, Kordass B, Suchan M, Voss G (2002) [17] stated that the virtual articulator (VA) is intended for use as a tool for the analysis for the complex static and dynamic occlusal relations. Its chief application is in individual diagnosis and the simulation of the mechanical articulator. VR combined with CAD/CAM technology has great potential in implant planning and design in terms of greater precision and shorter treatment duration.

DeLong R et al (2002) [18] concluded in his studies that occlusal contacts calculated from aligned virtual casts accurately reproduce articulator contacts.

Solaberrieta et al (2009) [19] **in their study** research project aiming at designing a Virtual Articulator in order to simulate and analyze mandibular movements of the human jaw. Its main goal is to improve the design of dental prostheses, adding kinematic analysis to the design process. First, they scanned the plaster models and then the type of articulator is selected. Third, the prosthesis is statically modelled. Fourth, excursive movements are simulated using a CAD system, analyzing occlusal collisions to adequate/modify the design and then Finally, the current shortcomings of virtual articulator simulation were discussed in detail and a research prospect is advanced.

Ghanai S, Marmulla R, Wiechnik J, Muehling J, Kotrikova B(2010)[20] presented a computer-assisted planning system for dysgnathia treatment and described the process of information gathering using a virtual articulator and how the splints are

constructed for orthognathic_surgery. Preliminary results showed that conventional repositioning could be replicated using the virtual articulator.

Solaberrieta E, Mínguez R, Barrenetxea L, Etxaniz O(2013)[21] described a digital technique to transfer the location of digitized casts obtained directly from the patient to a virtual articulator (digital/virtual facebow transfer). The primary advantage of this technique is that it allowed the dentist and the dental_laboratory technician to work in a fully digital environment without having to mount stone casts on a physical articulator. This resulted in a significant time reduction and a higher degree of accuracy in the cast location.

Solaberrieta E, Minguez R, Barrenetxea L, Sierra E, Etxaniz O (2013) [22] noted that working in a virtual environment offers the possibility to calculate the volumetric interference between teeth, which is obviously not possible in the physical articulator. This facilitates the elimination of interferences whereas in the traditional method, when interferences are detected, the only possible solution is to mark them with articulating foil, but virtual articulators show these interferences in three dimensions.

Koralakunte PR, Aljanakh M (2014) [23] stated that the virtual articulator is an application in prosthetic and restorative dentistry based on virtual reality which significantly reduces the limitations of the mechanical articulator, and by simulation of real patient data, allows analyses with regard to static and dynamic occlusion as well as to jaw relation. They presented the concepts and strategies for a future replacement of the mechanical articulator by a virtual one. Also, a brief note on virtual reality haptic system had been highlighted along with newly developed touch enabled virtual articulator.

Memon S (2014) [24] evaluated the benefits of the double casting technique with FGP over the conventional casting technique. They selected ten patients with root canal treated maxillary molar to fabricate metal crowns. Two techniques, one involving the conventional fabrication and other using functionally generated path with double casting were used to fabricate the prosthesis. A comparison was done between the two. The change in the height of castings for the double casting group was less compared to the conventional group and was highly statistically significant

($P < 0.001$). The time taken for occlusal correction was significantly lesser in double casting group than the conventional group ($P < 0.001$). The patient satisfaction (before occlusal correction) was more for double casting group compared to conventional ($P < 0.01$). The functionally generated path with double casting technique resulted in castings which had better dimensional accuracy, less occlusal correction and better patient satisfaction compared to the conventional castings.

Solaberrieta EE, Etxaniz O, Minguez R, Gorozika J, Barrenetxea L (2015) [25] stated that Dental virtual articulators constitute a great improvement in the design of dental prostheses. They used computer aided design (CAD) systems and Reverse engineering tools that permits the introduction of kinematic analysis in virtual design processes. The aim of their study was designing a dental virtual articulator in order to simulate and analyse the mandibular movements. After a virtual construction of the articulator, plaster models of the jaw were scanned. Afterwards, with the help of the CAD system, the dental prosthesis was finally developed as mandibular movements are simulated. The main value of their research paper was its contribution to the methodology for the implementation of virtual design in the production of dental prostheses.

Solaberrieta E, Otegi JR, Goicoechea N, Brizuela A, Pradies G (2015) [26] concluded of that the accuracy provided by a virtual occlusion procedure is greater than that of the traditional physical interocclusal records.

Saafi J et al (2018) [27] used a modified technique of FGP to fabricate a unit metal ceramic crown using a temporary crown and simple plastic occlude rather than a twin stage occluder.

Yamamoto T et al (2018) [28] introduced a simple technique for simultaneously taking a closed-mouth impression and functionally generated path (FGP) for a full coverage crown restoration. An alginate impression of the abutment tooth was made to fabricate a custom-made closed-mouth impression tray covering the abutment tooth and the adjacent teeth. The tray had an FGP table and an abutment tray in cameo and intaglio surfaces, respectively. The impression was taken with silicone impression material after adjusting the abutment tray and inscribing the FGP using self-curing acrylic resins. Plaster casts were made from the impression, and a

zirconia crown was fabricated. The crown was cemented to the abutment tooth with minimal adjustments. This simple technique resulted in a well-fitting crown that accounted for mandibular movements. Using the custom closed-mouth impression tray incorporating an FGP table simultaneously aids in fabricating an accurately fitting restoration that incorporates harmonious mandibular movements using a single impression capture

Seong-gi Park et al (2019) [29] developed a method which involved the digital application of the functionally generated path (FGP) technique to fabricate an implant-supported fixed prosthesis. They used an intraoral optical scanner, dental design software, and a specially designed removable FGP table and with this method, clinicians were able to design custom implant-supported fixed prostheses without occlusal interferences, reducing the chairside time required to deliver the prosthesis.

Lepidi L, Chen Z, Ravida A, Lan T, Wang HL, Li J (2019) [30] introduced a full digital approach to articulating a scan of the maxillary arch on a virtual articulator, using only a CBCT and intraoral scanner which reduced chairside time.

Hsu MR, Driscoll CF, Romberg E, Masri R (2019) [31] in their study proved that Dynamic movements on the virtual articulator were as true and precise as to the mechanical articulator. When there were deviations, these deviations were less than 100 μm and thus, these deviations may not be clinically relevant.

Lepidi L, Suriano C, Wang HL, Granata S, Joda T, Li J (2020) [32] described a completely digital protocol starting from the virtual articulator mounting to developing static and dynamic occlusion in a complex prosthetic rehabilitation.

Ye-Chan Lee et al (2020) [33] The Patient specific motion which is a digital form of FGP may be a simple and effective alternative tool that shows clinically acceptable results in the occlusal adjustment of a single posterior crown.

The present study was conducted in the Department of Prosthodontics, Crown and Bridges, Babu Banarasi Das College of Dental Sciences, BBD University, Faizabad Road, Lucknow, India. The aim of the study was Comparative evaluation of occlusal contacts and occlusal adjustments made using a virtual articulator and functionally generated pathways technique in a provisional restoration.

Patients requiring crowns for lower first molars were selected for the study sample as per the inclusion and exclusion criterias. The study was approved by the ethical committee of Babu Banarasi Das College Of Dental Sciences, BBD University. The number allotted to the study **IEC CODE 28.** Patients were provided with a consent form with written explanation regarding the nature of treatment, associated procedures.

Ten patients requiring complete veneers on lower first molars were selected and were given two provisional restorations one fabricated using functionally generated pathway and the other using a virtual articulator.

1. Mouth mirror (GDC)

2. Tweezers (GDC)

3. Explorer (GDC)

4. Airotor (NSK)

5. Round end tapered bur (Mani)

6. Torpedo diamond bur (Mani)

7. Tapered fissure bur (171L) (Mani)

8. Milling machine (IMS I core)

9. Irreversible hydrocolloid impression material (Algitex)

10.Dental stone plaster Type III (Kalabhai)

11. Medit- 3D scanner

12. EXOCAD software

13. Semi adjustable articulator (Bio-Art)

14. Self-curing acrylic resin (PYRAX)
15. Pattern resin (GC)
16. Tooth coloured self-cure acrylic resin (DPI)
17. GDC Articulating Paper Holder Apf2e Miller
19. Articulating Paper (Bausch)
20. Laboratory micromotor
21. Straight hand piece
22. Round bur (BR-31)

METHOD

The sample size of this study was 10.

Selection of patient depended on a thorough evaluation of the following points

Inclusion criteria-

- Patients requiring a crown on 1st mandibular molar with unrestored antagonistic dentition.
- Patients with Class 1 molar relation.
- Age group- 18-50 years.
- Patients with good periodontal health.
- Patients with good oral hygiene

Exclusion Criteria-

- Premature contacts
- Supra eruption of antagonistic teeth
- Allergic to material being used.
- Partially edentulous
- Peri-apical pathology

The selected patient as per the above-mentioned criteria's were given a full veneer crown.

The patients were selected according to the inclusion criteria and prior consent was taken before the initial treatment

An elastomeric impression was made using a single stage double mix technique prior to the treatment which would be used as an index for fabrication of a temporary crown using indirect method.

The molar was prepared using round end tapered bur, torpedo diamond bur and tapered fissure bur (171L).

Two impressions were made and poured using dental stone type III.

One set of casts was scanned using 3D scanner (MEDIT) and virtual casts were obtained.

These casts were mounted on the virtual articulator with condylar guidance as 30degrees and incisal guidance as 15 degrees.

CAD designing of the provisional restoration was done using the EXOCAD software.

The provisional restoration was milled on a milling machine (Imes Icore) on a Poly methyl metharcrylate block.

The final finishing and polishing of the provisional restoration were done.

The CAD milled provisional restoration was seated in the patient's mouth without adjusting the occlusal surface.

Articulating paper of 10 µm thickness was used to check the occlusal contacts in the patient's mouth.

Using FGP technique: -

The second set of casts was taken and a customized closed-mouth impression tray was made on the cast using a self-curing acrylic resin

The tray was designed to include and adapt on the adjacent teeth for stabilization and to have a flat top as an FGP table

After adjusting the custom tray using a self-curing acrylic resin, the tray was verified to be stable, to be smoothly inserted and removed, and not to interfere in centric and eccentric mandibular movements and then the next step was performed.

A self-curing acrylic resin (Pattern Resin,GC) was put on the FGP table, and the custom tray was placed on the prepared teeth. FGP was engraved into the resin as it was in the plastic stage by letting the patient move their mandible in protrusive, retrusive and lateral directions.

The custom tray with engraved pattern resin of the FGP is removed from the patient's mouth

Indexing of the pattern resin is done and both the casts are mounted on a semi adjustable articulator.

Provisional restoration is fabricated using tooth coloured acrylic resin using the index as a guide.

The resultant provisional restoration is trimmed, finished and polished, and then was seated on the prepared tooth.

The articulating paper is then used to check the occlusal contacts on the restoration.

First the patient was asked to occlude in centric occlusion and the number of contacts on the provisional restoration was noted and the number of adjustments were done till there were uniform and no premature contacts exist.

According to Jeffrey P Okeson in his book of management of temporomandibular disorders and occlusion The mandibular first molar is normally situated slightly mesial to the maxillary first molar in class 1 molar relation. In Class 1 molar relation each mandibular tooth occludes with its counterpart and the adjacent mesial tooth. The contacts between molars occur on both cusp tips and fossae and cusp tips and marginal ridges. figure depicts the buccal view and typical occlusal contact pattern of a Class I molar relationship.

To evaluate the occlusal contacts of each of the crowns two factors were taken into consideration i.e a reference tooth and patient compliance. The reference tooth that was designated was mandibular second molar that would have to show the same contact intensity with its opposing tooth both without the crown in place on the first molar and with the crown in place. Only once verified as fully seated, was the time taken to achieve a correct occlusal contact relationship.

The number of occlusal adjustments were noted for both the provisional prosthesis fabricated by virtual articulator and functionally generated pathway technique.

After noting the number of contacts in centric relation the patient is asked to make eccentric movements and the eccentric contacts were marked using the articulating paper and the number of contacts were noted.

According to Jeffrey P Okeson in his book of management of temporomandibular disorders and occlusion in the posterior teeth, the protrusive movement causes the mandibular centric cusps (buccal) to pass anteriorly across the occlusal surfaces of the maxillary teeth (Fig). Posterior protrusive contacts occur between the distal inclines of the maxillary lingual cusps and the mesial inclines of the opposing fossae and marginal ridges. Posterior protrusive contacts can also occur between the mesial inclines of the mandibular buccal cusps and the distal inclines of the opposing fossae and marginal edges.

During lateral movement of the mandible, on the working side there would be contacts on the outer inclines of the buccal cusp of mandibular first molar and inner inclines of the lingual cusp of the mandibular first molar. On the other hand in non-working side contact would be present on the inner slope of buccal cusp of mandibular first molar.

The necessary adjustments were done till there were uniform and no premature contacts. The resultant occlusal points were analysed on both the provisional restorations i.e the former using virtual articulator and the latter using the functionally generated pathway technique.

Figure-1 Diagnostics and airotor

Figure-2 Articulating paper

Figure-3 Recording of FGP

Figure-4 FGP after recording

Figure-5 Indexing of FGP

Figure-6 Twin bite

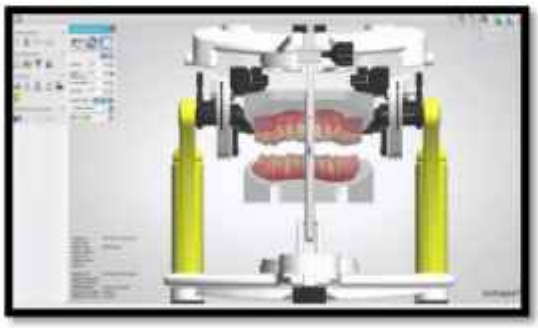


Figure-7 Virtual articulator

Figure-8 Lab scanner

Figure-9 CAD/CAM machine

Figure-10 checking occlusion

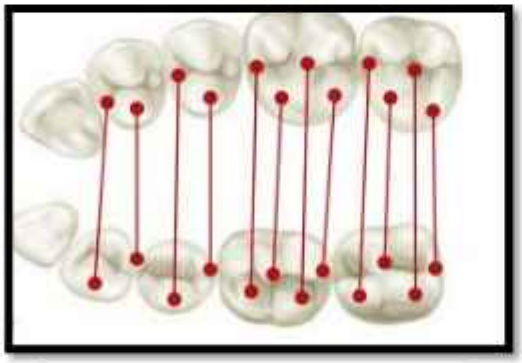


Figure-11 Normal occlusal contacts in centric

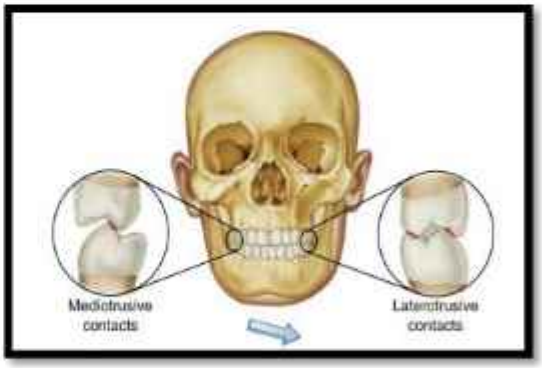


Figure-12 Normal occlusal contacts in eccentric

Figure-13 Occlusal contacts in centric

Figure-14 Adjusting occlusal contacts

Table 1:

Comparison of number of contacts (Centric)					
		Mean	N	Std. Deviation	P value
Adjustment 1	FGP	3.900	10	.9944	0.005, S
	VA	7.300	10	2.0575	
Adjustment 2	FGP	5.400	10	1.5776	0.007, S
	VA	9.700	10	3.0203	
Adjustment 3	FGP	5.000	4	1.4142	0.068, NS
	VA	9.250	4	1.7078	
Adjustment 4	FGP	6.667	3	1.1547	0.109, NS
	VA	10.000	3	2.6458	

Wilcoxon test

After 1st & 2nd adjustment, mean number of markings were significantly more among VA group as compared to FGP group.

After 3rd & 4th adjustment for centric, mean number of markings did not differ significantly.

Graph 1

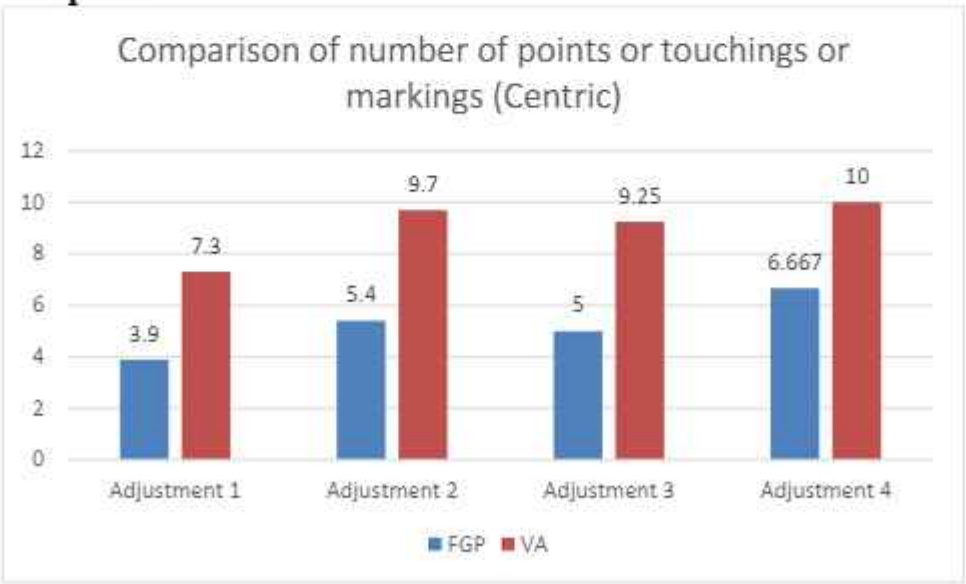


Table 2

Comparison of number of contacts (Eccentric)					
		Mean	N	Std. Deviation	P value
Adjustment 1	FGP	4.600	10	1.7764	0.722, NS
	VA	4.400	10	2.4129	
Adjustment 2	FGP	4.700	10	1.5670	0.327, NS
	VA	5.300	10	1.4181	

Wilcoxon test

After 1st & 2nd adjustment, mean number of markings did not differ significantly among FGP & VA group.

Graph-2

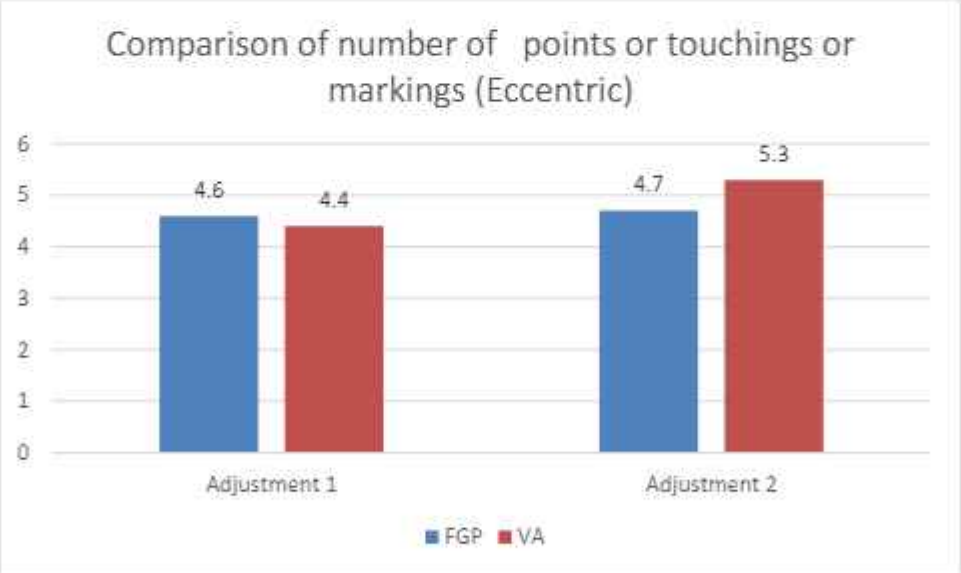


Table 3:

Comparison of adjustments in centric & eccentric					
		Mean	N	Std. Deviation	P value
FGP	Centric	6.400	10	1.7764	0.004
	Eccentric	2.800	10	1.1353	, S
VA	Centric	2.700	10	1.2517	0.038
	Eccentric	1.900	10	.5676	, S

Wilcoxon test

Mean number of adjustments done were significantly high among Centric type among both FGP & VA groups.

Graph 3:

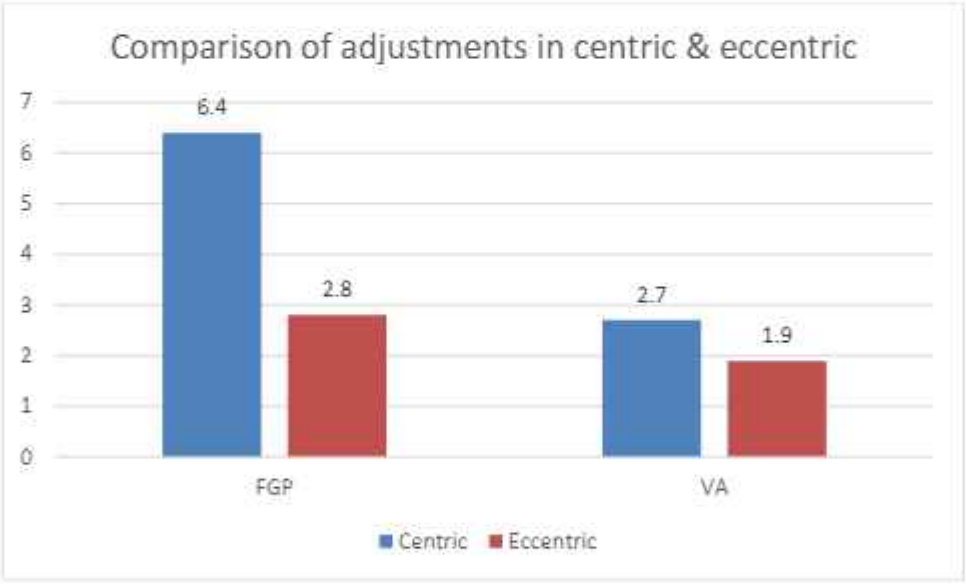


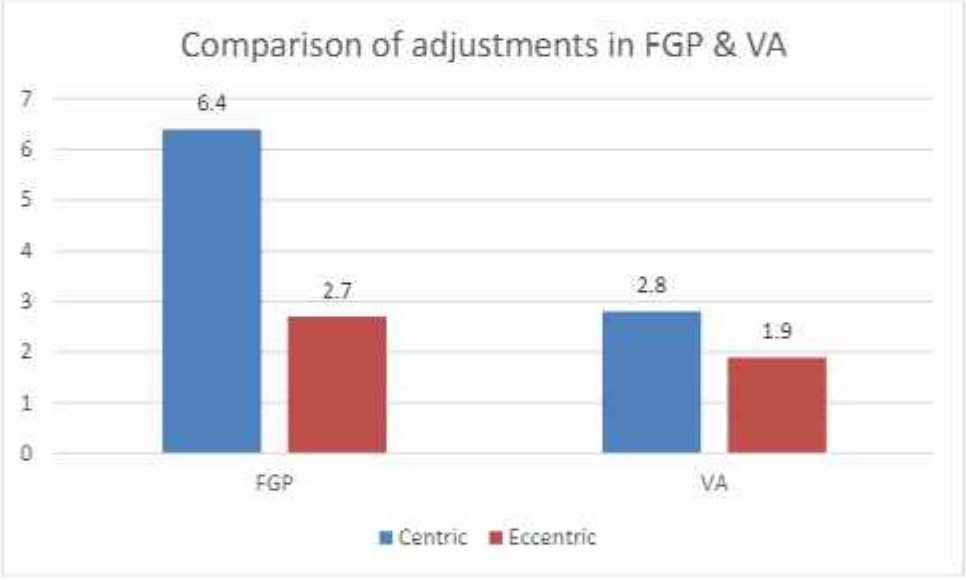
Table 4:

Comparison of adjustments in FGP & VA					
		Mean	N	Std. Deviation	P value
Centric	FGP	6.400	10	1.7764	0.005, S
	VA	2.700	10	1.2517	
Eccentric	FGP	2.800	10	1.1353	0.024, S
	VA	1.900	10	.5676	

Wilcoxon test

Mean number of adjustments, both centric & eccentric, done were significantly high among FGP group as compared to VA group.

Graph 4:



One of the major factors governing the success or failure of a prosthesis is the occlusal interferences in both centric and eccentric movements. It is very important to check the occlusal contacts as both under occlusion and unwanted occlusion can both lead to functional problems and in turn harm the abutment tooth.

Centric relation is a maxilla-mandibular relationship, independent of tooth contact, in which the condyles articulate in the anterior-superior position against the posterior slopes of the articular eminences; in this position, the mandible is restricted to a purely rotary movement; from this unstrained, physiologic, maxilla-mandibular relationship, the patient can make vertical, lateral or protrusive movements; it is a clinically useful, repeatable reference position.

Centric occlusion is the occlusion of opposing teeth when the mandible is in centric relation which may or may not coincide with maximum intercuspation.

Eccentric relation is any relationship of the mandible to the maxillae other than centric relation

Eccentric occlusion is an occlusion other than maximal intercuspal position.

Working side is the side toward which the mandible moves in a lateral excursion.

Working-side contacts is the contact of teeth made on the side of the articulation toward which the mandible is moved during working movements

Non-working side is that side of the mandible that moves toward the medial line in a lateral excursion.

Non-working contacts are contact of the teeth on the side opposite to the direction of laterotrusion of the mandible.

Meyers came up with an occlusal scheme called the Functionally Generated Path which records dynamic occlusion instead of static occlusion. According to him no occlusal adjustments is necessary if the technique is performed properly.

The present research is based on the comparative evaluation of occlusal contacts and number of occlusal adjustments in FGP technique and virtual articulator on a single provisional prosthesis on lower 1st molar with intact occlusion.

In this method the FGP was recorded after the biomechanical preparation of tooth is done on the lower 1st molar using an occlusal table and pattern resin. The patient is asked to do the centric and eccentric movements and the FGP is recorded. An index is formed according to which the provisional prosthesis is fabricated.

On the other hand, another set of casts of the prepared tooth were scanned and virtually articulated with 30° condylar inclination. A provisional prosthesis is fabricated using a PMMA block in a CAD/CAM machine.

First the patient is asked to occlude in centric and an articulating paper of 10µm is kept and the number of occlusal contacts are noted. The necessary adjustments are made using two parameters i.e the point of contact on the reference tooth and the patient compliance.

A high point is marked with a characteristic bull's eye appearance when an articulating paper is used. This shows that there is more force during occlusion at the given point. Such points should be reduced, else it will cause chipping of the prosthesis and weaken the prosthesis and the abutment tooth or even cause temporo-mandibular disorders.

The number of contacts and adjustments are noted in centric.

The same procedure is repeated when the patient is asked to occlude in eccentric and the number of contacts and adjustments are noted.

The mean number of occlusal contacts in FGP at centric after the first four adjustments were 3.9, 5.4, 5, 6.6 respectively.

The mean number of occlusal contacts in the prosthesis fabricated using virtual articulator at centric after the first four adjustments were 7, 9.7, 9.2, 10 respectively.

The mean number of occlusal contacts in the provisional prosthesis fabricated using virtual articulator were significantly more.

The mean number of occlusal corrections made in FGP at centric was 6.4 and the mean value of occlusal corrections in virtual articulator at centric was 2.7.

The number of occlusal corrections at centric is more in FGP than in virtual articulator significantly.

The mean value of number of occlusal contacts in prosthesis fabricated using FGP technique at eccentric after the first two adjustments were 4.6 and 4.7 respectively where as in the prosthesis fabricated using virtual articulator was 4.4 and 5.3 respectively.

The number of occlusal contacts were marginally more in the prosthesis fabricated using virtual articulator than from the prosthesis fabricated using FGP.

The mean value of occlusal corrections in FGP at eccentric was 2.7 whereas the mean value of number of occlusal corrections in a prosthesis using a virtual articulator was 1.9.

The number of occlusal adjustments in virtual articulator was less in both centric and eccentric than that of FGP proposed by Meyers.

LIMITATIONS:

1. As the impression is made from irreversible hydrocolloid there is a chance of distortion due to syneresis and imbibition.
2. The volumetric expansion of the dental stone type-3 has not been taken into consideration
3. Direct scanning was not done so there is a scope of error particularly while scanning the casts.
4. PMMA has an inherent nature of volumetric shrinkage which is not been taken into consideration.
5. The articulating paper used was of 10µm which is not as precise as T scan.

FGP was a technique developed in the year 1930. According to Meyers the prosthesis fabricated using FGP needed no occlusal corrections [2] but in the present study conducted this was not true as the occlusal corrections done in the prosthesis fabricated using FGP were significant. The virtual articulator is one such device which reduces the mechanical work and develops a much accurate prosthesis than the conventional FGP technique.

According to Pankey and Mann all occlusal interferences were avoided when they used the modified FGP technique but in our study the mean number of occlusal corrections in FGP at centric and eccentric were 6.4 and 2.7 respectively.

According to Saafi J et al there was absolutely no kind of patient discomfort with the prosthesis obtained using the FGP technique which was not true in our study as there was more patient discomfort in prosthesis fabricated using FGP than that of the prosthesis fabricated using VA.

Programming of the virtual articulator was first described by Kordass and Gartner in the year 1999. On comparing the DentCAM® virtual articulator with a mechanical articulator (Comp. KaVo, DLeutkirch), the same number of contacts were obtained in the lateralization movements with both articulators in 8 patients (mechanical articulator: 90; virtual articulator: 92). In our study we saw that virtual articulator has a greater number of contacts and needed less adjustments and had more patient compliance.

According to Solaberrieta E et al the most accurate occlusal surface reproduction can be achieved either by using fully adjustable articulator that simulates mandibular movements with high degree of precision or by using virtual articulators with CAD/CAM systems as shown in our study where the accuracy of the prosthesis using virtual articulator is more.

Singh K et al stated that the virtual articulator is a precise software tool that deals with the functional aspects of occlusion along with CAD/CAM systems substituting conventional procedures.

Pröschel et al. carried out a study of 57 asymptomatic patients in order to determine the occlusal errors appearing in the mechanical articulators. To this effect comparisons were made with the virtual articulator, yielding an error in the second molar of 200 µm in 16% of the patients and of 300 µm in 6% of the subjects – this implying a low risk of error, though the acceptable limits in clinical practice could be exceeded [34].

Song and Baek carried out a study in 25 patients previously subjected to orthodontic treatment and who were programmed for Le Fort 1 fracture in the maxilla and a sagittal osteotomy in the mandible. The authors compared the precision of the surgical model and of the splints, concluding that the virtual method is more precise than the conventional approach. [15]

Ghanai et al in 6 patients programmed for repositioning of one or both maxillas, compared the deviation between the two methods using MicroScribe G2X (Immersion Corporation, San Jose, CA, USA). The authors concluded that the virtual articulator can precisely reproduce conventional planning and help inexperienced surgeons to obtain good results.[16]

FGP which was proposed by Meyers in the year 1936 which is also called as chew in technique is a method to record the dynamic occlusion of the patient resulting in a successful prosthesis. With the era of modern dentistry new methods such as articulation through a virtual articulator has developed better results in terms of occlusal adjustments both in centric and eccentric contacts. By the present study virtual articulator has been deemed better in terms of both patient compliance as well as operator's ease in delivering of the prosthesis.

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Annexure-1

BABU BANARASI DAS COLLEGE OF DENTAL SCIENCES (FACULTY OF BBD UNIVERSITY), LUCKNOW

INSTITUTIONAL RESEARCH COMMITTEE APPROVAL

The project titled "**A Comparative Evaluation of Occlusal contacts and Occlusal Adjustments made in a Provisional Restoration fabricated using A Virtual Articulator and Functionally Generated Path Technique**" submitted by **Dr Matety Ashwin** Post graduate student from the **Department of Prosthodontics and Crown & Bridge** as part of MDS Curriculum for the academic year 2019-2022 with the accompanying proforma was reviewed by the Institutional Research Committee present on **19th December 2019** at BBDCODS.

The Committee has granted approval on the scientific content of the project. The proposal may now be reviewed by the Institutional Ethics Committee for granting ethical approval.

Prof. Vandana A Pant
Co-Chairperson

Prof. B. Rajkumar
Chairperson

Annexure-2

Babu Banarasi Das University
Babu Banarasi Das College of Dental Sciences,
BBD City, Faizabad Road, Lucknow – 226028 (INDIA)

Dr. Lakshmi Bala
Professor and Head Biochemistry and
Member-Secretary, Institutional Ethics Committee

Communication of the Decision of the VIII[th] Institutional Ethics Sub-Committee

IEC Code: 28 **BBDCODS/03/2020**

Title of the Project: A Comparative Evaluation of Occlusal contacts and Occlusal Adjustments made in a Provisional Restoration fabricated using A Virtual Articulator and Functionally Generated Path Technique.

Principal Investigator: Dr. Matety Ashwin **Department:** Prosthodontics and Crown & Bridge

Name and Address of the Institution: BBD College of Dental Sciences Lucknow.

Type of Submission: New, MDS Project Protocol

Dear Dr. Matety Ashwin,

The Institutional Ethics Sub-Committee meeting comprising following four members was held on 18[th] March, 2020.

1.	Dr. Lakshmi Bala Member Secretary	Prof. and Head, Department of Biochemistry, BBDCODS, Lucknow
2.	Dr. Amrit Tandan Member	Prof. & Head, Department of Prosthodontics and Crown & Bridge, BBDCODS, Lucknow
3.	Dr. Sahana S. Member	Reader, Department of Public Health Dentistry, BBDCODS, Lucknow
4.	Dr. Sumalatha M.N. Member	Reader, Department of Oral Medicine & Radiology, BBDCODS, Lucknow

The committee reviewed and discussed your submitted documents of the current MDS Project Protocol in the meeting.
The comments were communicated to PI thereafter it was revised.

Decisions: The committee approved the above protocol from ethics point of view.

Forwarded by:

18/03/20

(Dr. Lakshmi Bala)
Member-Secretary
IEC

Member-Secretary
Institutional Ethics Committee
BBD College of Dental Sciences
BBD University
Faizabad Road, Lucknow-226028

(Dr. B. Rajkumar)
Principal
BBDCODS

PRINCIPAL
Babu Banarasi Das College of Dental Sciences
(Babu Banarasi Das University)
BBD City, Faizabad Road, Lucknow-226028

Annexure-3

Babu Banarasi Das College of Dental Sciences
(Babu Banarasi Das University)
BBD City, Faizabad Road, Lucknow – 227105 (INDIA)

Consent Form (English)

Title of the Study .....

Study Number.....
Subject's Full Name.....
Date of Birth/Age .....
Address of the Subject.....
Phone no. and e-mail address.....
Qualification .....
Occupation: Student / Self Employed / Service / Housewife/
Other (Please tick as appropriate)
Annual income of the Subject.....
Name and of the nominees(s) and his relation to the subject .....(For the purpose of compensation in case of trial related death).

1. I confirm that I have read and understood the Participant Information Document dated .....for the above study and have had the opportunity to ask questions. **OR** I have been explained the nature of the study by the Investigator and had the opportunity to ask questions.
2. I understand that my participation in the study is voluntary and given with free will without any duress and that I am free to withdraw at any time, without giving any reason and without my medical care or legal rights being affected.
3. I understand that the sponsor of the project, others working on the Sponsor's behalf, the Ethics Committee and the regulatory authorities will not need my permission to look at my health records both in respect of the current study and any further research that may be conducted in relation to it, even if I withdraw from the trial. However, I understand that my Identity will not be revealed in any information released to third parties or published.
4. I agree not to restrict the use of any data or results that arise from this study provided such a use is only for scientific purpose(s).
5. I permit the use of stored sample (tooth/tissue/blood) for future research. **Yes** [ ] **No** [ ] **Not Applicable** [ ]
6. I agree to participate in the above study. I have been explained about the complications and side effects, if any, and have fully understood them. I have also read and understood the participant/volunteer's Information document given to me.

Signature (or Thumb impression) of the Subject/Legally Acceptable Representative:..... Date .....
Signatory's Name..... Date.....
Signature of the Investigator..... Date.....
Study Investigator's Name..... Date.....
Signature of the witness.....
Name of the witness.....
Received a signed copy of the PID and duly filled consent form Date.....
Signature/thumb impression of the subject or legally

Annexure-3

21. Contact for further information

Dr. Matety Ashwin
Department of Prosthodontics
BabuBanarasi College of Dental Sciences,
Lucknow-227105
Mob-9701247267

Dr. Amrit Tandan (HOD)
Department of Prosthodontics
BabuBanarasi College of Dental Sciences,
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Dr. LaxmiBala,
Member Secretary,
Babu Banarasi College of Dental Sciences,
Lucknow
bbdcods.iec@gmail.com

Pi signature.....
Name.....
Date.....

Annexure-4

Babu Banarasi Das College of Dental Sciences
(Babu Banarasi Das University)
BBD City, Faizabad Road, Lucknow – 227105 (INDIA)

सहमति पत्र

अध्ययन शीर्षक.....
अध्ययन संख्या.....
प्रतिभागी के पूर्ण नाम.....
जन्म तिथि / आयु.....
प्रतिभागी का पता .....
फोन न. और ई-मेल पता .....
पेशा .....
व्यवसाय: छात्र / स्व कार्यरत / सेवा / ग्रहिणी .....
धर्म (उचित रुप मे टिक करें) .....
प्रतिभागी की वार्षिक आय .....
अध्याशीयो के नाम और प्रतिभागी से संबंध...(परीक्षण से संबंधित मौत के मामले मे मुआवजे के प्रयोजन के लिए)

1. मेरी पुष्टि है कि मैने अध्ययन हेतु सूचना पत्र दिनांक ..... को पढ व समझ लिया तथा मुझे प्रश्न पुछने का मुझे अध्ययन अन्वेषक ने सभी तथ्यों को समझा दिया है तथा मुझे प्रश्न पुछने के समान अवसर प्रदान किए गये।

2. मैने यहाँ समझ लिया कि अध्ययन मे मेरी भागीदारी पूर्णतः स्वैच्छिक है और किसी भी दबाव के बिना स्वतंत्र इच्छा के साथ दिया है किसी भी समय किसी भी कारण के बिना , मेरे इलाज या कानूनी अधिकारो को प्रभावित किए बिना अध्ययन मे भाग न लेने के लिए स्वतंत्र हुँ ।

3. मैने यह समझ लिया है कि अध्ययन के प्रायोजक , प्रायोजक की तरफ से काम करने वाले लोग, आचार समिति और नियामक अधिकारियों को मेरे स्वास्थ्य रिकार्ड को वर्तमान अध्ययन या आगे के अध्ययन के सन्दर्भ देखने के लिए मेरी अनुमति की जरूरत नही है, चाहे मैने इस अध्ययन से नाम वापस ले लिया है। हॉलाकि मै यह समझता हुँ कि मेरी पहचान को किसी भी तीसरे पक्ष या प्रकाशित माध्यम मे नही दी जायेगी।

4. मै इससे सहमत हूँ कि कोई भी डेटा या परिणाम जो इस अध्ययन से प्राप्त होता है उसका वैज्ञानिक उद्देश्य (ओं) के उपयोग के लिए मेरी तरफ से कोई प्रतिबंध नही है।

5. भविष्य के अनुसंधान के लिए भंडारित नमूना (जत्तक/रक्त) पर अध्ययन के लिए अपनी सहमति देता हुँ।
हाँ [ ] नही [ ] अनउपयुक्त [ ]

6. मै परीक्षण की अनुमति देता हुँ। मुझे इसके द्वारा यदि कोई परेशानी होती है, इसके बारे मे जानकारी दे दी गई है। मैने रोगी जानकारी सूचना पत्र को पढ तथा समझ लिया है।

प्रतिभागी / कानूनी तौर पर स्वीकार्य प्रतिनिधि का हस्ताक्षर (या अंगूठे का निशान_____

हस्ताक्षरकर्ता का नाम_____ दिनांक _____अन्वेषक के हस्ताक्षर _____ दिनांक _____

अध्ययन अन्वेषक का नाम _____

गवाह के हस्ताक्षर _____ दिनांक _____गवाह के नाम _____

मैनें पीआईडी और विधिवत भरे सहमति फार्म का एक हस्ताक्षर की नकल प्राप्त की.

प्रतिभागी कानूनी तौर पर प्रतिनिधि का हस्ताक्षर/ अंगूठे का निशान _____ दिनांक _____

Annexure-5

BabuBanarasi Das College of Dental Sciences
(A constituent institution of BabuBanarasi Das University)
BBD City, Faizabad Road, Lucknow – 227105 (INDIA)

Participant Information Document (PID)

1. Study title

A comparative evaluation of occlusal contacts and occlusal adjustments made in a provisional restoration fabricated using a virtual articulator and functionally generated path technique

2. Invitation paragraph

You are being invited to take part in a research study. it is therefore important for you to understand why the study is being done and what it will involve. Please take time to read the following information carefully. Ask us for any clarifications or further information. Whether or not you wish to take part is your decision.

3. What is the purpose of the study?

To compare and adjust the number of occlusal contacts in a provisional restoration in centric occlusion using a virtual articulator and functionally generated path technique

4. Why have I been chosen?

You have been chosen for this study as you are fulfilling the required criteria for this study.

5. Do I have to take part?

Your participation in the research is entirely voluntary. If you do, you will be given this information sheet to keep and will be asked to sign a consent form. During the study you still are free to withdraw at any time and without giving a reason.

6. What will happen to me if I take part?

You will be one of 10 patients enrolled in the study and you would be given two provisional restorations on the tooth post endodontic treatment and prior to final restoration.

7. **What do I have to do?**

You do not have to change your regular lifestyles for the investigation of the study.

8. **What is the procedure that is being tested?**

The procedure will involve evaluating and comparing the number of occlusal contacts in a temporary restoration using virtual articulator and FGP technique.

9. **What are the interventions for the study?**

Post endodontic treatment crown preparation will be done and two sets of casts will be made after taking impressions. One set of casts are scanned and mounted on virtual articulator while the other set is used to make the FGP table. A provisional restoration using CAD/CAM is milled on a poly methyl methacrylate block. Another provisional restoration is made using FGP technique. Both the resotrations are luted and compared for the occlusal points using an articulating paper and necessary occlusal adjustments are made.

10. **What are the side effects of taking part?**

There are no side effects on patients of this study.

11. **What are the possible disadvantages and risks of taking part?**

There is no risk or disadvantages of taking part in this study.

12. **What are the possible benefits of taking part?**

This study will help us to evaluate the accuracy and precision of virtual articulator and FGP technique.

13. **What if new information becomes available?**

If additional information becomes available during the course of the research you will be told about these and you are free to discuss it with your researcher, your researcher will tell you whether you want to continue in the study. If you decide to withdraw, your researcher will make arrangements for your withdrawal. If you decide to continue in the study, you may be asked to sign an updated consent form.

14. **What happens when the research study stops?**

If the study stops/finishes before the stipulated time, this will be explained to the patient/volunteer.

15. What if something goes wrong?

If any severe adverse event occurs, or something goes wrong during the study, the complaints will be handled by reporting to the institution (s), and Institutional ethical community.

16. Will my taking part in this study be kept confidential?

Yes it will be kept confidential.

17. What will happen to the results of the research study?

The results of the study will be used to compare virtual articulator and FGP technique.. Your identity will be kept confidential in case of any report/publications.

18. Who is organizing the research?

This research study is organized by the academic institution (BBDCODS).

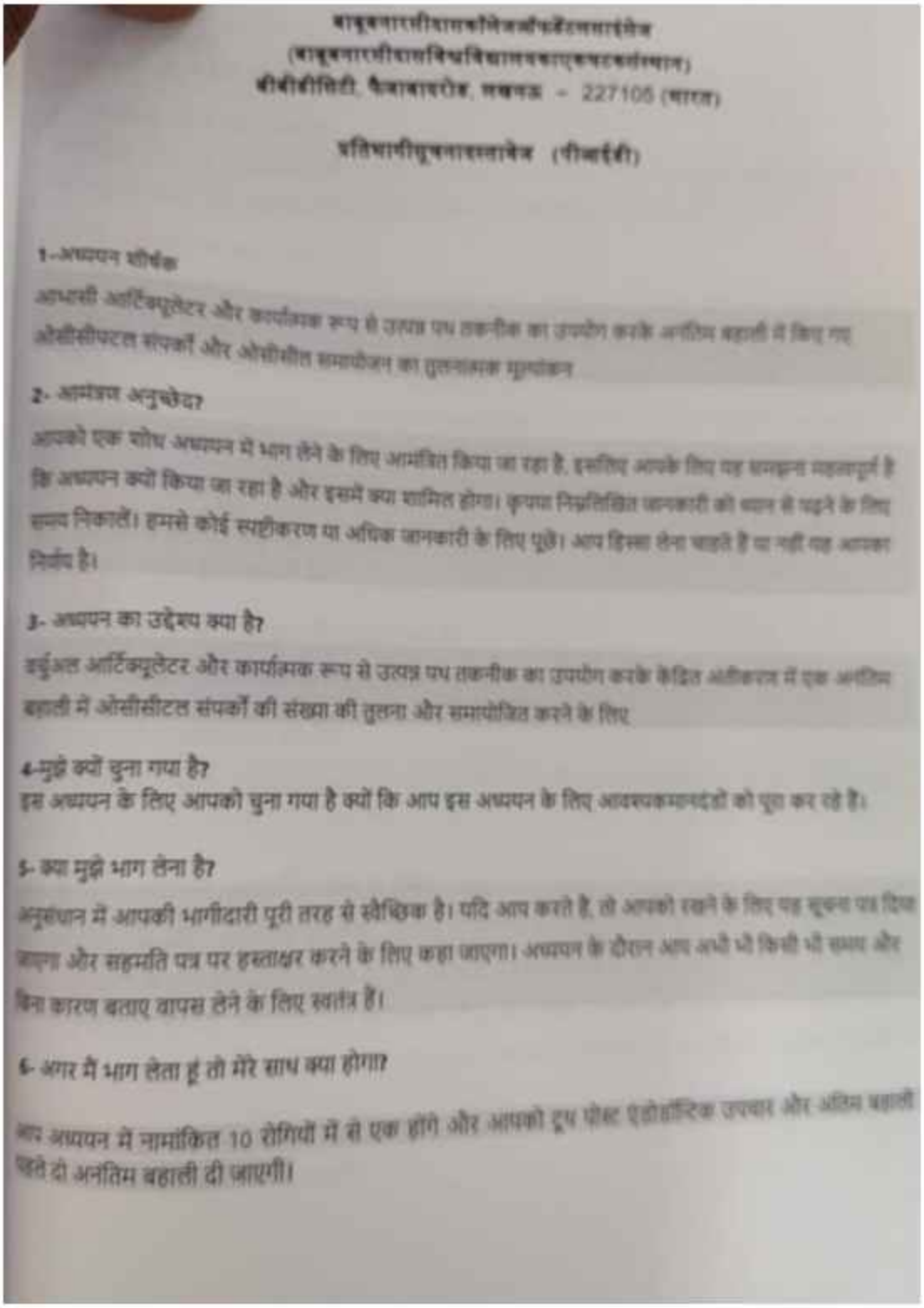
19. Will the results of the study be made available after study is over?

Yes.

20. Who has reviewed the study?

The study has been reviewed and approved by the Head of the Dept, and the IEC/IRC of the institution.

Annexure-6



बाबूबनारसीदासकॉलेजऑफडेंटलसाइंसेज
(बाबूबनारसीदासविश्वविद्यालयका एकघटकसंस्थान)
बीबीडीसिटी, फैजाबादरोड, लखनऊ - 227105 (भारत)

प्रतिभागीसूचनासम्मतपत्र (पीआईसी)

1-अध्ययन शीर्षक

आधारी आर्टिक्यूलेटर और कार्यात्मक रूप से उत्पन्न पथ तकनीक का उपयोग करके अंतिम बहाली में किए गए ओसीसीपटल संपर्कों और ओसीसीत समायोजन का तुलनात्मक मूल्यांकन

2- आमंत्रण अनुच्छेद

आपको एक शोध अध्ययन में भाग लेने के लिए आमंत्रित किया जा रहा है. इसलिए आपके लिए यह समझना महत्वपूर्ण है कि अध्ययन क्यों किया जा रहा है और इसमें क्या शामिल होगा। कृपया निम्नलिखित जानकारी को ध्यान से पढ़ने के लिए समय निकालें। हमसे कोई स्पष्टीकरण या अधिक जानकारी के लिए पूछें। आप हिस्सा लेना चाहते हैं या नहीं यह आपका निर्णय है।

3- अध्ययन का उद्देश्य क्या है?

इंट्राओरल आर्टिक्यूलेटर और कार्यात्मक रूप से उत्पन्न पथ तकनीक का उपयोग करके केंद्रित अभिलेखन में एक अंतिम बहाली में ओसीसीटल संपर्कों की संख्या की तुलना और समायोजित करने के लिए

4-मुझे क्यों चुना गया है?

इस अध्ययन के लिए आपको चुना गया है क्यों कि आप इस अध्ययन के लिए आवश्यकमानदंडों को पूरा कर रहे हैं।

5- क्या मुझे भाग लेना है?

अनुसंधान में आपकी भागीदारी पूरी तरह से स्वैच्छिक है। यदि आप करते हैं, तो आपको रखने के लिए यह सूचना पत्र दिया जाएगा और सहमति पत्र पर हस्ताक्षर करने के लिए कहा जाएगा। अध्ययन के दौरान आप अभी भी किसी भी समय और बिना कारण बताए वापस लेने के लिए स्वतंत्र हैं।

6- अगर मैं भाग लेता हूं तो मेरे साथ क्या होगा?

इस अध्ययन में नामांकित 10 रोगियों में से एक होंगे और आपको दूध पोस्ट एंडोडॉन्टिक उपचार और अंतिम बहाली पहले दी अनंतिम बहाली दी जाएगी।

7- मुझे क्या करना है?

अध्ययन की जांच के लिए आपको अपने नियमित जीवन शैली को बदल ने की ज़रूरत नहीं है।

8- परीक्षण की जारही प्रक्रिया क्या है?

इस प्रक्रिया में वर्चुअल आर्टिक्यूलेटर और फ़ंक्शनैली जनरेटेड पथ तकनीक का उपयोग करके अस्थायी बहाली में ओसीसीपटल संपर्कों की संख्या का मूल्यांकन और तुलना करना शामिल होगा।

9- अध्ययन के लिए हस्तक्षेप क्या है?

पोस्ट एंडोडॉन्टिक ट्रीटमेंट क्राउन की तैयारी की जाएगी और इंप्रेशन लेने के बाद कलाकारों के दो सेट बनाए जाएंगे। कलाकारों के एक सेट को वर्चुअल आर्टिक्यूलेटर पर स्कैन और माउंट किया जाता है जबकि दूसरे सेट का उपयोग एफजीपी टेबल बनाने के लिए किया जाता है। सीएडी / सीएएम का उपयोग करके एक अनंतिम बहाली एक पाली मिथाइल मेथैक्रिलेट ब्लॉक पर डाली जाती है। एक और अनंतिम बहाली फ़ंक्शनैली जनरेटेड पथ तकनीक का उपयोग करके की गई है। दोनों रेस्टोरेशन एक कलाकृत कागज का उपयोग कर ोक्क्लूसिल अंक के लिए और तुलना कर रहे हैं और आवश्यक ोक्क्लूसिल समायोजन किए गए है।

10- भाग लेने के दुष्प्रभाव क्या है?

इस अध्ययन के कोई दुष्प्रभाव नहीं हैं।

11- भाग लेने के संभावित नुकसान और जोखिम क्या हैं?

इस अध्ययन में भाग लेने का कोई जोखिम या नुकसान नहीं है।

12- भाग लेने के संभावित लाभ क्या हैं?

यह अध्ययन हमें वर्चुअल आर्टिक्यूलेटर और एफजीपी तकनीक की सटीकता और सटीकता का मूल्यांकन करने में मदद करेगा।

13- क्या होगा अगर नई जानकारी उपलब्ध हो जाए?

यदि अनुसंधान के दौरान अतिरिक्त जानकारी उपलब्ध हो जाती है, तो आपको इन के बारे में बताया जाएगा और आप अपने शोधकर्ता के साथ इस पर चर्चा करने के लिए स्वतंत्र हैं. आपका शोधकर्ता आपको बताएगा कि क्या आप अध्ययन जारी रखना चाहते हैं। यदि आप वापस लेने का निर्णय लेते हैं, तो आपका शोधकर्ता आपकी वापसी की व्यवस्था करेगा। यदि आप अध्ययन जारी रखने का निर्णय लेते हैं, तो आपको एक अद्यतन सहमति पत्र पर हस्ताक्षर करने के लिए कहा जा सकता है।

14- शोध अध्ययन बंद होने पर क्या होता है?

यदि अध्ययन निर्धारित समय से पहले बंद / खत्म हो जाता है, तो यह रोगी / स्वयंसेवक को समझाया जाएगा।

15- क्या होगा अगर कुछ गलत हो जाए?

यदि कोई गंभीर प्रतिकूल घटना होती है, या अध्ययन के दौरान कुछ गलत होता है, तो संस्थान (एस), और संस्थागत नैतिक समुदाय को रिपोर्ट करके शिकायतों को नियंत्रित किया जाएगा।

16- क्या इस अध्ययन में मेरा हिस्सा गोपनीय रखा जाएगा?

हां इसे गोपनीय रखा जाएगा।

17- शोध अध्ययन के नतीजों का क्या होगा?

अध्ययन के परिणामों का उपयोग आभासी आर्टिक्यूलेटर और एफजीपी तकनीक की तुलना करने के लिए किया जाएगा किसी भी रिपोर्ट / प्रकाशन के मामले में आपकी पहचान गोपनीय रखी जाएगी।

18- शोध का आयोजन कौन कर रहा है?

यह शोध अध्ययन शैक्षणिक संस्थान (BBDCODS) द्वारा आयोजित किया जाता है।

19 क्या अध्ययन के परिणाम अध्ययन के बाद उपलब्ध कराए जाएंगे?

हाँ।

20- अध्ययन की समीक्षा किसने की है?

अध्ययन की समीक्षा की गई है और संस्थान के प्रमुख, और आईईसी / आईआरसी द्वारा अनुमोदित किया गया है।

21- अधिक जानकारी के लिए संपर्क करें

डॉ. मातेती आश्विन

प्रोस्थोडॉन्टिक्स का विभाग
बाबूबनारसी कॉलेज ऑफ डेंटलसाइंसेज।
लखनऊ-227,105
मोब- 9452901798

Annexure-7

STATISTICAL ANALYSIS

Statistical analysis: Data were tabulated and examined using the Statistical Package for Social Sciences Version 22.0 (IBM SPSS Statistics for Mac, Armonk, NY IBM Corp. USA). Descriptive statistical analysis had been carried out in the present study. Results on continuous measurements are presented as Mean SD. Categorical data has been presented I as frequency distribution. The statistical power calculation was based on the assumption that the data were normally distributed, P-value of <0.05 was considered significant. Difference between two groups was determined using student T test.

The statistical analysis for the present study was done by applying the following formulae:

1. **Mean**: The mean (or average) is the most popular and well-known measure of central tendency. It can be used with both discrete and continuous data, although its use is most often with continuous data. The mean is equal to the sum of all the values in the data set divided by the number of values in the data set. So, if we have n values in a data set and they have values x_1, x_2, ..., x_n, the sample mean, usually denoted by $\bar{x}$ (pronounced x bar), is:

$$\bar{x} = \frac{(x_1 + x_2 + \cdots + x_n)}{n}$$

This formula is usually written in a slightly different manner using the Greek capitol i.e.:

Sample Mean	Population Mean
$\bar{x} = \frac{\Sigma x}{n}$	$\mu = \frac{\Sigma x}{N}$

where Σx is sum of all data values

N is number of data items in population

n is number of data items in sample

2. **Standard deviation**: the standard deviation (SD, also represented by the lower-case Greek letter sigma σ or the Latin letter s) is a measure that is used to quantify the amount of variation or dispersion of a set of data values. A low standard deviation indicates that the data points tend to be close to the mean (also called the expected value) of the set, while a high standard deviation indicates that the data points are spread out over a wider range of values.

$$\sigma = \sqrt{\frac{\Sigma\ (x - \bar{x})^2}{n}}$$

σ = **lower case sigma**
Σ = **capital sigma**
$\bar{x}$ = **x bar**

3. **Student T test**: A student *t*-test is any statistical hypothesis test in which the test statistic follows a Student *t*-distribution under the null hypothesis. It can be used to determine if two sets of data are significantly different from each other. It is most commonly applied when the test statistic would follow a

normal distribution if the value of a scaling term in the test statistic were known. When the scaling term is unknown and is replaced by an estimate based on the data, the test statistics (under certain conditions) follow a Student's *t* distribution.

Annexure-8

Curiginal

Document Information

Analyzed document	Ashwin Matety plag check.docx (D132549959)
Submitted	2022-04-04T13:09:00.0000000
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Sources included in the report

W	URL: https://synapse.koreamed.org/articles/1094276 Fetched: 2021-11-17T12:17:29.5930000	1
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