Evaluation of Occlusal Harmony of Fixed Partial Prosthesis Fabricated by Functionally Generated Path Techniques Using T-Scan – An In Vivo Study.

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ABSTRACT

Background: This study was performed to analyze methods to fabricate the restorations in harmony with both static and dynamic positions of mandible. This was attempted by using two different methods to incorporate functionally generated path by double casting technique and provisional restoration technique. By these methods the occlusal discrepancies encountered during fabrication of conventional restorations were eliminated. Aim: Evaluation of occlusal discrepancy of cast metal fixed partial restoration by using three different fabrication techniques. **Methods**: The occlusal harmonies of the restorations fabricated by the three different methods were evaluated by T-scan using clusion and disclusion time. The readings were recorded and subjected to statistical analysis. **Results**: The parameter of clusion time and disclusion time selected in the study has very little flexibilities, that is the time period between 0.1-0.3 sec was taken as the clusion time in centric position and the time period of less than 0.5 sec was set as the standard disclusion time for eccentric positions. It was found that the occlusal discrepancy was very minimal when the clusion and disclusion time was closer to these values. **Conclusion**: Thus it was finally concluded that the restorations fabricated using functionally generated path technique by double casting method and provisional restoration method simulated the preexisting occlusion more closely and the difference between the two types of restorations were not significant. This proves that the functionally generated path technique is very useful and can be used whenever the situations permit.

Keywords: Aluwax, Double casting, Functionally generated path way, Pattern resin, Provisional restoration.

INTRODUCTION

The best thing a man can achieve is to resemble nature because he cannot replace it. So it is necessary first to understand the natural stomatognathic system composed of teeth, muscles and TMJ. Nature has build the occlusal surfaces and incisal edges of the teeth to have certain curved pathways which balance and function harmoniously with the movements of the condyle in the glenoid fossa.[1] The human jaw with all its interferences and limitations makes the best articulator.

So this study aims to analyze methods to fabricate the restorations in harmony both during static and dynamic positions. This was attempted by using two different methods to incorporate functionally generated path by double casting technique and provisional restoration technique.[2-5] This makes the interdependent trio of occlusal harmony, muscular harmony and joint harmony to be successful.

The use of fully adjustable articulator, simulating the mandibular movements is cumbersome and labourious in a routine clinical practice. So an alternative method to reproduce a most precise occlusion, which was developed way back in 1930's has become increasingly popular in the present days, is the FGP.[2]

The original technique described by Meyer for obtaining the "functional occlusal path" for complete dentures[1] and fixed partial dentures were fabricated by a direct or indirect technique.[6] Later the frontiers of this technique was expanded to be

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used in complete occlusal rehabilitation by Mann and Pankey.[7-10] Recently FGP is becoming increasingly popular for the fabrication of implant retained FPD's.[11]

This technique may be completed in two steps, either during the actual fabrication of restoration or as a three dimensional check bite technique to correct the completed restorations.[12]

An ideal occlusal indicator should exclude positional errors influenced by tooth displacement and extended mandibular movements.[13] Recently reports have come supporting the fact that T- scan produces clinically better and reliable results when compared with the conventional method of occlusal analysis. The digital occlusal analyser system known as T-scan was first introduced by the Chairman of Prosthodontics of Boston University, Professor William L. Maness in partnership with M.I.T.54.[14]

The purpose of the present study is to compare the occlusal discrepancy of the castings made from a customized functionally generated provisional restoration technique and functionally generated path using a double casting technique with the conventional casting technique in fixed partial dentures.

Aim and Objectives
Aim

Evaluation of occlusal discrepancy of cast metal fixed partial restorations by using three different fabrication techniques.

Objective of the Study

1. To find the occlusal discrepancy in fixed partial restorations fabricated using conventional technique with the help of clusion and disclusion time.
2. To find and compare the occlusal discrepancies of these restorations with the preexisting occlusion and also between the three restorations using clusion and disclusion time.

MATERIALS AND METHODS

The subjects for this study were selected from the OPD, Department of Prosthodontics and Crown and Bridge, Tamilnadu Government Dental College and Hospital, Chennai - 600003. This present study was performed to evaluate the occlusal discrepancies found in the fixed partial restorations both in pre-insertion and post-insertion stages. The functionally generated pathway technique is selected to fabricate the restorations and they were compared with restorations made by conventional casting methods.

Selection Criteria:
Inclusion Criteria:

1. Patients requiring 3 unit posterior maxillary or mandibular fixed partial dentures for replacement of missing 1st molar (Unilateral or Bilateral).
2. Intact dentition opposing the edentulous space.

3. The incisal guidance should be acceptable.
4. Both males and females selected were of age between 25 and 45 years.

Exclusion Criteria:

1. Loss of anterior guidance, which cannot be corrected without extensive restorative procedures.
2. Multiple tooth missing (long span).

Place of Study

1. Department of Prosthodontics, Tamilnadu Government Dental College & hospital.
2. Best laser dental clinic, valasarawalkam, Chennai.

Methodology
Study Design

Six patients, who required 3 unit fixed partial dentures for the replacement of their maxillary or mandibular posterior teeth were selected for the study. In each patient three methods of generating the occlusal morphology and two methods of castings were employed. Grouping was done based on the technique used for generating occlusal anatomy and casting.

Group A -- for evaluating the conventional wax pattern and casting technique

Group B -- for evaluating the functionally generated occlusal morphology and a double casting technique

Group C -- for evaluating the functionally generated occlusal morphology with provisional restoration technique and conventional casting

In the initial appointment, a preliminary impression was made using irreversible hydrocolloid impression material(Vignette, Dentsply, india) and the diagnostic casts were mounted on a semi adjustable articulator (C.S.A 600 Articulator,Corident Co., Ltd) using a face-bow transfer (CORI Facebow, Corident Co., Ltd.). Centric and Protrusive records were made using Aluwax. The patient was trained to close in maximum intercuspation(MIP) and perform various other eccentric movements. [Right lateral (RL) left lateral (LL) and protrusive (P)] and back to MIP.

Methods

After proper examination and analysis, premature contacts were eliminated and occlusal harmony was established and finally it was verified with T–scan. It was verified whether the bite force readings on both sides were almost equal.

Tooth Preparation for Restorations:
Fabrication of Restorations

Establishment of Functionally Generated Path Using Double Casting Method

Wax patterns were fabricated in infraocclusion of 0.5 to 1 mm and retention beads were attached on the occlusal surfaces of wax pattern for aiding in the retention of the Autopolymerising pattern resin

(GC corp). It was used for functional generation of the occlusal morphology. The pattern along with the base casting was invested and double casting done.

Crown ppn:

Steps in fabrication of double casting

Establishment of Functionally Generated Path Using Provisional Restoration

The occlusal surface of the provisional restoration was made short of contacts with the opposing tooth and verified in the patient's mouth. After addition of autopolymerising resin in the dough stage onto the occlusal surface of the restoration, the patient was asked to perform movements. After 2 weeks, a second provisional restoration was made ready and the previous one was removed from the patient's mouth and second provisional was cemented.

The removed provisional restoration was sprued, invested and cast with non precious Ni-Cr alloy.

Fabrication of provisional restoration by FGP

Statistical analysis used is

Wilcoxon Signed Ranks Test
Friedman Test

Descriptive statistics mean & S.D

The restorations fabricated using the conventional technique, functionally generated path using double casting technique and the restorations made using provisional restoration technique were placed in the patient's mouth and the clusion and disclusion time values were obtained. These values were compared with that of the pre-existing occlusion and that between the three restorations.
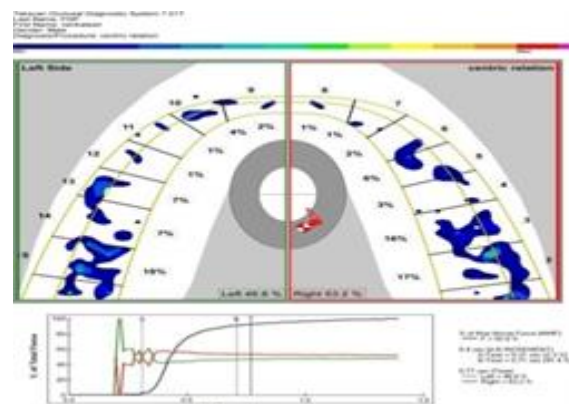
Clusion Time

It was found that the time elapsed from the 1st contact to the complete occlusal interdigitation should be ideally zero or as minimum as possible, but achieving this clinically is impossible So we keep the time frame of 0.1- 0.3 sec as standard in our study as it is also easier to achieve clinically. [OT-A and OT-B].
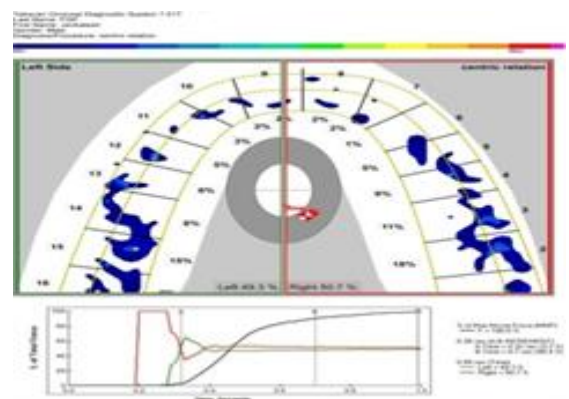
Disclusion Time

This time should be within the range of < 0.5 sec as the patients selected were free of TMJ dysfunction, jaw discrepancies and were having good neuromuscular coordination (DT-C and DT-D).
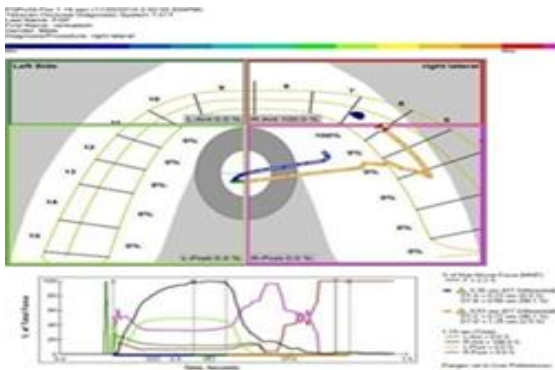
Significance of C-D Lines

Prolonged posterior Disclusion Time (> .5 seconds per excursion) has been determined to be etiologic for Myofascial Pain Dysfunction Syndrome (MPDS)1. The shorter the duration of the elapsed posterior Disclusion time, the faster the anterior Guidance takes complete control over excursive function.
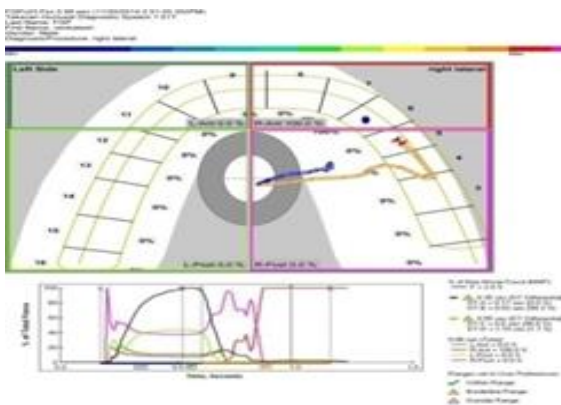

Centric Relation - Double Casting

Centric Relation - Provisional Restoration

Right Lateral - Provisional Restoration

Right Lateral - Double Casting

RESULTS

The collected data was analysed with SPSS 16.0 version. To describe about the data descriptive statistics mean and S.D were used. To find the significance difference between the bivariate samples in Paired groups (PRE with CT,DCT& FGP) Wilcoxon signed rank test was used and for repeated measures (CT,DCT& FGP) the Friedman test was used. In both the above statistical tools the probability value 0.05 is considered as significant level.

Descriptive Statistics

Table 1: Multiple Comparison Using Friedman Test on Maximum Intercuspation

Maximum Intercuspation	N	Mean	Std. Deviation	P-value
PRE	6	.298	.063	0.009
CT	6	.616	.116	
DCT	6	.411	.071	
FGP	6	.410	.068	

Table 2: Multiple Comparisons Using Friedman Test for Lateral Excursion on Restorative Side

Restorative Side	N	Mean	Std. Deviation	P-value
PRERS	6	.478	.091	0.009
CTRS	6	.805	.124	
DCTRS	6	.550	.089	
FGPRS	6	.540	.068	

Table 3: Multiple Comparison Using Friedman Test For Lateral Excursion on Normal Side

Normal side	N	Mean	Std. Deviation	P-value
PRENS	6	.461	.067	0.009
CTNS	6	.753	.142	
DCTNS	6	.516	.048	
FGPNS	6	.501	.024	

Table 4 - Multiple Comparison Using Friedman Test on Protrusion

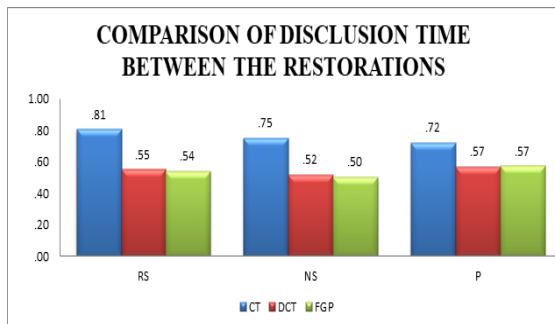| On Protrusion	N	Mean	Std. Deviation	P-value
PREP	6	.496	.073	0.015
CTP	6	.720	.084	
DCTP	6	.566	.102	
FGPP	6	.571	.034	

[Table 1] The multiple comparisons between the restorations with the preexisting occlusion during maximum intercuspation reveals that the mean and the standard deviation of the restorations fabricated using the functionally generated provisional restoration technique was 0.410 and 0.068 followed by the restoration of the double casting technique with the mean 0.411 and standard deviation 0.071 which is closer to the preexisting occlusion values of 0.298 and 0.063 whereas the conventional restoration showed a variation of mean value 0.616 and a standard deviation of 0.116. The overall comparison showed a significant variation of p value 0.009.

[Table 2] The multiple comparisons between the restorations with the preexisting occlusion during lateral excursion on the restorative side reveals that the mean and the standard deviation of the restorations fabricated using the functionally generated provisional restoration technique was 0.540 and 0.068 followed by the restorations of the double casting technique with the mean 0.550 and standard deviation 0.089 which is closer to the preexisting occlusion values of 0.478 and 0.091 whereas the conventional restorations showed a variation of mean value 0.805 and a standard deviation of 0.124. The overall comparison showed a significant variation of p value 0.009.

[Table 3] The multiple comparisons between the restorations with the preexisting occlusion during lateral excursion on the normal side reveals that the mean and the standard deviation of the restorations fabricated using the functionally generated provisional restoration technique was 0.501 and 0.024 followed by the restorations of the double casting technique with the mean 0.516 and standard deviation 0.048 which is closer to the preexisting occlusion values of 0.461 and 0.067 whereas the conventional restorations showed a variation of mean value 0.753 and a standard deviation of 0.142. The overall comparison showed a significant variation of p value 0.009.

[Table 4] The multiple comparisons between the restorations with the preexisting occlusion on

protrusion reveals that the mean and the standard deviation of the restorations fabricated using the functionally generated provisional restoration technique was 0.571 and 0.034 followed by the restorations using the double casting technique with the mean 0.566 and standard deviation of 0.102 which is closer to the preexisting occlusion values of 0.496 and 0.073 whereas the conventional restorations showed a variation of mean value 0.720 and a standard deviation of 0.084. The overall comparison showed a significant variation of p value 0.015.

DISCUSSION

The objective behind making of any kind of occlusal restoration or prosthesis is the restoration of function and occlusal harmony with mandibular movements for the long term and efficient functioning of the stomatognathic system.[1] Group function occlusion is mostly beneficial in both removable and fixed prosthodontics but they demand usage of semi adjustable or fully adjustable articulators, but they cannot be equal to that of the patient's TMJ.[15]

In functionally generated pathway, it is considered that mouth is the best articulator and the functional occlusal registration obtained was free of errors. This technique may seem to be simple but proper understanding and execution of the technique is of utmost importance.

This technique uses a tracing made in the mouth to capture the pathways travelled by the opposing cusps in functional mandibular movements, rather than employing an articulator to simulate the movements of the mandible. In this situation, the articulator is reduced to the role of a simple hinge.[16,17]

As any advantage cannot be without disadvantages, the demerits of the technique is that FGP can be employed only for single missing teeth, short span bridges and inlays and it is not useful in cases of long span bridges.

Our study is based on evaluation of occlusal discrepancies between the fixed partial restorations fabricated by conventional technique and that which are fabricated by FGP by using T-scan. The parameters like clusion and disclusion time help us

in finding out this discrepancy by finding the deviation from normal range of values. Two methods were adopted in this study to achieve this purpose, one was by double casting technique and another was by using a provisional restoration placed in the patient oral cavity for 2 weeks and later on it was cast. It was concluded from the results that these two types of restorations had clusion time and disclusion times which were more closer to the normal range when compared with that of the restorations made by conventional technique. So it became evident from the study that use of Functionally generated path technique helps a lot in creating restorations with a natural touch.

Clusion time and Disclusion time was first defined by Kerstein and Wright for T-scan.

The comparatively decreased clusion and disclusion time (closer to the normal range) led to decreased time of contact of the teeth and their subsequent compression over the periodontium as well. This phenomenon led to decreased accumulation of lactic acid and allows adequate time for reoxygenation of the muscle fibers, thus the damage created to the teeth and its supporting structures is less.[18]

According to Zimmermann EM, functionally generated path is a "three dimensional static expression of dynamic tooth contact". Achievement of this harmony may seem to be a difficult task which requires the use of complicated gnathological instruments and materials.[19]

From this study it is found that the occlusal discrepancies after employing this FGP technique was very meagre and the time spend by the clinician and the patient is considerably reduced.

E Prashanti, Suresh Sajjan, Jagan Mohan Reddy, Accordingly, double casting technique is basically an error compensation step as it eliminates the inherent dimensional errors of indirect method.[16]

As any attempt to correct the occlusal discrepancies is irreversible, the method opted to do the correction is very deciding in determining the accuracy. According to M Reza Moini, the shortcomings like the influence of saliva, inability to store the data, non standardisation in thickness, strength of the marking substance etc are ruled out when T-scan was used.[20]

T-Scan is a computerised device introduced by William L. Maness, used to diagnostically quantify occlusal contacts in three new ways: balance plot, time display and comparison screen.[21,22] Our study is based on the accuracy of the results provided by T-scan. The T-scan systems measures the distribution of forces per tooth, both the halves of jaw and the center of force each time, thus the premature contacts and interferences in dynamic occlusion are identified easily.

In-Sung Yeo and Jae-HoYang, made a study where it is found that incorporation of group function

occlusion in fabrication of fixed partial dentures is not easy as it is difficult to achieve it by gnathologic instruments. Functionally generated path concept solves this problem easily where occlusal restoration of the prosthesis is customized to the patient's own occlusal patterns.[23]

In our study also functionally generated path concept gave better results on comparison with the restorations made by conventional technique.

Edalat MP, Khadjavi K, The authors suggested the use of acrylic crowns as a base to carry the FGP recording material.[5] In our study also, a similar methodology was adopted wherein a simple, accurate and time saving technique for the fabrication of a fixed partial denture in which both a provisional restoration technique and a one piece casting were assimilated.

Kafandaris NM, The functionally generated path was used to develop a functional core, which was utilized for constructing the interim restorations in acrylic resin. The interim restoration was inserted in the patient's mouth for 2-3 weeks to wear off any possible interference. In our study also the interim restoration was inserted in the patient's mouth for 2-3 weeks and casting was done directly.

Melvin A. Engelman, Curtis L. Engelman, Conducted a study where it is said that FGP harmoniously reproduces the occlusal surfaces with minimal chair side adjustments and avoids the need for counter models and adjustable articulators for construction of inlays, crowns and short span fixed partial dentures.[4] These results were in accordance with our study.

R. W. Wassell G. St. George R. P. Ingledew and J. G. Steele, Made a review on provisional restorations based on functions, materials and techniques. Their functions are comfort, positional stability, function, gingival health and contour, esthetics, diagnosis etc.[23] These ideal characteristics of provisional restorations were reproduced in the provisional restorations fabricated in our study.

Hajime Shirai, Jun-ichiSejima, Yuka Mantani, Conducted a study where patients with highly keen oral sensory complaints are restored with fixed partial dentures using double casting method. It is not only provides functionally generated occlusal path but also precise outline form adapting to the surrounding soft tissues.[24]

Satheesh B. Haralur, Within the limitations of the study, it can be concluded that the balancing side interferences and centric slide of more than 2 mm were found to have a strong association with TMD.[25]

In our study also, clusion and disclusion time was used to find out the occlusal harmony.

BogdanOprea, According to his study the use of the T-Scan III system provides a better quality in the dental treatments providing information at a level of accuracy not obtained by conventional methods.[26] In our study also T Scan III system was used as a guide to find out the interferences.

Kerstein, In his study it was found that combined right and left disclusion time were comparatively greater in cases of MPDS, Open occlusion, Orthodontic treatment.[17]

In our study also the most ideal restorations had comparatively least clusion time and disclusion times.

Kerstein, John Radke, This study concluded that the simultaneous recording of excursive function and muscle activity levels demonstrated the reduction in prolonged disclusion time creating a therapeutic effect in MPDS patients.[18]

In our study also, disclusion time was used as a parameter to find the occlusal discrepancies.

CONCLUSION

Thus it was finally concluded that the restorations fabricated using functionally generated path technique by double casting method and provisional restoration method simulated the preexisting occlusion more closely and the difference between the two types of restorations were not significant. This proves that the functionally generated path technique is very useful and can be used whenever the situations permit.

Further studies can be made by extending this study using a large sample size to rule out the variations involved in small sample size. One disadvantage observed in T-scan is that the markings obtained in the graph has to be transferred intraorally by manual methods, So further research in this aspect may be helpful to discover a marker which can be simultaneously used to make both intraoral and extraoral recording of discrepancies.

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