# A study of change in occlusal contacts and force dynamics after fixed prosthetic treatment and after equilibration – Using Tekscan III

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## Abstract

**Aim:** A study has been undertaken to evaluate the changes in occlusal force dynamics after conventional prosthetic rehabilitation.

**Materials and Methods:** In Phase I, the preprosthetic phase, force distribution of 50% ± 10% on either sides of arch in maximum intercuspation and disclusion time (DT) <1 s during mandibular excursions was attained in all patients using Tekscan before starting prosthetic treatment. Conventional procedures to replace missing tooth by fixed dental prosthesis were carried out. Occlusal corrections were performed using articulating paper to the satisfaction of operator and patient. In Phase II, postprosthetic phase, 1 week after cementation of the fixed partial dentures, the occlusal force dynamics were rerecorded and evaluated using Tekscan. Any corrections required were done to restore the equilibrium. Occlusal perception of patient before and after equilibration was recorded by means of a standard questionnaire both in pre- and postprosthetic phase. Twenty patients requiring replacement of a single posterior missing tooth were selected. The obtained values were statistically analyzed using Student's *t*-test.

**Results:** Subsequent to rehabilitation, the right–left balance of occlusal load was lost and DT was significantly increased. However, the subjective evaluation revealed no significant decline in occlusal comfort.

**Conclusion:** Null hypothesis was rejected. Operator's assessment of articulating paper marks and patient's occlusal perception is not reliable in restoring occlusal equilibrium.

**Keywords:** Disclusion time, fixed partial denture, occlusal force dynamics, occlusion perception, Tekscan

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## INTRODUCTION

During prosthetic rehabilitation, we aim to restore occlusal contacts to their original condition. Any mild alterations in force distribution are countered by subtle changes in stomatognathic system in order to adapt to the situation. However, beyond physiological limits of the individual,

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altered force dynamics trigger problems such as including sensitivity,[1] deteriorating periodontal condition, loss of implant osseointegration,[2] masticatory muscle pain, and temporomandibular disorders (TMDs).[3] This highlights the need for high accuracy in identifying and eliminating occlusal interferences.

Conventional procedure during correction of occlusal interferences guided by articulating paper relies on operator's interpretation of paper marks and patient's proprioception. The accuracy of these perceptions needs to be investigated. The aim of this *in vivo* study was subjective and objective analyses of changes in occlusal force dynamics post fixed prosthetic treatment, and post equilibration. Tekscan was used in precise analysis of force distribution across the arch and identifying prolonged disclusion time (DT). Null hypothesis was that conventional occlusal adjustments are reliable in attaining desired dynamics of occlusal forces during prosthetic treatment.

## MATERIALS AND METHODS

A total of 20 patients, referred to the department of prosthodontics, maintaining healthy periodontium with loss of single posterior tooth within 1 year from date of reporting were selected for the study. The sample size was determined based on the pilot study taking 95% confidence interval and 80% power, with the assumption that in 50% of participants, the occlusal forces will be in equilibrium after prosthetic rehabilitation. An error of 20% was expected. Sample size was calculated based on the formula $(Z\alpha + Z\beta) \times (pq)/(d)^2$.

The opposing teeth were ensured to be vital and unrestored. Age range of the participants was 22–58 years. Selected members had no history/clinical evidence of bruxism, TMD symptomatology, malocclusion, or orthodontic

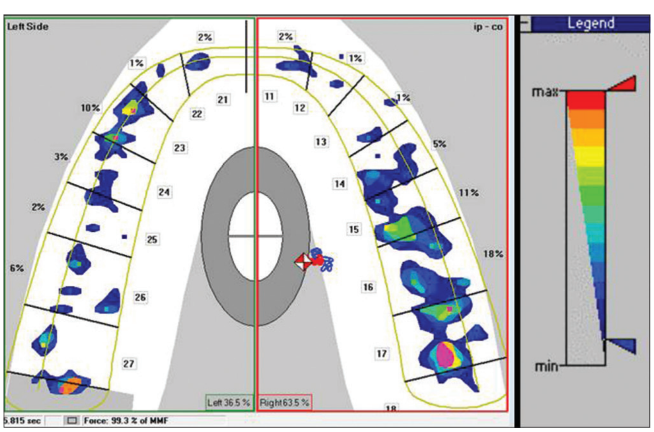



**Figure 1:** Force concentration zones in Tekscan two-dimensional force plot

therapy. Institutional ethical clearance was obtained for the study. Informed consent from the participants was recorded. Computerized real-time occlusal analysis system Tekscan has been used to analyze and equilibrate forces [Figure 1]. The standard questionnaire used in the study [Questionnaire 1] was formulated based on Horton's Questionnaire.[4] It was designed to measure (1) how well their teeth fit together, (2) their level of occlusal discomfort, and (3) chewing efficiency, during prosthetic rehabilitation.

### Data and examination procedure

Case history was recorded and diagnostic study models were mounted after facebow transfer (Whip mix, HANAU Spring-Bow) in maximum intercuspal position (MIP). Preoperative clinical photographs, Intra-Oral Peri Apical Radiographs of abutment teeth, and panoramic radiographs were made.

### Phase I – Preprosthetic phase

In this phase, recording and correcting force dynamics using Tekscan was done.

#### *Step 1*

Arch model in the system was customized according to the patient. Initial training procedures to occlude in MIP were practiced by the operator and the patient. Using Tekscan sensor (Tekscan, Inc., South Boston, MA, USA), with chair in semireclined position, uniform bite in MIP was recorded. Occlusal time (OT) from the 1st tooth contact till MIP was recorded. Location of the first tooth contact, its force content, and the length of time that it is premature to the rest of the occlusal contacts were viewed by incremental playback of force-time graph [Figure 2].

Occlusal contacts were marked with articulating paper 40-μm thick (Bausch Arti-Check; Dr. Jean Bausch GmbH and Co.). The articulating paper marks were correlated with the force concentration zones contained within the

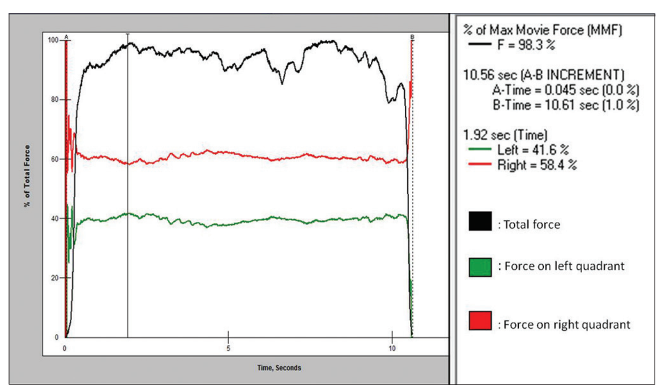



**Figure 2:** Incremental playback of force movie by moving the "T" line

two-dimensional Tekscan force plot [Figure 3]. The sum total of occlusal forces was viewed by observing center of force (COF) icon. The relative distribution of force between the right and left sides was indicated at the bottom of the arch [Figure 1]. Occlusal equilibration, guided by Tekscan force plot, was continued till

- The COF icon came within the target for COF, represented by white circle[3]
- Force on the right and left sides of arch each were within range of a 50% ± 10% of total occlusal load.[5,6]

### Analyzing disclusion time

DT was measured in MIP, right lateral excursion, left lateral excursion, and protrusive movement, using four-quadrant force-time graph [Figure 4]. Persisting contacts on nonworking side were identified precisely and corrected till DT was ≤1 s.[3] All the areas corrected during the equilibration procedure were smoothened with Enamel Adjustment Kit (SHOFU INC-Kyoto, Japan). After each occlusal correction, patient's occlusion was rescanned to view the resultant change in force dynamics.

Patient's response to the questionnaire was recorded before equilibration (Response-1) and after equilibration (Response-2).

#### *Step 5*

Tooth preparation was done under local anesthesia. Gingival retraction was performed and impressions were made with polyvinyl siloxane (Aquasil Ultra; Dentsply Caulk) impression material. Temporary fixed partial dentures (FPDs) were fabricated using indirect technique and were cemented with GC-free eugenol (GC Co, Tokyo, Japan).

Metal framework was casted with Ni-Cr alloy (Wirolloy, BEGO Germany Ref 50140 and Lot 12174). Hygienic pontic was preferred. Where esthetics demanded, modified ridge lap pontic was given. Connector size was 3 mm × 3 mm circular cross-section. Metal try in was done and required corrections were made. Ceramic build-up and firing was done. During bisque trial, occlusal contacts were evaluated using articulating paper. Required corrections were performed both in centric and during lateral and protrusive excursions till operator was satisfied and patient felt comfortable. Finishing of the metal-ceramic FPD, glazing, and polishing were done and the FPD was cemented.

### Phase II – Postprosthetic phase

At 1 week, recall changes in OT, DT, and occlusal force distribution were analyzed using Tekscan. Required corrections were performed to reestablish occlusal equilibrium. Response to the questionnaire was recorded before equilibration (Response-3) and after equilibration (Response-4). The same procedure was followed for all 20 patients. Tekscan data and patients' response to questionnaire were analyzed statistically using Student *t*-test.

The statistical tests used in the present study were paired Student *t*-test. Significance of difference in occlusal force distribution, DT, and patients' occlusal perception as a result of occlusal equilibration was analyzed. For statistical evaluations, $P < 0.05$ was considered statistically significant and $P < 0.001$ was considered highly statistically significant.

## RESULTS

Occlusal equilibration guided by Tekscan brought about significant harmony in distribution of forces in preprosthetic phase. In Phase I, (preprosthetic phase), 55% of patients had no equilibrium in the distribution of occlusal force [Table 1]. Among these patients, 90% showed greater occlusal load on intact half of the arch. Paired *t*-test conducted between the right–left balance of force after equilibration in the preprosthetic phase and 1 week into the postprosthetic phase showed significant differences in 70% of patient [Table 2]. Out of these, in 43% of patients, the occlusal load was increased on half of the arch rehabilitated with FPD. In the remaining 57% of patients, it was unanticipated to find that the occlusal load

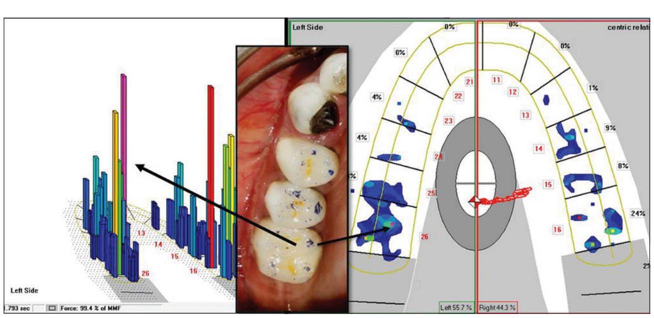



**Figure 3:** Correlating occlusal contacts marked with articulating paper with Tekscan force concentration zones

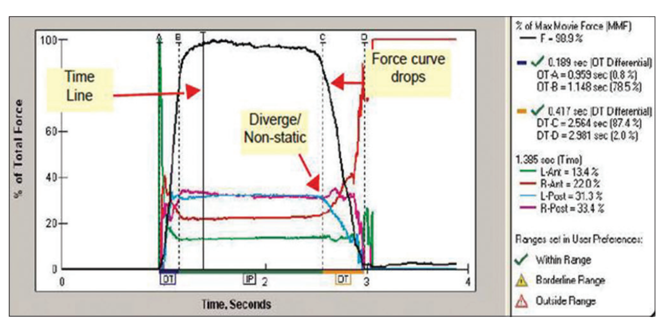



**Figure 4:** Force-time graph of a four-quadrant force plot during left lateral mandibular excursion

was increased on the intact half of the arch, compared to the rehabilitated side.

The DT was significantly high when quadrant with missing tooth was on nonworking side [Graph 1]. After prosthetic treatment, DT in general was seen to increase. The amount of increase was significantly high when prosthesis was on nonworking side.

Subjective analysis 1 week after prosthetic intervention showed negative response only to 27% of questions, indicating no significant decline in occlusal comfort [Graph 2]. Significant improvement in occlusal comfort and chewing efficiency was noted both after pre- and postprosthetic equilibration guided by Tekscan [Table 3].

## DISCUSSION

Research has shown that to achieve occlusal harmony the key ingredients are as follows:[7,8]

- Bilateral simultaneous contacts and equilibrated force distribution in MIP
- Immediate posterior disclusion during lateral excursions.

Accordingly, these two variables have been used to assess attainment of occlusal harmony in the present study.

In preprosthetic phase (Phase I), 55% of patients had no equilibrium in the distribution of occlusal force [Tables 1 and 2]. Among these patients, 90% showed greater occlusal load on intact half of the arch. These findings are not in accordance with the previous studies.[3,9] Higher percentage of patients having imbalance in occlusal load distribution can be attributed to change in chewing pattern and movement of teeth after extraction.

Numerous authors have found symmetry in distribution of the occlusal contacts between the right and left sides in healthy individuals.[3,5,6,10] The time moments and force moments of occlusal contacts in natural dentitions were also found to be symmetrical about the mid-sagittal axis of occlusal plane.[3,9] Taking into consideration, these findings occlusal equilibration were performed in patients with asymmetric force distribution. This ensured a baseline of 50% ± 10% force distribution on either side of the arch before prosthetic intervention.

One week into postprosthetic phase evaluation of occlusal force distribution using Tekscan revealed that 70% of patients had imbalance in force distribution between the right and left sides of arch [Tables 1 and 2]. Use of Tekscan revealed occlusal disharmonies in spite of corrections performed during cementation of prosthesis guided by articulating paper, till the patient and operator were satisfied.

In all these patients, premature contact was observed on the FPD. Hence, in patients who had increase force on the segment with FPD (30%), the reason can be attributed to the presence of premature contact. However, it was unanticipated to find increased force concentration on intact half of the arch in 40% of patients. In these patients also, the 1st contact was noted on area on the FPD. This premature contact could have led to deviation of mandible to an altered path of closure.

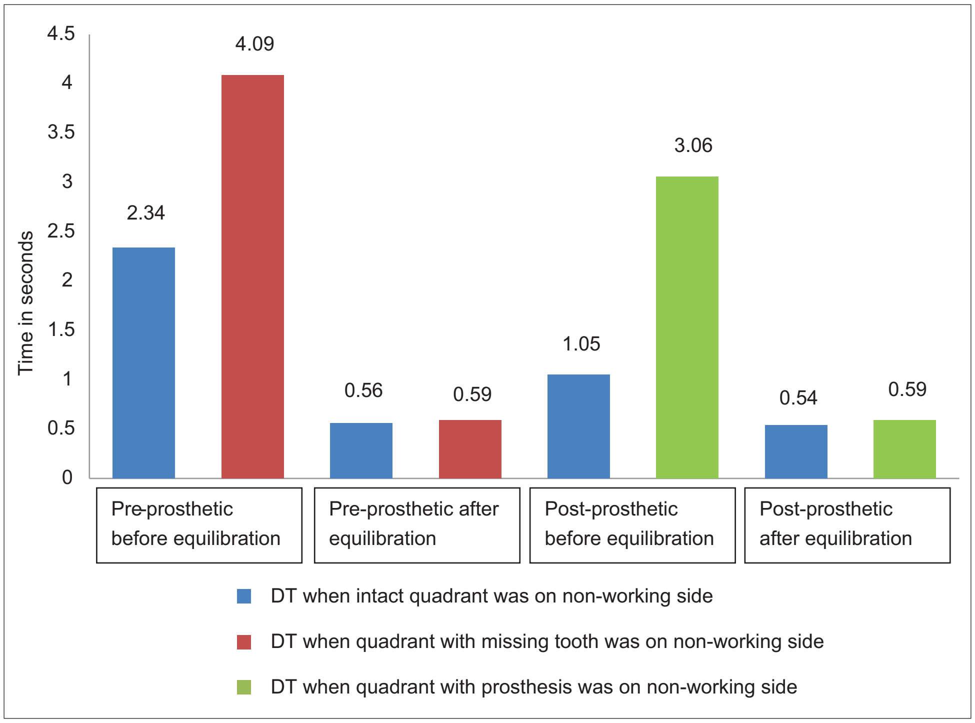
This imbalance of occlusal forces after prosthetic rehabilitation can be explained based on the inability of articulating paper marks to convey force concentration. It is also not possible to differentiate between early and late contacts using articulating paper. The corrections carried out depend also on patients occlusal feel feedback, which is quite variable.

Occlusal high points are said to be marked by articulating paper as a central area devoid of color, surrounded by dense peripheral rim of die. These marks are referred by different authors as "target," "bull's eye," or "iris."[11] Numerous textbooks of occlusion have advocated that the mark area is representative of load contained within the mark.[6,12] Large, dark marks have been advocated to indicate heavy occlusal load, and smaller, lighter marks have been advocated to indicate lighter loads.[13] The presence of many similar-sized marks on neighboring teeth is purported to indicate equal occlusal contact intensity, evenness, and time simultaneity.[12] These paper mark appearance perceptions have been trusted by practitioners as a basis to select contacts requiring correction. However, in the present study, correlation observed between articulating paper marks and Tekscan force concentration zones was

**Table 1: Mean relative force distribution on each quadrant (percentage) during four stages**

| Treatment phase | Quadrant | Percentage force±SD | | *t* | *P* |
|---|---|---|---|---|---|
| | | Before equilibration | After equilibration | | |
| Preprosthetic | On intact side | 42.60±13.94 | 49.70±4.94 | 2.291 | 0.034* |
| | On side of missing tooth | 57.40±13.94 | 50.30±4.94 | 2.291 | 0.034* |
| Postprosthetic | On intact side | 47.05±18.36 | 50.25±5.54 | 0.962 | 0.348 |
| | On side of fixed prosthesis | 52.95±18.36 | 49.75±5.54 | 0.962 | 0.348 |

*$P<0.05$ significant difference, SD: Standard deviation




**Graph 1:** Disclusion time changes during different phases of treatment

**Numerical data of Graph 1**

| | Preprosthetic before equilibration | | Preprosthetic after equilibration | | Postprosthetic before equilibration | | Postprosthetic after equilibration | |
|---|---|---|---|---|---|---|---|---|
| | DT when intact quadrant was on nonworking side | DT when quadrant with missing tooth was on nonworking side | DT when intact quadrant was on nonworking side | DT when quadrant with missing tooth was on nonworking side | DT when intact quadrant was on nonworking side | DT when quadrant with prosthesis was on nonworking side | DT when intact quadrant was on nonworking side | DT when quadrant with prosthesis was on nonworking side |
| Time (s) | 2.34 | 4.09 | 0.56 | 0.59 | 1.05 | 3.06 | 0.54 | 0.59 |

DT: Disclusion time

**Table 2: Comparison between patients with and without balance in distribution in occlusal load between the right and left halves of the arch before equilibration**

| Phase of treatment | Patients with balance in distribution of occlusal load | Patients without balance in distribution of occlusal load |
|---|---|---|
| Preprosthetic phase (Phase I), *n* (%) | 9/20 (45) | 11/20 (55) |
| Postprosthetic phase (Phase II), *n* (%) | 6/20 (30) | 14/20 (70) |

low. In many instances, a small mark corresponded to high force concentration. On the other hand, large, dark marks did not contain much force [Figure 3].

Some limitations have been observed in the previous studies using articulating paper. The reproducibility of marking points using articulating paper was low.[14] Saliva and moisture in the oral cavity reduce the accuracy of articulating paper marks.[11,15] There was no direct correlation between the articulating paper marked area and the applied occlusal load. Barely, in 1 out of 5 times did equal-sized marks describe equal loads.[16] It is also not possible to differentiate timing of occlusal contacts using articulating paper. In this study, problematic occlusal contacts were identified by computer force and time measurement. Articulating paper marks are used only to locate these problematic contacts. The paper mark size is not used as a force indicator. Hence, there is no subjective mark size interpretation to assess the correctness of occlusal endpoints.[9]

There is a controversy as to whether contacts on nonworking side during lateral excursions are to be removed or not. Effects produced by contacts on nonworking side during lateral excursions have been extensively studied. Earlier studies have reported signs and symptoms such as pain on mandibular movements, muscle tenderness to palpation,[17-20] tenderness to palpation of temporomandibular joints (TMJ),[20] pain on passive jaw opening,[20] tooth mobility, bone loss, pocket depth greater in teeth with nonworking side contacts,[21] symptoms of mandibular dysfunction,[22] increased electromyographic (EMG) activity of masseter and temporalis,[23,24] bruxism,[25,26] and reduced masticatory performance[27] as a result of contacts on nonworking side. Experimental study in monkeys showed that occlusal interferences caused increase in bone density at the condylar neck as measured by computed tomography scans. Higher density bone absorbs shock less effectively, placing greater demands on the disc and increasing the chance of disc breakdown.[5]

A previously published mechanism for the etiology of masticatory muscular hyperactivity is as follows: afferent mechanoreceptors of molar and premolar periodontal ligaments, when compressed by prolonged excursive tooth contact, activate excess contractions in masticatory muscles. Longer the time of excursive interferences, longer is the period that periodontal ligaments are compressed. Hence, masticatory muscles are activated to contract for a longer period of time. Therefore, prolonged occlusal surface engagement during both functional and parafunctional mandibular movements adds on excessive muscle contractions to the baseline contractions. In patients who are susceptible, this leads to clinical appearance of muscular hyperactivity and progression to symptoms of mandibular dysfunction.[9]

However, other researchers have found no correlations between nonworking side interferences and signs and symptoms of mandibular dysfunction.[28-31] From an epidemiological point of view, it is probable that some individuals are muscularly well adapted to occlusal interferences, while in others, there is a closer correlation between occlusal disturbances and mandibular dysfunction.[15] When contacts on nonworking side develop gradually (e.g., as a result of attrition) and do not act as interference to mandibular movements, there is greater chance that individuals get adapted to them.[15] Interferences that are developed all of a sudden (e.g., due to iatrogenic causes) are likely to result in deleterious consequences. Hence, they should be precisely identified and eliminated.

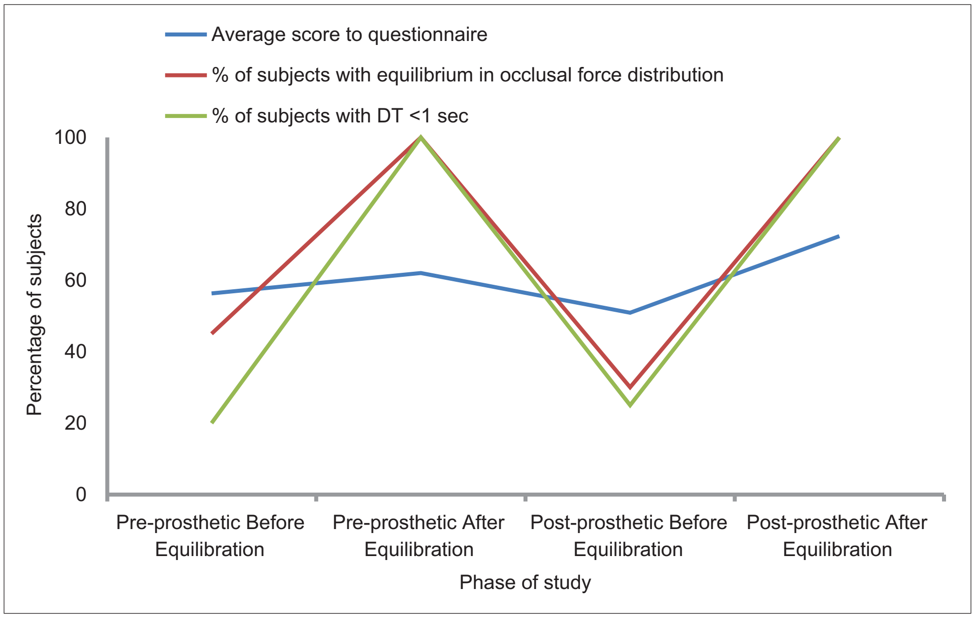
DT calculated by Tekscan is an indicator of the presence or absence of nonworking contacts and interferences. It is the elapsed time in seconds measured from beginning of a jaw movement made in one direction, when all teeth are in complete contact, until only teeth on working side contact [Figure 4].[24,32] The average DT when measured with Tekscan for normal individuals was 1.118 s; on the contrary, mean DT of myofascial pain dysfunction syndrome patients was 1.513 s.[33] Considering the previous studies, the acceptable range of DT was taken as 1 s for our study.

In the beginning of the study (Phase I), DT during lateral excursions of all selected patients was analyzed with help of Tekscan. In all patients, DT was outside the acceptable range (i.e., >1 s). Movement of teeth after extraction resulting in occlusal interferences may have increased DT. Statistically significant increase in DT from pre- to postprosthetic phase ($P < 0.01$) can be attributed to the inability of articulating paper marks to display duration of contacts during lateral excursions [Graph 1].

According to this study, considering patients' occlusal perception as a guide to attain occlusal equilibrium was not found to be reliable. Occlusal perception or tactile discrimination of a tooth is the function of periodontal mechanoreceptors. Spindle afferents from jaw-closing muscles and TMJ take up the function of perception sensitivity in case of the absence of periodontal ligament. Natural teeth have an interocclusal perception sensitivity of 15–30 μm.[34] The perception sensitivity of natural teeth opposing fixed dental prosthesis was estimated to be 63 μm and the perception sensitivity of fixed replacement opposing fixed replacement was estimated to be 66 μm.[16] Hence, restoration on coronal part of the tooth is seen to affect perception sensitivity. Few explanations put forward explaining this finding are changes in mechanical properties of a tooth after bonding rigid restoration to the tooth substance. Obturation of dentin tubule by restorations/crowns could be hypothesized to induce alterations in viscoelastic properties and the hydrodynamic flow of vital teeth. Trauma to the pulpal tissue related to treatment procedure was another contributing factors cited.[35] Hence, it is difficult for the patients to exactly perceive the occlusal interferences on the fixed dental prosthesis.

Prosthetic intervention resulted in marked loss in equilibrium in force distribution and increased DT. However, the patient did not complain of any discomfort at the end of prosthetic treatment. One week after cementation few patients felt a decline in chewing efficiency [Graph 2 and Table 3].

Repeated tapings by the patient during occlusal corrections can reduce occlusal perception sensitivity. Increased interocclusal discrimination threshold was observed for participants with a natural dentition after 30 min of intense chewing training. The authors did not, however, find any




**Graph 2:** Line diagram showing comparison of subjective and objective findings in different phases of the study

**Numerical data of Graph 2**

| | Pre-prosthetic before equilibration | Pre-prosthetic after equilibration | Post-prosthetic before equilibration | Post-prosthetic after equilibration |
|---|---|---|---|---|
| Average score to questionnaire | 56.36 | 62.05 | 50.95 | 72.39 |
| % of subjects with equilibrium in occlusal force distribution | 45 | 100 | 30 | 100 |
| % of subjects with DT <1 sec | 20 | 100 | 25 | 100 |

DT: Disclusion time

**Table 3: Comparison of patient's response before versus after prosthetic treatment in Phase I and before versus after equilibration using Tekscan in Phase II**

| Question number | Question | *P* Before versus after prosthetic treatment | *P* Before versus after postprosthetic equilibration |
|---|---|---|---|
| Q1 | Comfort on biting on teeth lightly | NS | NS |
| Q2 | Comfort while biting hard on back teeth in maximum intercuspation | Reduced 0.045* | Improved 0.0007** |
| Q3 | Comfort while biting on quadrant with missing tooth/FPD | Reduced 0.0006* | Improved 0.0000** |
| Q4 | Comfort while biting on intact half of the arch | NS | Improved 0.039* |
| Q5 | Even contact of back teeth when biting hard in maximum intercuspation | NS | Improved 0.033* |
| Q6 | Even contact of teeth when biting hard on quadrant with missing tooth/FPD | NS | Improved 0.0005** |
| Q7 | Even contact of teeth when biting hard on intact half of the arch | NS | NS |
| Q8 | Pain while biting down hard on back teeth in maximum intercuspation | NS | NS |
| Q9 | Pain while biting down hard on back teeth on quadrant with missing tooth/FPD | Increased 0.019* | Reduced 0.014** |
| Q10 | Pain while biting down hard on back teeth on intact half of the arch | NS | NS |
| Q11 | Sliding of back teeth when biting down hard | NS | Reduced 0.028* |
| Q12 | Pain/tenderness during chewing at jaw joint corresponding to quadrant with missing/restored tooth | NS | NS |
| Q13 | Pain/tenderness at jaw joint on side corresponding to the intact quadrant of the arch | NS | Reduced 0.032* |
| Q14 | Ability to chew tough food such as meat/chapathi with back teeth | Reduced 0.024* | Increased 0.047* |
| Q15 | Ability to chew fresh fruits such as guava and carrot with back teeth | NS | NS |

*$P<0.05$ significant difference, **$P<0.001$: Highly significant difference. NS: Not significant, FPD: Fixed partial denture

neurophysiological background factor completely explaining their results but speculated on fatigue of the receptor system as a possible explanation.[36] This may be another explanation as to why patients did not complain of discomfort even though all interferences were not removed following prosthetic intervention. The effect of equilibration procedure on patient's occlusal perception has not been extensively studied. When patients' response to standard questionnaire was recorded significant difference in response was observed for 60% of questions as a result of equilibration [Table 3]. The improved occlusal comfort of the patient may be due to the following reasons. The occlusal prematurities in centric have been removed and the force distribution across the arch has been equalized during occlusal equilibration. Hence, the patients would have felt a simultaneous and widespread contact bilaterally while occluding in maximum intercuspation ($P = 0.0007$); on the quadrant with FPD ($P = 0.0000$) and on the intact quadrant ($P = 0.039$). The reduction of slide ($P = 0.028$) when occluding can also be attributed to the same reason. Removal of interferences during lateral excursions may have been the reason of even contact perceived while biting on quadrant with FPD after equilibration ($P = 0.0005$). Nonworking side contacts FPD were present during lateral excursions. Prolonged contact will give feedback causing prolonged muscle contraction and increased strain on TMJ. Hence, pain/tenderness at jaw joint contra lateral to side being rehabilitated was reduced as a result of equilibration ($P = 0.032$). Points of force concentration on the FPD would have caused pain on maximum intercuspation. Articulating paper points could not convey these lengthy contacts to the operator. Tekscan helped in accurate identification of these points. Removal of these precise points alleviated the patients' pain ($P = 0.014$) [Table 3]. Tekscan-guided equilibration significantly improved occlusal comfort and chewing efficiency by equalizing force distribution across the arch and reducing DT.

### Further studies

1. Further studies on larger samples would help in analyzing the effects of equilibration and the maintenance of equilibrium after prosthetic interventions
2. Analyzing the EMG of masticatory muscles during equilibration would help in understanding effect of Tekscan-guided equilibration on the masticatory muscles.

## CONCLUSION

The null hypothesis was rejected. It was found that operators inference of articulating paper marks and patients perception are not quite successful in restoring occlusal force dynamics to a state of equilibrium. When these force dynamics are beyond physiologic limits, they result in deleterious consequences.

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### Conflicts of interest

There are no conflicts of interest.

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## QUESTIONNAIRE

### Questionnaire 1

1. Do you feel comfortable when you bite on your teeth lightly?/While swallowing

| | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

Very uncomfortable I feel comfortable

2. Do you feel comfortable when you bite down hard on your back teeth in maximum intercuspation?

| | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

Very uncomfortable I feel comfortable

3. Do you feel comfortable when you bite down hard on your back teeth in the right lateral position?

| | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

Very uncomfortable I feel comfortable

4. Do you feel comfortable when you bite down hard on your back teeth in the left lateral position?

| | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

5. Do your back teeth contact each other evenly when you bite down hard in maximum intercuspation?

| | |
|---|---|
| 1 | 2 |

No even contact Yes, even contact

6. Do your back teeth contact each other evenly when you bite down hard in right lateral position?

| | |
|---|---|
| 1 | 2 |

No even contact Yes, even contact

7. Do your back teeth contact each other evenly when you bite down hard in left lateral position?

| | |
|---|---|
| 1 | 2 |

No even contact Yes, even contact

8. Do you feel any pain when you bite down hard on your back teeth maximum intercuspation?

| | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

Very uncomfortable I feel comfortable

9. Do you feel any pain when you bite down hard on your back teeth in right lateral position?

| | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

Very uncomfortable I feel comfortable

10. Do you feel any pain when you bite down hard on your back teeth

Left lateral position?

| | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

Very uncomfortable I feel comfortable

11. When you bite down hard do you feel your back teeth slide?

| | |
|---|---|
| 1 | 2 |

Yes they slide No they don't slide

12. Do you feel pain/tenderness at the right jaw joint while moving the jaw

| | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

Very painful No pain

13. Do you feel pain/tenderness at the left jaw joint while moving the jaw

| | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

Very painful No pain

14. How well were you able to chew tough food like meat/chapatti/roti with your back teeth?

| | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

Cant chew well Chew very well

15. How well were you able to chew fresh fruits like guava/carrot with your back teeth?

| | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

Cant chew well Chew very well